2000s-11

The Asian Financial Crisis: The Role of Derivative Securities Trading and Foreign Investors

Eric Ghysels, Junghoon Seon

Série Scientifique
Scientific Series

CIRANO
Centre interuniversitaire de recherche en analyse des organisations

Montréal
Mars 2000

CIRANO

Le CIRANO est un organisme sans but lucratif constitué en vertu de la Loi des compagnies du Québec. Le financement de son infrastructure et de ses activités de recherche provient des cotisations de ses organisations-membres, d'une subvention d'infrastructure du ministère de la Recherche, de la Science et de la Technologie, de même que des subventions et mandats obtenus par ses équipes de recherche.

CIRANO is a private non-profit organization incorporated under the Québec Companies Act. Its infrastructure and research activities are funded through fees paid by member organizations, an infrastructure grant from the Ministère de la Recherche, de la Science et de la Technologie, and grants and research mandates obtained by its research teams.

Les organisations-partenaires / The Partner Organizations

- •École des Hautes Études Commerciales
- •École Polytechnique
- •Université Concordia
- •Université de Montréal
- •Université du Québec à Montréal
- •Université Laval
- •Université McGill
- •MEQ
- •MRST
- •Alcan Aluminium Ltée
- •Banque Nationale du Canada
- •Banque Royale du Canada
- •Bell Québec
- •Développement des ressources humaines Canada (DRHC)
- •Fédération des caisses populaires Desjardins de Montréal et de l'Ouest-du-Québec
- •Hydro-Québec
- •Imasco
- •Industrie Canada
- •Raymond Chabot Grant Thornton
- •Téléglobe Canada
- •Ville de Montréal

ISSN 1198-8177

The Asian Financial Crisis: The Role of Derivative Securities Trading and Foreign Investors*

Eric Ghysels†*, Junghoon Seon*‡

Résumé / Abstract

Nous étudions la crise financière asiatique et en particulier le marché coréen. Contrairement aux études précédentes, nous analysons le rôle des titres dérivés durant la crise et en particulier les transactions par des investisseurs étrangers. Nous démontrons l'impact négatif sur le marché causé par l'intervention de ces investisseurs.

This paper is part of a larger research program pertaining to the role of derivatives during financial crisis and also part of the research pertaining to the causes of the Asian financial crisis. The Korean market is studied because of two reasons: (1) it is a representative example of the Asian financial meltdown and (2) there is a detailed data set available of all transactions by different types of protagonists, including foreign investors. The paper begins with establishing first the role of derivatives securities during the crisis. Once the role of futures contracts is understood, the paper examines whether derivatives trading by either domestic or non-resident investors, or both together, exerted a destabilizing influence during the crash.

Mots Clés : Crise financière, titres dérivés

Keywords: Herding, feedback trading, futures

JEL: G10, G13, G15, G18

* Corresponding Author: Eric Ghysels, Pennsylvania State University, Department of Finance, 523 Kern Graduate Building, University Park, PA 16802 Tel.: (814) 865-7924 Fax: (814) 863-4775 email: eghysels@psu.edu

† Pennsylvania State University

‡ Pennsylvania State University

The role of derivatives during financial market meltdowns is still not well understood. The Brady Report, written by a Presidential task force in the wake of the October 1987 stock market crash, blamed trading in stock index futures for the financial crisis. According to the report, portfolio insurers tried to cover their equity exposure by 'mechanical, price-insensitive selling' stock market index futures. Their actions drove down futures prices and created arbitrage opportunities which led index arbitraguers to implement reverse cash-and-carry strategies, i.e. they bought futures and sold the underlying stocks. The dynamic interaction between portfolio insurers and index arbitraguers was lethal and caused a spiral downward tumbling of prices. The events of October 1987 were characterized by the Brady Report as a vivid example of the dire consequences derivative securities can have during a financial crisis.[1]

The Asian financial crisis is certainly not a carbon copy of the October 1987 crash. There are similarities and differences which make a comparison interesting. The most blatant difference is the role played by foreign investors. Not surprisingly, several authors, including Kim and Wei (1999), Park and Song (1999) and Radelet and Sachs (1998), have put the blame for the Asian crisis on foreign investors. In particular, Radelet and Sachs put financial panic as the main cause of the Asian crisis. They argued that the sudden pull-out of foreign investments exacerbated the crisis by causing a financial panic combined with policy mistakes by Asian government and International Monetary Fund. Along the same lines, Kim and Wei and Park and Song argue that the financial crisis in the East Asian countries, especially Korea, should in a large measure be ascribed to the panic reaction and herd behavior of foreign investors rather than economic fragility of those countries. Choe, Kho and Stulz (1999) refute the idea of market de-stabilization by foreign investors. They take advantage of a unique data set covering transactions by domestic and foreign investors on the Korean Stock Exchange (henceforth KSE). The KSE trading system is very similar to the Paris Bourse screen-driven market, studied by Biais, Hillion and Spatt (1995). The pure order-driven market makes identification of foreign and domestic traders easy, particularly since the former have to register before they are allowed to trade. Like many other Asian markets, the KSE experienced tumultuous times during the last quarter of 1997. With the widespread contagion of the crisis across Southeast Asia, the outflow of foreign funds started in August and continued until the IMF bail-out in December 1997. As the crisis affected the economy, the KSE experienced its most severe crash in its history.[2] Over a span of four consecutive business days, from October 24 to October 28, the KOSPI 200 market index, lost 20.72 % of its value.[3] The KSE crash is comparable to the Hong Kong stock market crash from October 20 to October 23 when the Han-Seng index drop 23.34 %,

[1]Much has been written about the Brady Report, both supportive and critical. For further details see Kleidon and Whaley (1992), Blume, MacKinlay and Terker(1989), and Santoni (1988).

[2]For an elaborate discussion of the Asian stock market crashes and economic fundamentals, see for instance Corsette et al. (1998).

[3]KOSPI stands for Korean Stock Price Index, the KOSPI 200 index represents the 200 most actively traded stocks in Seoul, which take up about 80 % of the total market value.

and the October 1987 NYSE crash with a one-day drop of 22.61 % of the Dow Jones Industrial Average.

This paper examines two questions. First, what was the role of derivative securities in the Korean stock market crash. Once the role of futures contracts is understood, we examine whether derivatives trading by either domestic or foreign investors, or both together, exerted a destabilizing influence during the KSE October 1997 crash. Despite the fact that futures and options markets are typically not as well developed in emerging economies, Korea had very active futures trading. Established only two years prior to the crisis, the market for the KOSPI 200 index futures contracts grew fast and established itself quickly. Moreover, in the Korean case, futures contracts had the appealing feature that foreign ownership restrictions were removed before the crisis.[4] Futures and options on the KOSPI 200 market index are traded on the KSE. The data collected from the electronic trading system enables us to investigate the pattern and impact of transactions by domestic (institutions and individuals) and foreign investors. Hence, similar to the equity trading study of Choe et al., we can identify the contracts bought and sold by domestic institutional and individual investors as well as non-residents.[5] One may wonder whether either foreign or domestic traders, like portfolio insurers during the 1987 crash, were net sellers of futures in a falling stock market with negative futures basis, and caused the same downward spiral effect on prices experienced a decade earlier in the U.S. and elsewhere. This paper is therefore part of a larger research program pertaining to the role of derivatives during financial crisis and also part of the research pertaining to the causes of the Asian financial crisis.

We begin by establishing the role of derivatives securities during the crisis. We follow closely the approach of Kleidon and Whaley (1992), Blume, MacKinlay and Terker (1989) and Santoni (1988), who examine futures trading during the October 1987 NYSE crash. At this first stage we do not make a distinction between domestic and foreign traders. We show that the fraction of KOSPI 200 futures volume started to rise dramatically in July 1997, three months ahead of the crash, and died out after the crash. Furthermore, we also report that selling pressures in the futures market during the crisis were transmitted to the cash market causing a decline in cash prices, a pattern which was not observed prior to the crisis. In particular, the first main finding in the paper is that futures trading was a contributing factor during the crisis. The basis, measured as the difference between the futures and cash prices, decreased dramatically and became negative during the Korean crisis, like it did during the October 1987 NYSE crash. Granger causality patterns between the cash and futures markets changed dramatically

[4]To be more precise, foreign ownership restrictions were removed for futures and options in July 1997, i.e. three months before the crisis. More recently, namely in May 1998, they were also lifted for equities. Choe, Kho and Stulz (1999) provide a detailed discussion of the restrictions which were in place for non-resident equity holders.

[5]We will use foreign investors and non-resident investors interchangeably. Strictly speaking, however, there are foreigners who reside in Korea and have to register to trade.

during the crash, namely there is unidirectional causality from futures to cash markets, both in terms of returns and order imbalances. This, and other evidence reported in the paper, leads us to conclude that trading in index futures played a significant role during the Korean stock market turbulence of 1997.

Having established the importance of derivatives trading, we turn next our attention to the role by foreign investors and examine whether they acted differently from domestic institutional and individual traders. Choe, Kho and Stulz (1999) examine buy and sell strategies of domestic and non-resident traders thoroughly and do not find any evidence supporting the idea that foreigners had a destabilizing effect during the crisis. To make a direct comparison between equity and futures trading we reexamine equity trading focusing exclusively on the 200 stocks of the KOSPI 200 index.[6] Many of the arguments put forward by the opponents of financial liberalization apply to equity as well as derivatives trading. For instance, the argument that foreign investors act like a herd applies to stock buy and sell strategies as well as the long and short positions in futures contracts. We examine whether there is herding behavior among foreigners as well as domestic institutional and individual investors in the futures market and compare this with equity trading. Next, we investigate whether there is any feedback trading by either type of investor and whether this destabilizing in nature. Finally, we study the price impact of trading in the futures and equity markets by all types of investors during and prior to the crisis.

When we examine the intra-daily patterns for each group of market participants we find that non-resident traders moved to the post-closing trading session of the equity market, where trading occurs with less price uncertainty and price impact compared to the regular trading hour sessions. Non-resident investors also increased their presence in the futures market. In contrast, Korean individual traders increased their share across all time intervals and across both cash and futures markets. Moreover, when we examine herding measures we find that during the KSE crisis the herding measures for equities increase for Korean individual and institutional investors, compared to their pre-crash levels, and decline for foreigners. Note that these results, obtained for the 200 KOSPI stocks, differ from those of Choe, Kho and Stulz (1999), since they find no evidence showing that herding is more important during the crisis. For futures trading we find the opposite to equity trading, namely foreign traders increase dramatically their herding. It is also interesting to note that for equities the level of herding before the crisis is roughly the same for Korean institutions and foreign investors (who are mostly institutions). In the futures market the herding of non-resident traders is significantly higher compared to domestic investors, both before and during the crisis. We also find that, for the period January-September 1997, foreign investors are positive feedback traders in both the cash and futures markets. During the same period, Korean institutions are sellers of equity irrespective of the previous day's market return and positive feedback

[6] Choe, Kho and Stulz (1999) considered a larger set of stocks, namely 414 of the 762 stocks listed on the KSE at the end of November 1996.

traders in futures while Korean individuals are negative feedback traders in stocks and sellers in futures regardless of the previous day's market return. During the KSE crash era, foreign investors are sellers in the stock market regardless of the previous day's market return and negative feedback traders in the futures market. Korean institutions, as a group, remain sellers of stocks regardless of the previous day's return and become negative feedback traders of futures. Korean individuals, as a group, also become negative feedback traders in the futures market while they become equity buyers irrespective of the market condition. Our findings differ from Kim and Wei (1999), who find that foreign institutional investors in Korea engage in positive feedback trading before, during and after the crisis and herd significantly more than their domestic counterpart. Kim and Wei use monthly data, while we use daily transaction-based series.

Herding and feedback trading measures rely exclusively on the direction of trades. A critical issue is also the price impact of trades. We therefore examine whether trades by non-resident investors had a destabilizing impact on prices and market returns and compare their trade impact with those of Korean individuals and institutions. We compute temporary and permanent price impacts for equities and futures, using real-time data. We find that the temporary impacts of sell price setting trades of foreigners slightly increase in equity markets and dramatically decrease in the futures markets but neither movements appear statistically significant. The evidence for permanent price impacts is far different. Here the price impacts of foreign traders on the futures market dramatically increase during the crisis. The permanent impact of futures sell price setting trades by Korean institutions, also increases during the crisis but the increase is far less dramatic.

The paper is organized as follows. In section I we examine the role of the futures market during the KSE crisis. In section II we describe the trading mechanism of the KSE in order to dissect and separate the influence of foreign investors. We also describe the nature of our data set and discuss stylized facts regarding trading in equities and derivatives by foreigner investors. In section III we compare the trading patterns of domestic and foreign investors. In section IV we analyze whether foreign and domestic traders herd and whether they pursue positive feedback trading strategies. For domestic market participants we make a distinction between institutional and individual traders. The impact of foreign investors on prices and market returns in both the stock and futures market is studied in Section V. Finally, Section VI concludes the paper.

I. Trading in futures and equities

We examine first whether index futures trading was a contributing factor to the Korean financial crisis. In particular, we will investigate whether there existed similarities between the cash and futures market during the 1987 NYSE crash and the Korean crisis.

The 1987 crash has been extensively studied. It is therefore useful to draw comparisons with this particular historical benchmark.

In addition to stocks, KOSPI 200 index futures and options are traded on the KSE. The underlying asset for both the futures and options contracts is the KOSPI 200 index, which is composed of the 200 most actively traded stocks on the KSE. At the time of the crisis, the KOSPI 200 futures contracts were traded on a liquid market with significant daily volume and open interest, even though it was introduced two years earlier.[7] We focus exclusively on futures contracts as trading in options on the KOSPI 200 index, established in June 1997, was still in its infancy during the crisis roughly four months later. The contract months for futures are March, June, September and December, and the longest maturity period is one year. The last trading day of each contract is the second Thursday of each expiration month. Figure 1 plots monthly averages of daily volume for nearest month KOSPI 200 contracts in 1997 and S&P 500 futures contracts in both 1987 and 1997 as a fraction of the trading volume of the underlying asset. Prior to July 1997 the KOSPI 200 futures-to-cash market volume was comparable to levels for the S&P500 futures and cash market during the 1987 crash year and 1997. After July 1997 the monthly averages in Korean markets soared far above levels observed for S&P 500 futures contracts. At the peak of the crisis the ratio exceeded 13 %, more than double the typical level find prior to the crisis (and levels applicable to S&P 500 futures markets).

It will be useful to summarize first some of the findings regarding futures trading during the 1987 NYSE crash. During the October 19 crash, the nearest month index futures basis, i.e. the difference between the futures and cash prices, fell dramatically below zero and prior to the crash it was also frequently negative. The negative basis is believed to be evidence of a disintegration between the cash and futures markets, since the basis is normally positive as a result of the short term interest rate exceeding the dividend yield on the underlying assets. The Brady Report argues that the financial panic observed during the crash is best explained by the so-called cascade theory. According to the theory, the dynamic interaction between portfolio insurers and index arbitraguers was repeated time after time causing a downward cascade in stock prices. Proponents of the cascade theory argue that their theory is supported by the negative basis during the crash. Many studies which attempted to explain the negative basis, including Kleidon and Whaley (1989) and Santoni (1988), do not agree with the idea that the negative basis itself supports the cascade theory. There are indeed several competing explanations for the negative basis during the 1987 NYSE crash. Firstly, Harris (1989) points to non-trading effects in the cash market as the main cause of the negative basis. The cash prices are measured by an index, an average of prices of all

[7] ¿From its incubation the trading volume of futures contract increased by 203.4 %. Comparable figures for the Nikkei 225 futures contract are 0.49 % (from 1988 to 1990), for the S&P 500 futures contract 106.96 % (from 1982 to 1984) and 191.82 % for the Han-Seng futures contract (from 1986 to 1988).

the stocks included in the index, while the futures prices are real prices. The indexes of cash market prices respond to new information more slowly than the futures prices since the observed prices of non-traded stocks remain stale. Part of the large absolute basis was therefore due to non-synchronous trading. Kleidon and Whaley (1989) find the cause of the negative basis in the physical order processing problem on the cash market during the crash. They examine whether the S&P 500 cash indexes and futures prices are serially correlated using data on 5 minute intra-day returns on October 19. They find that the S&P 500 cash indexes had strong serial correlation on October 19. Meanwhile, individual stock returns and the S&P 500 futures prices are not serially correlated. They believe that if the cascade theory is correct, then serial correlation in both the cash and futures price should be observed. Since they observe serial correlation only in the cash indexes, they conclude that the primary cause of market de-linkage lies in the cash market instead of the futures market. More specifically, they blame the physical order processing problems on the NYSE for the breakdown between markets. Finally, Blume, MacKinlay and Terker (1989) argue that the main cause of the de-linkage between futures and cash market is market illiquidity in the face of extreme selling pressure on stocks. They find that on October 19 the prices of S&P 500 stocks decline 7.4 % more than stocks not included in the index. By the morning of October 20, however, the S&P 500 stocks recover nearly to the level of the non-S&P 500 stocks. The trading volume of S&P 500 stocks exceed constantly the trading volume of non-S&P 500 stocks. All these facts, they maintain, were evidence that on October 19, 1987 there was greater selling pressure for index futures related stocks and the selling pressure drove prices of those stocks down more than warranted. They suggest the extremely high level of selling pressure on stocks might be associated with index arbitrage activities but do not provided evidence for this. They also find that there was a strong positive correlation between the 15-minute return and the aggregated net buying and selling pressure for S&P 500 stocks. The positive correlation between the S&P 500 stock returns and the aggregated net buying and selling pressure might be consistent with the cascade theory in which an order imbalance caused a price change and this price change in turn caused further order imbalance, and so on.

During the Korean financial crisis, we can also find a de-linkage between the cash and futures markets. The upper panel of Figure 2 plots both the daily KOSPI 200 index and the prices of the nearest month KOSPI 200 futures contracts. The lower panel of Figure 2 plots the basis defined as the differences between the two prices shown in the upper panel. We observe in Figure 2 that the basis falls below zero on October 20, 1997 and remains negative, with a few exceptions, throughout the rest of the crisis period. In Figure 3 we compare the basis during the 1997 KSE crash with that of the 1987 NYSE crash. To facilitate the comparison, we compute the basis as a percentage of the cash index, respectively the S&P 500 and KOSPI 200 index. While both market crashes experience a negative basis, it is clear from Figure 3 there is a striking difference between the two cases: the de-linkage between the cash and futures market during the

1997 KSE crisis is less dramatic but more persistent than during the 1987 NYSE crash. This difference came from the fact that the market confidence was restored quickly on the NYSE, while the crisis lingered on in the KSE case.

One main feature of the cascade theory is that declines in cash and futures prices are mutually perpetuating. This phenomenon is revealed in several ways. Firstly, price changes in each market are positively correlated with their own past. Secondly, changes in cash prices will be positively correlated with past changes in the price of futures contracts and conversely, i.e., changes in futures price lead to changes in cash price and vice versa. Finally, the above relationships should be observed only during the crash but not at other times as the efficient market theory suggests that: (1) changes in the price of futures contracts are not serially correlated even though intra-day cash prices are correlated due to non-synchronous trading effects, and (2) changes in cash prices do not lead to changes in futures prices while changes in futures price may lead to changes in cash prices. We examine whether the cash and futures prices are serially correlated, whether changes in futures prices lead to changes in cash prices and vice versa, and whether the relationships that exist across the two markets are unique to the crisis period. Firstly, we investigate whether current changes in cash or futures price are related to their own past. Table 1 reports Box-Pierce tests for the daily the KOSPI 200 cash and nearest month futures prices. The autocorrelations are reported for lags 1, 2, 3, 6 and 12 as well as the corresponding portmanteau tests which are χ^2 distributed with the degrees of freedom equal to the number of lags. We divide the entire sample period into four equal sub-periods. The first three sub-periods belong to pre-crisis period while the last is the crisis period. We can observed that none of the individual autocorrelations for index and futures returns are significant, while there is some evidence, based on the Box-Pierce statistics, that the cash index return is serially correlated, though only in the first sub-period (January-March 1997). Futures returns are serially correlated only during the crisis period (October-December 1997).

Next we examine whether the cash market leads the futures market and vice versa. Table 2 reports Granger causality tests for the cash and futures returns and order imbalances.[8] For the purpose of comparison, we divide again the entire sample period into four equal sub-periods and apply pairwise Granger causality tests.[9] Before the crisis there is no Granger causality, in neither direction, between futures returns and cash market order imbalances, futures order imbalances and cash returns. During the crisis Granger causality patterns changed dramatically. We observe unidirectional causal relationships between returns from the futures market to the cash market. Furthermore, changes in the futures order imbalances lead to changes in cash returns while changes in cash returns did not cause changes in the futures order imbalances. These results indicate that

[8]Details about the computations of the order imbalances will be provided later.

[9]The lag length for the tests was chosen according to the Akaike Information Criterion (AIC). Out of several commonly used criteria for lag-length selection, AIC outperform the others in hypothesis testing. See Thornton and Batten (1985) for more details.

selling pressures from the futures market are transmitted to the cash market, causing a decline in cash prices.

The results in this section clearly show that futures markets played a key role during the KSE crisis period. We find that futures prices were serially correlated and that there existed unidirectional causality from futures to cash markets, both in terms of returns and order imbalances. In addition, we also find that these relationships are not observed at other times, with the exception of the causation from the futures return to the cash return during the second and third quarter of 1997.

II. The Market Structure and the Data

So far, we have shown the importance of futures trading without identifying the main actors on the stage. In the remainder of the paper we try to identify who is responsible for trading in stocks and futures prior to and during the crisis. We need to elaborate first on the market microstructure of the KSE to pursue further our analysis. This section is entirely devoted to the description of the market and the data that is recorded.

The KSE is a pure order-driven market, like the Paris Bourse, where buy and sell orders compete for the best prices. Liquidity is provided by limit and market orders submitted by investors who buy and sell at the ask and bid prices set through previously placed limit orders or market orders.[10] Both limit and market orders are continuously fed into the Automated Trading System (ATS) which is a matching scheme satisfying supply and demand according to price, time, customer and size priorities. In addition, a call trading system is used at market opening and closing. Since all the security trading on the KSE is fully computerized, transactions are executed promptly and are recorded completely. The market microstructure of equity trading also applies to derivatives trading, with the exception that only limit orders are allowed in the KSE futures and options markets.

The trading hours of stocks in the KSE are divided into three sessions: the morning, the afternoon and the post-closing session. The former is from 9:30 until 11:30 AM. The afternoon session starts at 1 PM and ends at 3 PM whereas the post-closing session

[10]More specifically, the KSE is a pure order-driven market which has neither formal dealers nor specialists. The NASDAQ and the NYSE are classified respectively as a quote-driven market and a hybrid of order-driven and quote-driven market. The KSE and Tokyo Stock Exchange (hereafter TSE) have no liquidity-provider of last resort. Moreover, the KSE has no exchange-designated agencies unlike the NYSE or the TSE. On the NYSE, exchange-designated specialists have affirmative obligation to provide continuous liquidity and to maintain a limit order book with the public's limit orders. The TSE has exchange-designated intermediaries (saitori) who collect limit orders and match limit and market orders but have no obligation of market making. For more details on the institutional structure of the TSE, see Lehmann and Modest (1994) and Hamao and Hasbrouck (1993). The KSE market microstructure is discussed in Choe, Kho and Stulz (1999).

operates from 3:10 through 3:40 PM. The post-closing session has a special character distinct from the morning and afternoon regular trading sessions. The post-closing session only features equity trading and was introduced on November 25, 1996 to provide investors with additional opportunities to trade stocks after the close and facilitate trading block orders by institutional investors. This session also features limited price discovery since the price of paired block orders can be negotiated within two ticks from the closing price of the day. The trading hours of futures in the KSE are same with those of stocks except two things: the afternoon session ends at 3:15 PM and there is no post-closing session for futures. The KSE sets a daily price movement limit to cap excessive price fluctuations. Stock and futures prices cannot move in excess of a certain percentage above or below the previous day's closing price. During the Korean financial crisis period, the limit was 8 %, 7 % respectively for stocks and futures. In our sample period, the KSE was also open for trading on Saturdays but with shorter trading hours. For this reason we excluded Saturdays from our sample. We can classify investors active on the KSE into the following three groups: Korean individuals, Korean institutions and foreign investors. Foreign investors are required to register with the Financial Supervisory Commission. In 1997, there were a total of 6,514 foreign investors from 66 countries registered, of which 4,514 (69.3 %) were institutional and the remaining 2,000 (30.7 %) were individuals. Consequently, it will be more meaningful to compare foreign investors with Korean institutional traders. Choe, Kho and Stulz (1999) discuss in detail the Korean government restrictions which apply to both individual and aggregate foreign investment in stocks and derivatives. According to the restrictions, stock holdings cannot exceed a certain percentage of the total outstanding shares of each company and cannot exceed the average daily open interest for the last three months for futures. In July 1997, right before the crisis, the aggregate ceiling for the derivatives was removed, even though the individual ceiling was not changed. Individual contract restrictions remained in place until May 1998 when all types of ownership restrictions were completely removed. The relaxing of restrictions on holding derivatives obviously provided extra incentives for foreign investors to trade futures and options instead of stocks during the Korean crisis. In Table 3 we report the percentage upper bounds on aggregate and individual foreign ownerships. While these restrictions were gradually removed after the Asian financial crisis, we note from Table 3 that throughout the crisis, the aggregate ceiling for equities ranged from 20 % to 26 % and from 5 % to 7 % for individual foreign investor ownership.

For our analysis we use real-time data of trades in all stocks comprised in the KOSPI 200 and the KOSPI 200 index futures contracts from January 3 to December 26, 1997, a sample period which brackets the crash from October 24 to October 27, 1997. Each record in our data set provides detailed information on orders and transactions: the time stamp, size and type of each order, bid or offer price, the country of residence and type of buyers and sellers. Henceforth, we will divide the entire sample period into two sub-period: before the crisis (January-September 1997) and during the crisis period (October-December 1997). The source of our data is the same as Choe et al. (1999)

who provide specific details we omit here. However, as noted before, we do not examine all the stocks used by Choe, Kho and Stulz. Instead, we synchronize equity trading with futures and therefore focus exclusively on the 200 stocks in the index. In addition, we aggregate all activity in stocks and characterize it as equity trading. Moreover, for futures we consider only the nearest month contract at any time, since it has the most liquidity.[11]

III. Domestic and Foreign Trading Patterns

Korean individuals take respectively a 65 % and 25 % share in KOSPI 200 equities and futures volume prior to the crisis. During the crisis period, their share in equities and futures trading volume increases to 68 % and 50 % respectively. Korea did not have a well developed financial services sector. In particular, hardly any contract-type mutual funds existed which explains why Korean individual investors took the lion's share of equity trading volume. Figure 4 shows the share of the trading volume of foreign investors relative to total buy and sell volume in the cash (KOSPI 200 stocks) and futures markets. For the 200 equities, volume by foreign investors takes up roughly a 10 % share of total volume. Right before the crisis, i.e. in September 1997, their share in sell volume soars to 22 %, while their share in buy volume increased slightly. During the first two months of the crisis period, October and November 1997, the fraction of sell volume initiated by non-resident market participants remains high while the fraction of their buy volume continues to decrease. In contrast, from the lower panel in Figure 4 we note that there is a steady increase of the futures sell and buy volume attributed to non-resident traders during the same period.[12]

In Figure 5 we plot the monthly averages during 1997 of net buy volume for all KOSPI 200 stocks and for the nearest month KOSPI 200 futures contracts. The top panel covers equity trading, the lower panel covers futures. Each panel displays the three categories of traders, domestic institutions/ individuals and foreign investors. Positive values indicate net buy volume, whereas negative values reflect net sell volume. During October 1997, when the KSE suffered its severest market crash, both foreign investors and Korean institutions were net sellers for both equities and futures. The cash and futures market curves of foreign net trading volume show a steady downward trend until October, meaning ever increasing net selling. This trend dramatically reverses in both markets after October 1997. During the crisis the net selling volume of foreign investors was greater than that of Korean institutions. Meanwhile, Korean individuals were net

[11] The nearest term contract changes maturity at the end of the first week of the expiration months, namely March, June, September and December.

[12] We exclude December 1997 from this consideration since a new March 1998 contract was introduced on December 8, 1997. The share of buy volume, in particular, appears to have a cycle which is associated with the roll-over effect of nearest month futures contracts.

buyers. In the equity markets there is a clear upward trend starting mid-year and climbing almost without interruption until December 1997. In the futures market the picture is more dramatic, as shown in the lower Panel of Figure 5. There is essentially a spike in October 1997, namely the net selling by foreign investors and Korean institutions are exactly offset by a huge surge of net buying of Korean individuals.

The combination of the evidence in Figures 4 and 5 clearly reveals that net selling by non-resident investors on both markets starts to increase several months before the crisis and keeps increasing until October 1997, when the KSE experienced its severest market crash. The fact that the share of foreign sell volume was increased and foreign investors were net sellers of equities and futures during the crisis period reminds us of portfolio insurers during the October 1987 crash who were believed to initiate, in conjunction with index arbitrageurs, the vicious cycle of price declines. However, we can draw any firm conclusion at this stage, since we only examine monthly averages which reveal a very partial aggregate picture.

We turn our attention now to intra-day trading patterns. In particular, we examine whether the intra-daily trading patterns for each group of market participants have changed during the crisis. We divide a typical day of trading in stocks into eight relatively homogeneous time slots. We will denote by $TS1$ the morning-session opening batch auction, whereas $TS2$ (9:30-10:30) and $TS3$ (10:30-11:30) cover the morning-session continuous trading periods. Similarly, we denote by $TS4$ the afternoon-session opening batch auction, while $TS5$ (13:00-14:00) and $TS6$ (14:00-14:50) are the afternoon-session continuous trading time slots. Finally, $TS7$ is the closing batch auction and $TS8$ (15:10-15:40) is the post-closing trading session. Since there is no post-closing trading session in the futures market, we have samples for $TS1$ through $TS7$. $TS6$ for futures is from 14:00 to 15:05 since the futures market closes at 15:15 and there are no trades during the last 10 minutes before the closing batch auction. Table 4 reports descriptive statistics of the intra-day share of trading volume for each type of market participant. Table 4 also reports the t-test statistics for the differences in means of the shares before and during the crisis. Figures 6 and 7 show for each class of traders the intra-day volume share averaged before and during the crisis period, for all stocks in the index and for the nearest month index futures contracts. Table 4 Panel A and Figure 6 show that there are important differences before and during the crisis, between the intra-day trading pattern for equities. From Figure 6 we note that the share of Korean individuals increases for all the continuous trading time slots, i.e. $TS2$, $TS3$, $TS5$ and $TS6$, while their share in the post-closing session decreased. The statistics reported in Panel A of Table 4 confirm that the increases are also statistically significant. Some of the increases are also large in economic terms. The mean of the volume share of resident individual traders increases from 68.1 % to 76.6 % and from 65.6 % to 73.3 %, respectively during the two morning $TS2$ and $TS3$ sessions. The median changes are similar. In the afternoon continuous trading sessions the increases are not so dramatic, though they remain statistically significant. Meanwhile, the share of Korean institutions decreased for all time slots

except the post-closing trading session. The decreases reported in Panel A of Table 4 are again economically very significant. In the morning continuous trading sessions the mean shares are almost cut in half, dropping for instance from 21.6 % to 13.5 % in $TS2$. Again, during the afternoon the drops are less dramatic in absolute terms, though still statistically significant. The median decreases are of the same magnitude as the means, which indicates a fairly symmetrical shaped distribution of volume share. The last set of statistics reported in Table 4, Panel A, confirm the results in Figure 6, namely that during the crisis period, the share of foreign investors increased only in the closing batch auction and post-closing trading session where trading occurs with less price uncertainty and price impact compared to the regular trading hour sessions. Particularly, in the $TS8$ session there is a dramatic increase, the mean share almost doubles from 15.3 % to 28.1 %. For the median the ratio triples from 6.9 % before the crisis to 28.1 % which is almost a third of the trading volume.

Table 4 Panel B and Figure 7 show that for futures markets, there are also important differences between intra-day trading patterns before and during the crisis. The share of Korean individuals increased across all time slots. The increases are again dramatic, the mean and median shares basically double from 25 % to 50 % throughout the entire day. The largest relative and obsolete decreases in mean and median shares are observed for Korean institutions. Before the crisis Korean institutions are the dominant players in terms of volume in futures contracts. This leading role was overtaken by Korean individuals with about half of the volume throughout the day. The share of foreign investors also increased for all continuous trading periods, i.e. $TS2$, $TS3$, $TS5$ and $TS6$.

The results in Figures 6 and 7 and Table 4 clearly indicate that non-resident traders moved to the post-closing session of the equity market and, as was shown in Figure 4 as well as Table 4, increased their presence in the futures market. Korean individual traders increased their share across all time intervals and across both cash and futures markets. The spike in net buying, shown in the lower panel of Figure 5 and the statistics in Table 4, revealed that Korean individual traders also ranked first in share of volume in the futures market during the crisis, a position which was taken by Korean institutions before the crisis. Since non-resident traders are mostly institutions, it is interesting to note the differences in the response of institutions, non-resident and domestic, during the KSE financial crisis. Domestic institutions basically reduced their presence on the futures market. Foreign investors and Korean individuals did precisely the opposite.

IV. Herding and Feedback Trading

The behavior of U.S. institutional investors features positive feedback trading and herding, according to evidence documented in Nofsinger and Sias (1999) and Wermers (1999).

Kim and Wei (1999), among others, also argue that foreign investors in emerging markets, most of whom are institutional investors, follow feedback strategies similar to their domestic market behavior. They investigate the behavior of foreign institutional investors around the Asian crisis using monthly Korean share holdings data and find that foreign institutional investors engage in positive feedback trading before, during and after the crisis and herd significantly more than their domestic counterpart. Furthermore, they suggest that foreign investors' positive feedback strategies combined with their herding behavior might have exacerbated or even caused market crashes during the Asian financial crisis. Choe, Kho and Stulz (1999) examine trading strategies of foreign investors on the KSE using transaction-level data and find no evidence showing that herding is more important during the crisis. In addition, there appears to be no clear evidence of positive feedback trading by foreign investors during the crisis, while before the crisis there is. Their analysis focuses exclusively on equity trading. Given the significance of futures trading we complement their analysis by examining herding and feedback futures market trading for each type of investors.

Herding is trading by a group of investors in the same direction over a certain period of time (the herding interval).[13] Like Choe, Kho and Stulz (1999), we take the narrow and simple view of herding that is prevalent in the empirical literature. Namely, we regard that a group of investors herd if they move together over the span of a single day. As noted by Lakonishok, Shleifer and Vishny (1992), herding itself does not necessary exert a destabilizing effect on the market. If a group of investors with better information than others form a herd in buying undervalued stocks and in selling over-valued stocks, then their herding behavior will stabilize the market by moving prices toward fundamental values. To examine the importance of herding for each type of investor, we calculate herding measures for equities (using only KOSPI 200 stocks) and futures (using nearest month KOSPI 200 futures contracts) following the method proposed by Lakonishok, Shleifer and Vishny (hereafter LSV). In particular, the herding by group i on day t is measured as:

$$H_{it} = \left| \frac{B_{it}}{N_{it}} - P_{it} \right| - E\left[\left| \frac{B_{it}}{N_{it}} - P_{it} \right| \right] \tag{1}$$

where $\mathrm{B}_{it}/\mathrm{N}_{it}$ is the observed ratio of buys to trades by group i on day t and P_{it} is the expected value of the ratio of buys to trades by group i on day t. Since P_{it} is a population quantity, we need to calculate its sample counterpart. As a sample estimate of P_{it} for equities, we use the portion of buys relative to the total transactions by group i for *all* stocks traded on day t. As a sample estimate of P_{it} for futures, the same ratio with equities is used to make comparisons with the measures obtained from equities trading. The first term in this measure will be larger if the trading by group i is polarized on either the buy or sell side of the market. The second term is an adjustment factor, which accounts for the fact that the mean of the first term is always greater than zero due to

[13] Nofsinger and Sias (1999) provide more details about the definition of herding.

the absolute value. The adjustment factor is computed under the assumption that B_{it} follows, in the absence of herding, a binomial distribution with probability P_{it} of success.

We compute the herding measure (1) each trading day for equities and futures separately and take averages before and during the crisis period. Table 5 Panel A reports herding measures for equities while Table 5 Panel B covers futures. The herding measures in Table 5 Panel A reflect how much each group's trades of KOSPI 200 stocks is tilted towards either buying or selling. The herding measures for stocks reported in Table 5 are substantially lower than those find by Choe et al. Our findings, which range between 1 % and 5 % are comparable to the results find by Wermers (1999) for herding among mutual funds in the U.S. (except for small stocks). Choe et al. report measures of at least 20 % for different size portfolios. The differences in results are due to two reasons: (a) we study the entire portfolio of 200 KOSPI stocks, whereas Choe et al. compute the measure in (1) for individual stocks and report averages and medians of individual stock herding measures across size-sorted portfolios and (b) the herding measure (1) is not invariant with respect to portfolio formation.[14] We prefer to report herding measures for the entire portfolio of the 200 KOSPI stocks in order to make comparisons with the measures obtained from futures trading.

During the KSE crisis the herding measures for equities increase for Korean individual and institutional investors, compared to their pre-crash levels, and decline for foreigners. The changes are strongly statistically significant. Note that the direction of herding measure changes obtained for the 200 KOSPI stocks also differ from those of Choe, Kho and Stulz (1999), since they find no evidence showing that herding is more important during the crisis. The herding measures reported in Table 5 Panel B indicate how much each group's trades for nearest month futures contracts compare to its trading activity for all stocks. The magnitude of the herding measures for futures are much larger compared to the results in Panel A for equities. Herding among foreigners is strongest and even increases during the crisis. Only the herding of Korean individuals, which is the weakest, remains the same during the crisis. The t statistics in the last column of Table 5 reveal, that the movements are statistically significant except for the minor decline of herding in the futures market among Korean individuals.[15] It is also interesting to note that for

[14] An illustrative example may show this. Consider a portfolio of two stocks and assume the expected ratio of buys to trades by a group of investors to be 0.5. Furthermore let the observed ratio Buy/Trade for the first stock be 9/10 and for the second stock be 1/10. A portfolio of both stocks has therefore a Buy/Trade ratio of 10/20. It is easy to show that the averaged herding measures of two individual stocks is 0.3961, whereas the herding measure for the portfolio is zero. It should also be noted that our measures are not directly comparable with those of Wermers (1999), since he studies quarterly sampling frequencies.

[15] It is worth noting at this point that one might have some reservations about the validity of the t statistics reported in Table 5. As noted by Wylie (1998), the LSV test of herding may be imperfect for several reasons. Firstly, since H_{it} is computed using the sample estimate of P_{it}, the mean of H_{it} may not be equal to zero. Under such circumstances the standard the Central Limit Theorem is not applicable and statistical tests are not valid. Secondly, short sale restrictions, which are implicitly ruled

equities the level of herding before the crisis is roughly the same for Korean institutions and foreign investors (who are mostly institutions).

Having examine herding measures, we turn our attention now to the analysis of feedback trading. Theoretical models, along the line of DeLong et al. (1990), show that the presence of positive feedback traders can make rational speculation destabilize the security market as against the prediction of market efficiency literature. Cutler et al. (1990) showed that profitable speculation can raise the variance of returns relative to the variance of shocks to fundamental values in the futures market. If positive feedback traders exist in a market and their trading behavior is expected by rational speculators, rational speculators will not counter the irrational price movement by positive feedback traders. Instead, they will hop on the bandwagon and thus will form a herd with positive feedback traders. Their behavior will drive prices further away from fundamentals and thus increase the volatility of the market. Balduzzi et al. (1995) investigate the effect of on asset price dynamics of positive and negative feedback trading using a multi-asset model in which stocks and bonds are traded by two types of agents: speculators and feedback traders. They find positive feedback strategies make stock returns more volatile while negative feedback strategies decrease the volatility of stock returns. To investigate whether each group of investors choose positive feedback strategies in both the cash and futures market, we define a measure of order imbalance, namely price-setting order imbalances ($PSOI$). Trades on the KSE can be divided into two categories: buy price-setting trades, and sell price-setting trades. A buy (sell) price-setting trade is defined as a trade where the buy-side (sell-side) comes after the sell-side (buy-side) and thus the former makes the trade possible. Price-setting trades we can only considered during the continuous trading periods. This may slightly bias our results as we reported in Table 4 a shift of non-resident traders to the post-closing session during the crisis. The PSOI of group i (for a stock or futures contract) on day t, denoted $PSOI(i,t)$, is computed as the price-setting buy volume of i on day t minus the price-setting sell volume on the same day by the same group of investors normalized by the daily average price-setting volume for group i (across all assets - equity or futures) during the entire sample period. It should be noted that the definition $PSOI(i,t)$ differs slightly from the order imbalance measure used by Choe et al. The numerator is the same, the denominator differs. Choe et al. normalize by the daily average price-setting volume for group i for each stock, while we compute the normalization across all assets - equity or futures. We did this on purpose to accommodate the more erratic behavior of futures trading. Since the normalization is merely a scaling factor this difference is inconsequential. A positive (negative) sign of $PSOI(i,t)$ indicates net buying (selling) pressure of group i on day t. The magnitude of $PSOI(i,t)$ shows the strength of net buying or selling pressures compared to an average day during the sample period. In Table 6 we report the means

out in the LSV measure, imply a left truncation in the distribution of B_{it} and therefore invalidate the binomial distributional assumption. Moreover, the distribution of B_{it} can be misspecified, even in the absence of herding.

of price-setting order imbalances in the cash and futures markets conditional on the sign of the previous day's market return since this indicates whether a group of investors are feedback traders. If a group of investors show net buying (selling) pressure following a positive market return and show net selling (buying) pressure following a negative market return, then they will be classified as positive (negative) feedback traders. In addition to the $PSOI$ measure we also report three types of t statistics. Namely, we test whether there are significant differences in the means of $PSOI$ measures across the major categories of participants in the market (i.e. across i), we also test whether there were any structural shifts during the stock market crisis and finally we test whether the means of $PSOI$ measures conditional on the previous day's return differ.

The results in Table 6 clearly indicate that, for the period January-September 1997, foreign investors are positive feedback traders in both the cash and futures markets. The $PSOI$ measures have the same sign as the market return on the previous day, hence foreign traders buy equities or futures contracts following a positive market return and sell following a negative market return. During the same period, Korean institutions are sellers of equity irrespective of the previous day's market return and positive feedback traders in futures while Korean individuals are negative feedback traders in stocks and sellers in futures regardless of previous day's market return. We also note from Table 6 that the magnitudes of the PSOI measures are much larger for non-resident investors, particularly on the derivatives market (with one exception, Korean institutions after a market decline). The t statistics comparing the means across the three classes of investors are nevertheless mostly insignificant or borderline.

During the crisis, foreign investors are sellers in the stock market regardless of previous day's market return and negative feedback traders in the futures market. Korean institutions as a group remain sellers of stocks regardless of the previous day's return and become negative feedback traders of futures. Korean individuals, as a group, also become negative feedback traders in the futures market while they become equity buyers irrespective of the market condition. Table 6 also reports t statistics comparing the means between the pre-crisis and the crisis period. For all types of investors, the absolute value of the $PSOI$ measures for equities show significant increases during the crisis (with one exception). The t statistics for individual investors are 0.28 and 3.17, respectively for days with positive and negative market returns, which indicates that during the crash individuals as a group bought equities significantly more, compared to the pre-crisis sample, after negative market returns. Meanwhile, Korean institutions and foreign investors sell significantly more than before regardless of the market return. The absolute values of the $PSOI$ measures for futures, however, increase significantly only for days with positive futures market returns across all investors. It should parenthetically be noted that our results differ from Choe et al. (1999)'s study. They find that Korean individuals are positive feedback traders in the stock market both before and during the crisis.

Portfolio insurers typically follow positive feedback strategies while index arbitraguers follow negative feedback strategies. During the crisis we find no evidence of such strategies. In particular, we find that all investors are negative feedback traders in the futures market and none of the groups we can identify are involved in equity feedback trading. This result suggests that we cannot find evidence of dynamic interactions between portfolio insurers and index arbitraguers in both the futures and cash market during the stock market turbulence, at least for the classification of traders we use. In that respect the KSE crisis is not a carbon-copy of the NYSE 1987 crash.

V. The Price Impact of Foreign Investors on the Market

As a last piece of the puzzle we would like to examine the price impact of trades. Thus far, we only examine the direction of trades either via herding measures or via the PSOI measure. We know from the results reported in Table 4 that foreign investors had a tendency to trade more during the post-closing trading session of the equity market, where trading occurs with less price uncertainty and price impact compared to the regular trading hour sessions. In this section we focus on the price impact of trades by non-resident and Korean investors during regular continuous trading hours.

We examine whether trades by non-resident investors had a destabilizing impact on prices and market returns and compare them with Korean individuals and institutions. We compute temporary and permanent price impacts of trade for equities and futures, using the real-time data. Note that we have chosen a slightly different approach from Choe et al. who use two distinct event studies. In the first they measure abnormal returns for eleven 5-minute intervals centered around large trades by foreign market participants. In the second event study they use a coarser daily sampling frequency. To define temporary and permanent price impacts associated with a trade, we follow the conventional definition of price impacts used in the empirical literature.[16] A temporary price impact is defined as the difference between the price of a trade and the price of a subsequent trade, i.e., by: $\tau = -\ln(P_{t+1}/P_t)$. A permanent price impact is defined as the difference between price before and after a trade, that is, by: $\pi = \ln(P_{t+1}/P_{t-1})$. We calculate the components of price impacts respectively for sell price-setting trades and buy price-setting trades. Table 7 reports the average temporary and permanent price impacts, classified by types of trader, before and during the crisis period. The upper panel of Table 7 pertains to sell price-setting trades, and the lower to buy price-setting trades. For equities the results pertain to the 200 stocks of the KOSPI index, while for futures the results pertain to the various active contracts. For Korean institutions and foreign investors, the average temporary and permanent price impacts are represented as

[16] For more details on temporary and permanent price effects, see Keim and Madhavan (1996).

a percentage of the corresponding measures for Korean individuals. For sell price-setting trades, we note that Korean institutions and foreign investors have smaller temporary components and larger permanent components of price impact, compared to Korean individuals. For the temporary impact, the percentages range between 10 % and 60 %. It is interesting to note that the temporary price impact change significantly for Korean individuals and institutions in both cash and futures markets. The temporary impact of sell price setting trades of foreigners slightly increase in equity markets and dramatically decrease in the futures markets but neither movements appear statistically significant. The evidence for permanent price impacts is far different. Here the price impacts of foreign traders on the futures market dramatically increase, more than double from 81.75 %, i.e. smaller impact than Korean individuals, before the crisis to 187.50 % during the crisis. This finding is of course important and significant, since foreigners were mostly net sellers of contracts, and increased their share of volume, and they also increased their herding. The permanent impact of futures sell price setting trades by Korean institutions, also increases during the crisis but the increase is far less dramatic, from 114 % to 139 %. For equities, the permanent impact of Korean institutions actually declines slightly while the equity sell price setting trades by foreigners is slightly higher during the crisis.

For buy price-setting trades, the relative magnitudes of temporary and permanent price impacts relative to Korean individuals are reversed. The temporary impact of Korean institutions and foreigners are larger than 100 % and drop in the equity markets during the crisis, while they increase significantly in futures market. The relative permanent impacts of buy price setting trades by foreigners and Korean institutions are about 60 % in both equities and futures and have a tendency not to change during the crisis.[17]

[17] To further examine the determinants of temporary and permanent price impacts, we also estimated regression models which explain the size of the price impacts, namely:

$$\begin{aligned} \tau_i &= a_0 + a_1 PINV_i + a_2 Q_i + a_3 DINS_i + a_4 DFOR_i + e \\ \pi_i &= a_0 + a_1 PINV_i + a_2 Q_i + a_3 DINS_i + a_4 DFOR_i + a_5 R_i^{post} + e. \end{aligned} \tag{2}$$

where τ_i (π_i) is temporary (permanent) impact of a trade, PINV_i is the inverse of the trade price, a proxy for market value, Q_i is number of shares traded as a percentage of the total number of shares outstanding, DINS_i is a dummy for Korean institutions, DFOR_i is a dummy for foreign investors, and R_i^{POST} is the post-trade return defined as $\ln(\mathrm{P}_{t+3}/\mathrm{P}_{t+2})$. We find, with some exceptions, that all the parameters have the expected signs. To streamline the exposition we briefly summarize the results for the coefficients on DINS_i and DFOR_i. We find that the marginal effect of trades associated with Korean institutions and foreign investors imply smaller temporary and larger permanent price impacts. Chow tests to examine whether there exist structural changes in individual parameters reveal important breaks. The same regression models were applied to futures, with the same variables except Q_i which is number of contracts traded as a percentage of the open interest of the nearest month futures contract. The regression results for futures imply that sell price-setting trades associated with Korean institutions and foreign investors have smaller temporary and larger permanent price impacts as expected.

VI. Conclusion

Many papers, including Choe, Kho and Stulz (1999), Kim and Wei (1999), Park and Song (1999) and Radelet and Sachs (1998), have examined the Korean market as a representative example of the Asian financial crisis. The role of derivative securities is typically, either implicitly or explicitly, overlooked when examining the crisis. In this paper, we investigated first the role of trading in index futures during the Korean crash. We find that the fraction of futures volume as a percentage of cash volume soared around the crisis and that selling pressures in the futures market were transmitted to the cash market causing a decline in cash prices. These phenomena were not observed prior to the crisis, indicating that index futures trading played a role during the stock market turbulence in 1997. Given the significance of futures trading, we complement Choe, Kho and Stulz (1999)'s analysis examining whether futures trading by either domestic or foreign investors, or both together, exerted a destabilizing influence during the crash. We find that foreign investors increased their presence in the futures market and dramatically increase their herding of futures trading. Foreign traders also become negative feedback traders of futures and the permanent impact of their futures contracts sales increases substantially during the crisis. We can only conclude that overlooking the role of futures trading understates the influence of foreign traders on the Asian financial crisis.

VII. References

Balduzzi, Pierluigi, Giuseppe Bertola and Silverio Foresi, 1995, Asset Price Dynamics and Infrequent Feedback Trades, *Journal of Finance* 50, 1747-1766.

Biais, Bruno, Pierre Hillion and Chester Spatt, 1995, An Empirical Analysis of the Limit Order Book and the Order Flow in the Paris Bourse, *Journal of Finance* 50, 1655-1689.

Blume, Marshall E., Craig A. MacKinlay and Bruce Terker, 1989, Order Imbalances and Stock Price Movement on October 19 and 20, 1987, *Journal of Finance* 44, 827-848.

Choe, Hyuk, Bong-Chan Kho and René M. Stulz, 1999, Do Foreign Investors Destabilize Stock Markets? The Korean Experience in 1997, *Journal of Financial Economics* 54, 227-264.

Corsetti, Giancarlo, Paolo Pesenti and Nouriel Roubini, 1998, What caused the Asian Currency and Financial Crisis?, NBER Working Paper 6833, December.

Cutler, David M., James M. Poterba and Lawrence H. Summers, 1990, Speculative Dynamics and the Role of Feedback Traders, *The American Economic Review* 80, 63-68.

DeLong, J. Bradford, Andrei Shleifer, Lawrence H. Summers and Robert J. Waldmann, 1990, Positive Feedback Investment Strategies and Destabilizing Rational Speculation, *Journal of Finance* 45, 379-395.

Hamao, Yasushi and Joel Hasbrouck, 1995, Securities Trading in the Absence of Dealers: Trades, and Quotes on the Tokyo Stock Exchange, *Review of Financial Studies* 8, 849-878.

Harris, Lawrence, 1989, The October 1987 S&P 500 Stock-Futures Basis, *Journal of Finance* 44, 77-99.

Keim, Donald B. and Ananth Madhavan, 1996, The Upstairs Market for Large-Block Transactions: Analysis and Measurement of Price Effects, *Review of Financial Studies* 9, 1-36.

Kim, Woochan and Shang-Jin Wei, 1999, Foreign Portfolio Investors Before and During a Crisis, NBER Working Paper 6968, February.

Kleidon, Allan W. and Robert E. Whaley, 1992, One Market? Stocks, Futures, and Options During October 1987, *Journal of Finance* 47, 851-877.

Lakonishok, Josef, Andrei Shleifer and Robert W. Vishny, 1992, The Impact of Institutional Trading on Stock Prices, *Journal of Financial Economics* 32, 23-43.

Lehmann, Bruce N. and David M. Modest, 1994, Trading and Liquidity on the Tokyo Stock Exchange: A Bird's Eye View, *Journal of Finance* 49, 951-984.

Park, Yung Chul and Chi-Young Song, 1999, Financial Contagion in the East Asian Crisis - With Special Reference to the Republic of Korea -, Working paper, Korea University and Kookmin University.

Radelet, Steven and Jeffrey Sachs, 1999, The Onset of the East Asian Financial Crisis, Working paper, Harvard University.

Santoni, Gary J., 1988, The October Crash: Some Evidence on the Cascade Theory, *Federal Reserve Bank of St. Louis Review* May/June, 18-33.

Nofsiger, John R. and Richard W. Sias, 1999, Herding and Feedback Trading by Institutional and Individual Investors, *Journal of Finance* 54, 2263-2295.

Thornton, Daniel L. and Dallas S. Batten, 1985, Lag-length Selection and Tests of Granger Causality Between Money and Income, *Journal of Money, Credit and Banking* 17, 164-178.

Wermers, Russ, 1999, Mutual Fund Herding and the Impact of Stock Prices, *Journal of Finance* 54, 581-622.

Wylie, Sam, 1998, Tests of the Accuracy of Measures of Herding, Working paper, Dartmouth College.

Figure 1: Monthly Average Near-month Futures Volume relative to Underlying Assets Volume (Futures Volume×100 / Underlying Assets Volume)

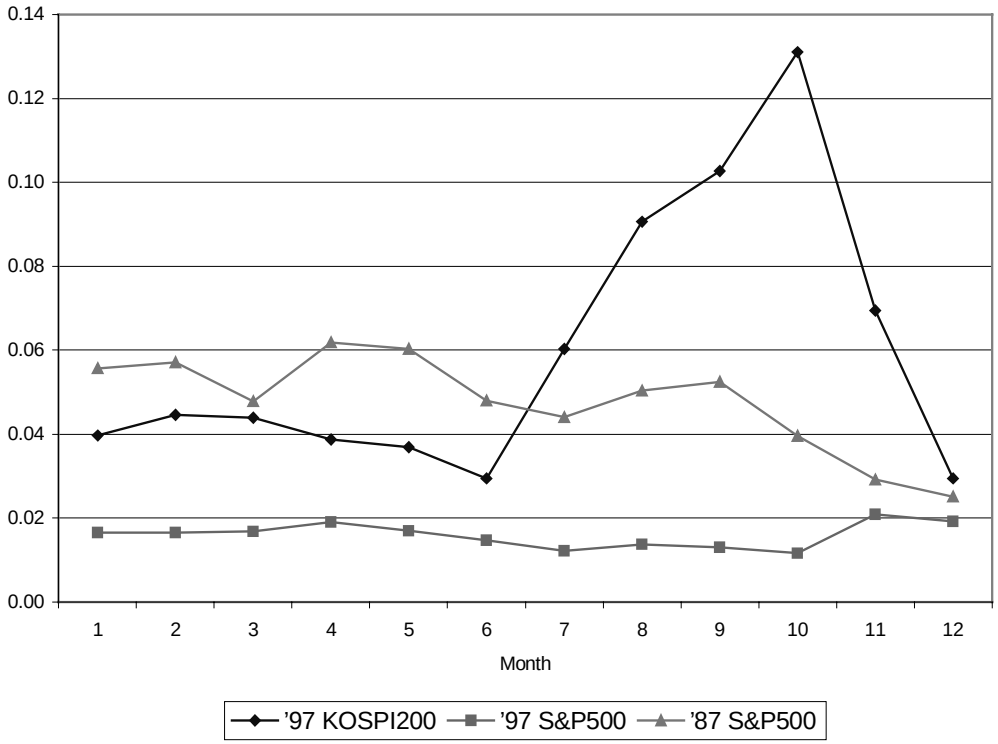
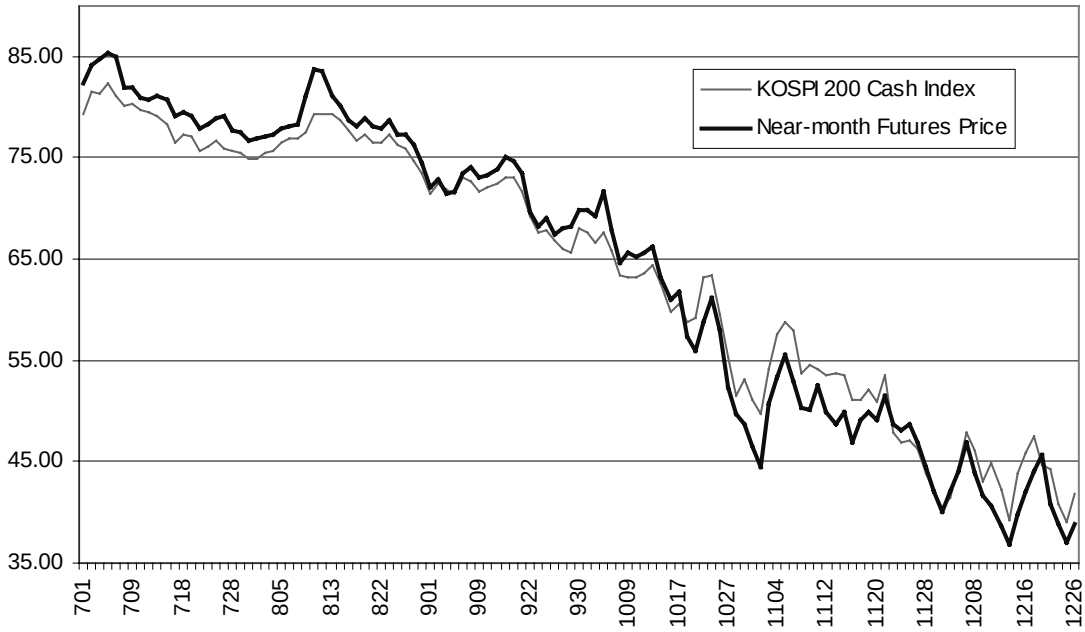


Figure 2: KOSPI 200 Cash Index, Price of Near-month Futures Contracts and the Basis

(a) KOSPI 200 Cash Index and Price of Near-month Futures Contracts



(b) Basis on the KOSPI 200 Futures contracts
(Price of Near-month Futures Contract - Cash Index)

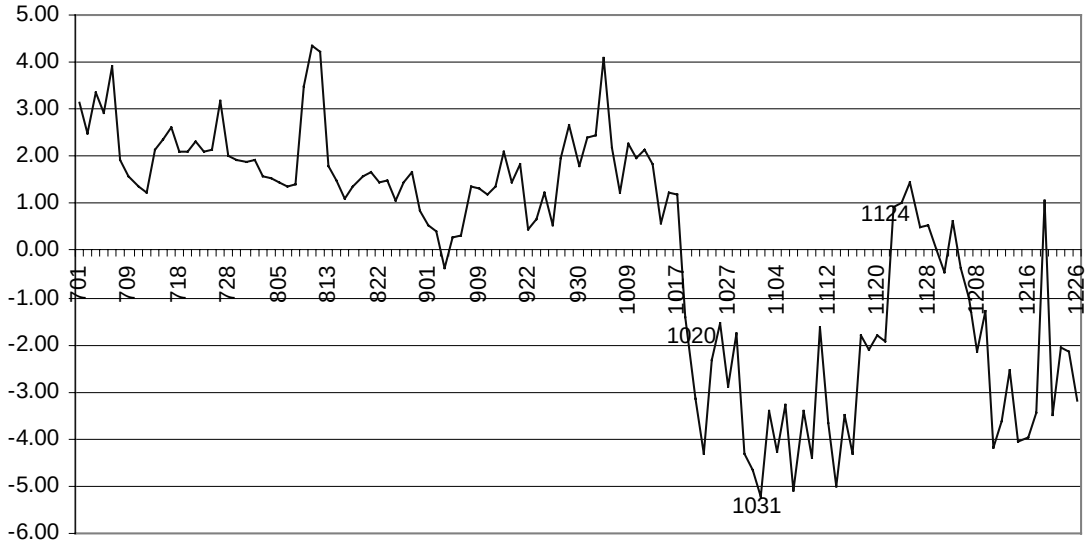
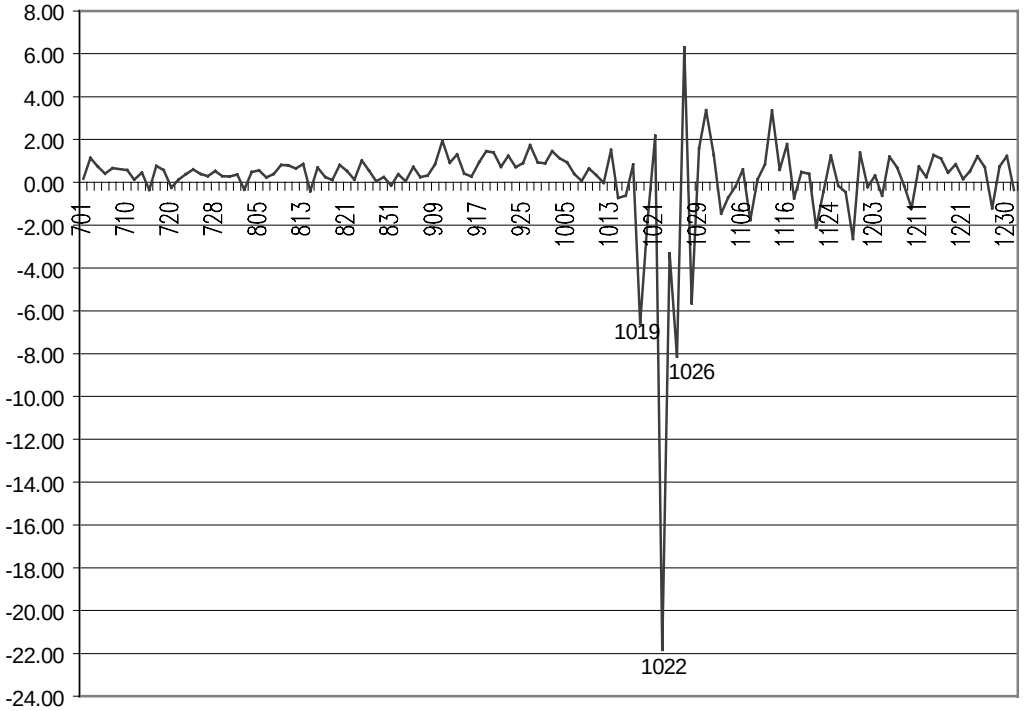


Figure 3: The Basis of Futures Contracts as a Percentage of Cash Index

(a) 1987 S&P 500 Near-month Futures Contracts



(b) 1997 KOSPI 200 Near-month Futures Contracts

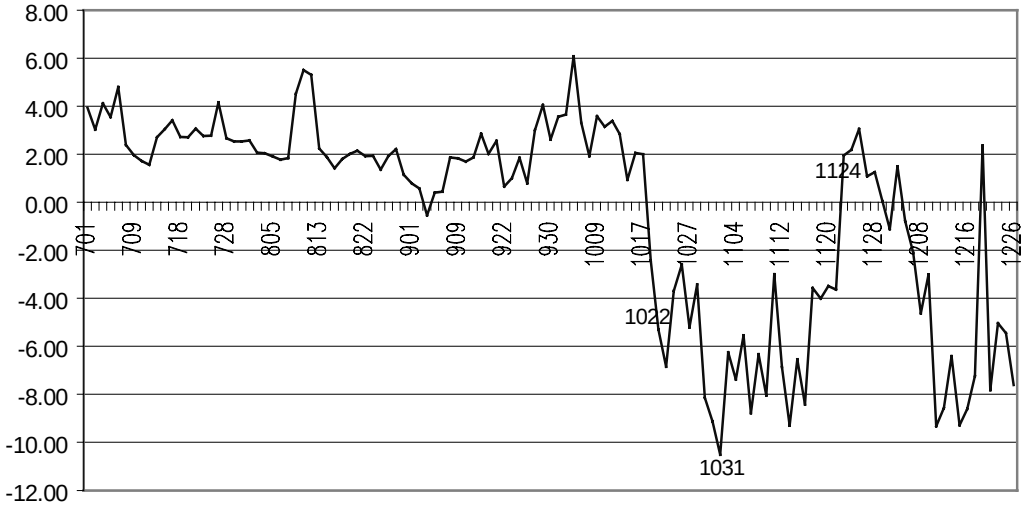
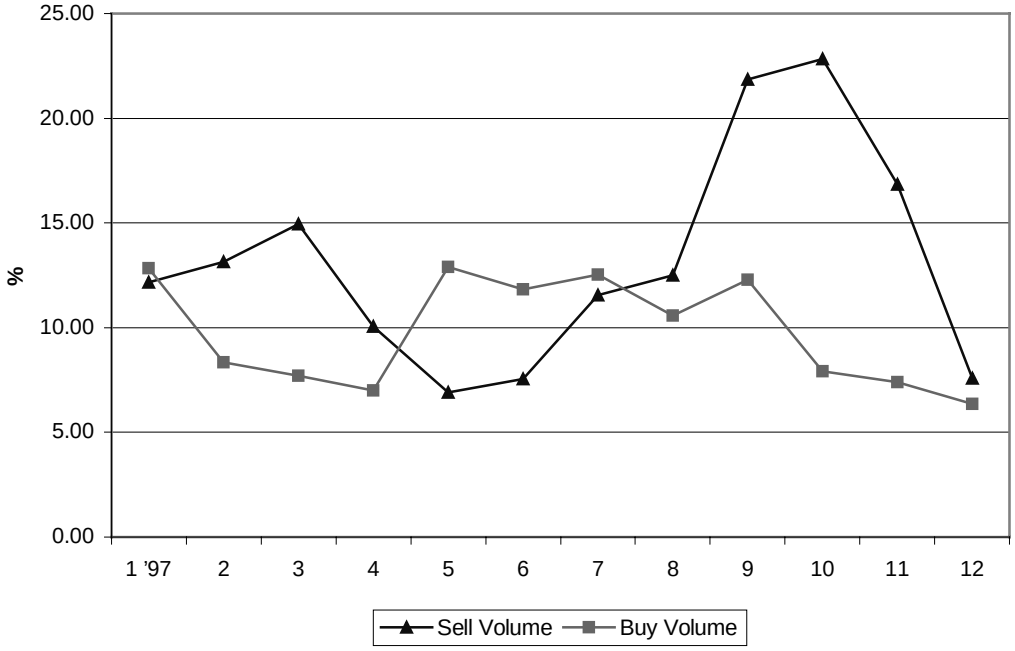


Figure 4: Monthly Average Share of Foreign Investor's Buy and Sell Volume

(a) All KOSPI 200 Stocks



(b) Near-month KOSPI 200 Futures Contracts

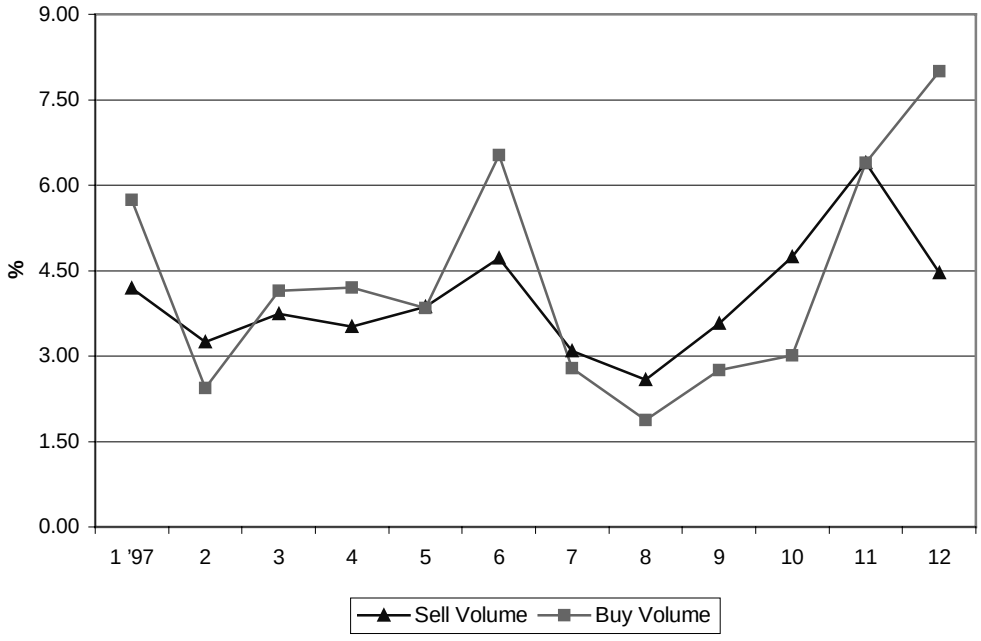
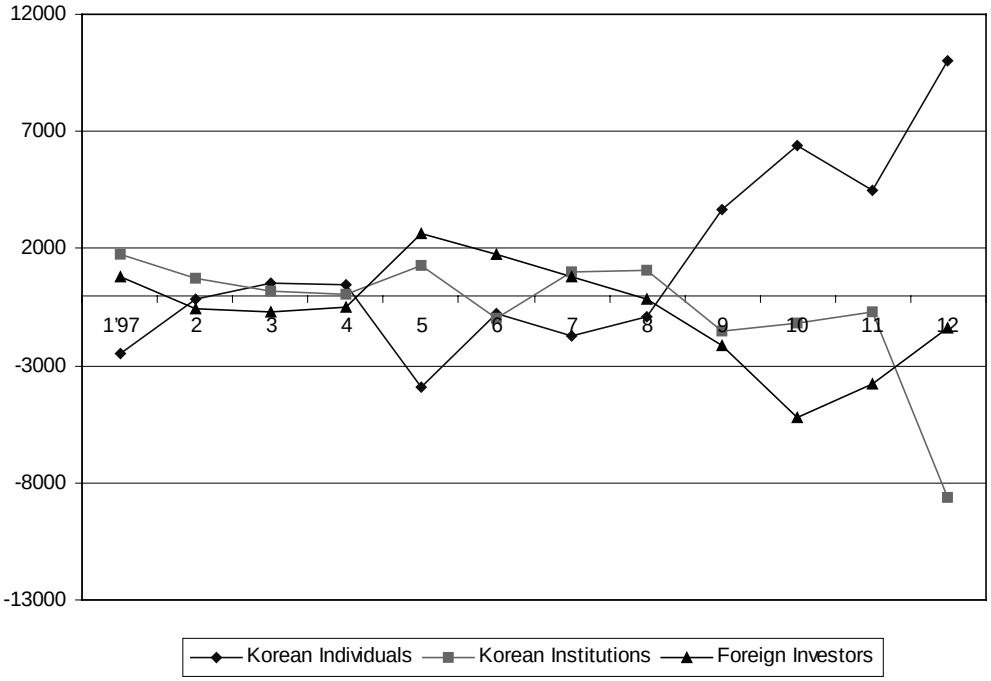


Figure 5: Monthly Average of Net-buy Volume

(a) All KOSPI 200 Stocks



(b) Near-month KOSPI 200 Futures Contracts

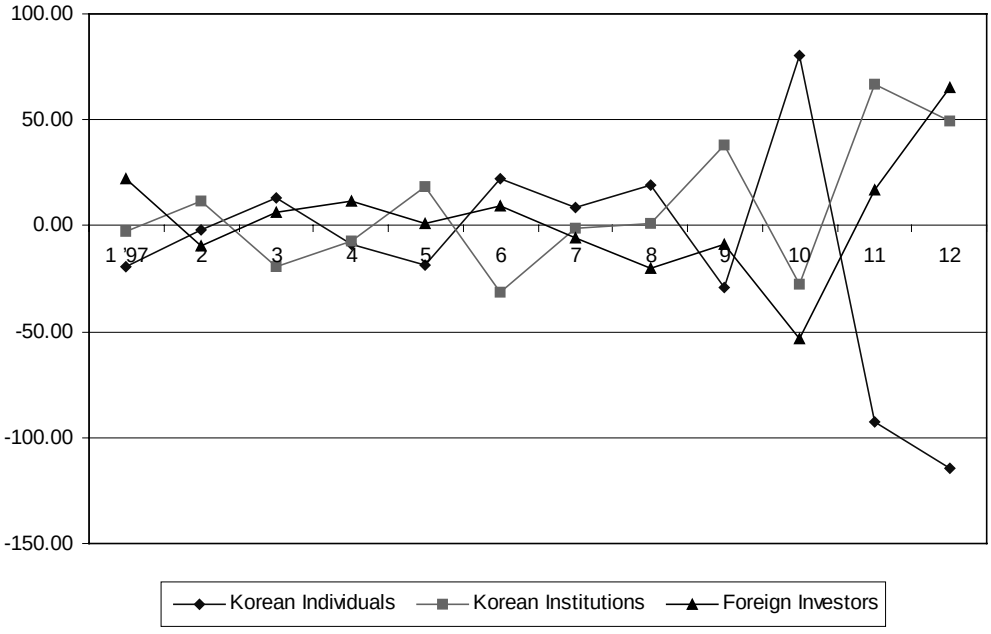
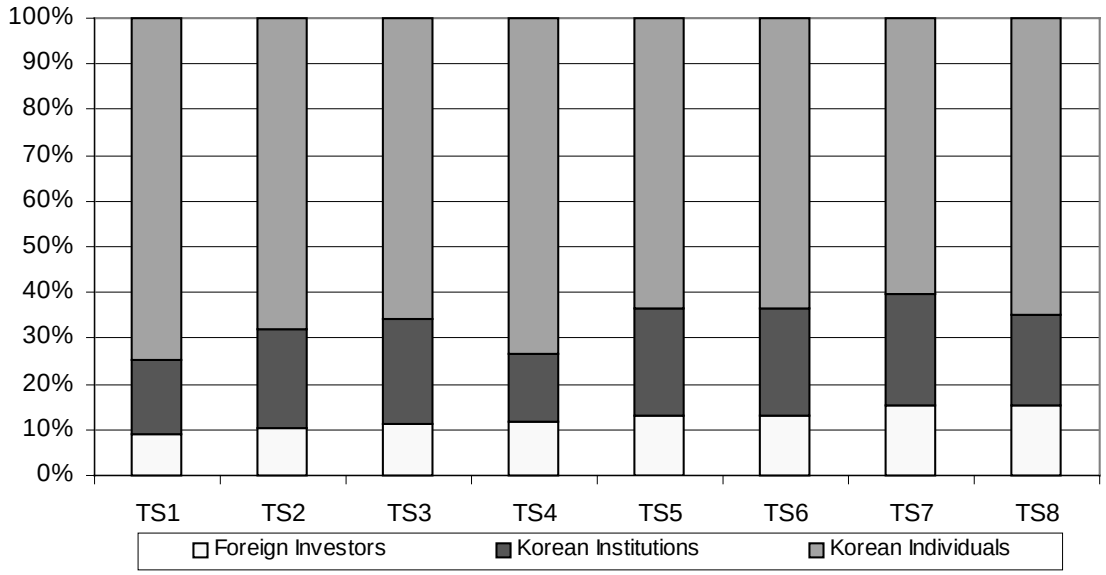
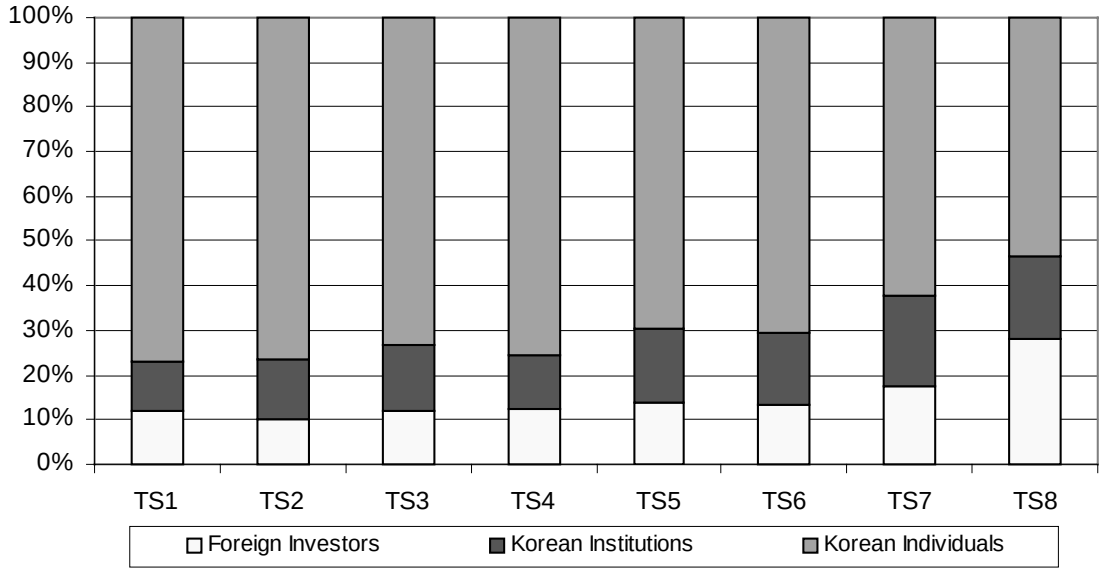


Figure 6: Intraday Share of Trading Volume for All KOSPI 200 Stocks

(a) Pre-crisis (Jan.~Sept. 1997)



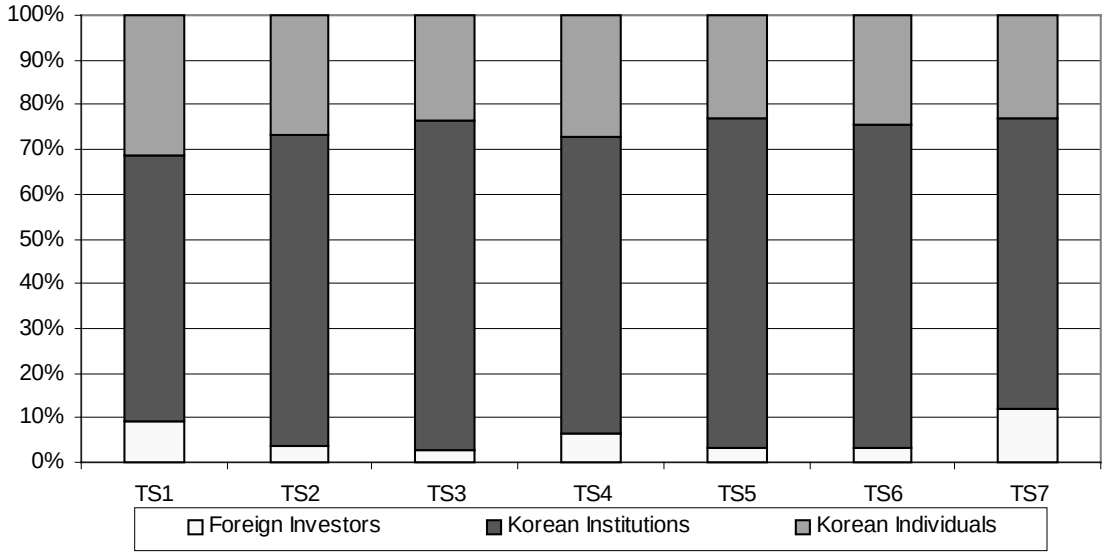
(b) Crisis Period (Oct.~Dec. 1997)



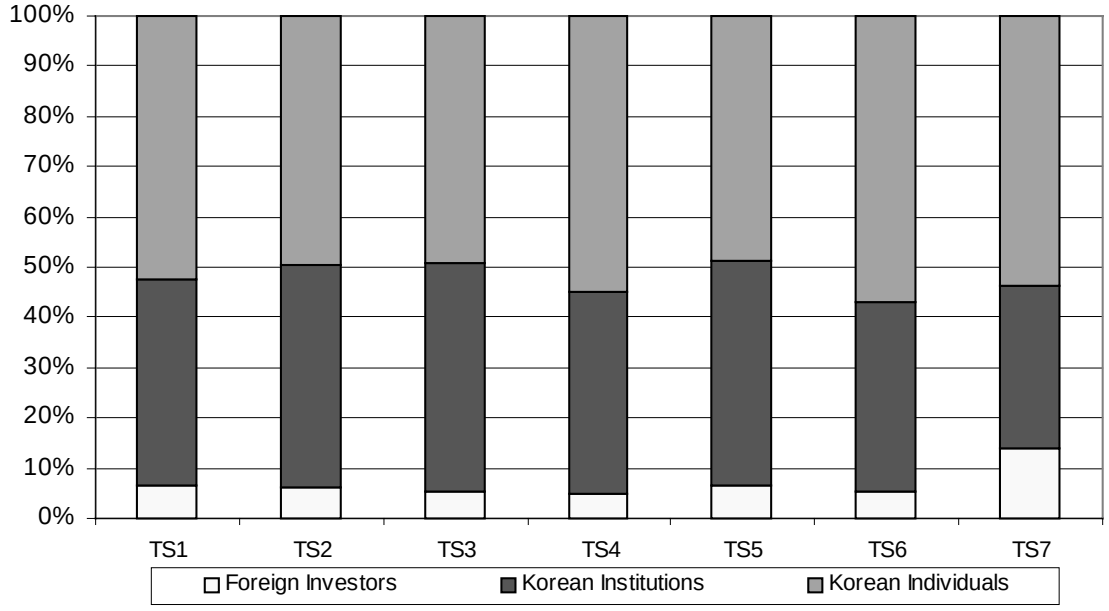
Note that TS1 is the morning-session opening batch auction, TS2 (9:30-10:30) and TS3 (10:30-11:30) are the morning-session continuous trading periods, TS4 the afternoon-session opening batch auction, TS5 (13:00-14:00) and TS6 (14:00-15:00) are the afternoon-session continuous trading periods, TS7 is the closing batch auction and TS8 (15:15-15:40) is the post-closing trading session.

Figure 7: Intraday Share of Trading Volume for Near-month KOSPI 200 Futures Contracts

(a) Pre-crisis (Jan.~Sept. 1997)



(b) Crisis Period (Oct.~Dec. 1997)



Note that TS1 is the morning-session opening batch auction, TS2 (9:30-10:30) and TS3 (10:30-11:30) are the morning-session continuous trading periods, TS4 the afternoon-session opening batch auction, TS5 (13:00-14:00) and TS6 (14:00-15:00) are the afternoon-session continuous trading periods, TS7 is the closing batch auction.

Table 1
Autocorrelation Tests for the Daily KOSPI 200 Cash and Futures return

This sample covers daily data from January 3, 1997 until December 26, 1997, which is divided into four equal sub-periods. The first three belong to pre-crisis era while the last one is the crisis period. The entries are autocorrelation coefficients and corresponding Box-Pierce statistics for KOSPI 200 cash and futures returns. A Box-Pierce statistic in excess of its critical value indicates significant autocorrelation. Critical values for 6 and 12 lags are 10.64 and 18.55 respectively. * indicates statistical significance at the 1 % level.

Period	**Cash Index Return**			**Near-month Futures Return**		
	To Lag	Autocorrelation Coefficient	Box-Pierce Statistic	To Lag	Autocorrelation Coefficient	Box-Pierce Statistic
Jan.~Mar. 1997	1	0.171	1.88	1	0.008	0.00
(Pre-crisis)	2	-0.131	2.99	2	0.037	0.09
	3	0.145	4.37	3	0.146	1.51
	6	-0.179	13.92*	6	-0.154	5.87
	12	-0.051	17.78	12	0.074	13.35
April~June 1997	1	0.129	1.07	1	0.014	0.01
(Pre-crisis)	2	0.070	1.38	2	0.122	0.10
	3	0.082	1.82	3	0.096	1.60
	6	-0.091	6.77	6	-0.181	8.90
	12	0.100	17.36	12	0.061	13.70
July~Sept. 1997	1	0.184	2.16	1	0.265	4.51
(Pre-crisis)	2	0.001	2.16	2	0.012	4.52
	3	0.094	2.75	3	-0.051	4.69
	6	0.008	5.61	6	-0.044	10.51
	12	0.049	12.10	12	0.187	15.94
Oct.~Dec. 1997	1	0.080	0.41	1	0.164	1.70
(Crisis Period)	2	-0.214	3.34	2	-0.162	3.38
	3	-0.134	4.52	3	-0.234	6.94
	6	0.001	9.90	6	-0.007	15.15*
	12	-0.175	14.96	12	-0.155	27.51*

Table 2
Granger Causality Tests for the Daily KOSPI 200 Cash and Futures Return

Entries to the table represent results of Granger Causality tests between futures and cash returns (denoted by FRE and CRE respectively), futures returns and cash order imbalances (denoted by COI), futures order imbalances (denoted by FOI) and cash returns, and futures order imbalances and cash order imbalances. Entries in the tables are lag lengths and F-statistics for each causality test. The lag length was selected using the Akaike Information Criterion (AIC). * indicates statistical significance at the 5 % level.

Null hypothesis	**Jan.~Mar. '97**		**April~June '97**		**July~Sept. '97**		**Oct.~Dec. '97**	
	Lags	F-statistic	Lags	F-statistic	Lags	F-statistic	Lags	F-statistic
FRE does not G. C. **CRE**	6	1.71	4	3.24*	2	3.64*	4	3.19*
CRE does not G. C. **FRE**		3.57*		2.07		0.37		1.72
FRE does not G. C. **COI**	6	0.53	4	0.10	6	1.26	6	3.20*
COI does not G. C. **FRE**		3.24		0.84		0.31		1.36
FOI does not G. C. **CRE**	5	2.21	2	1.00	2	1.05	5	3.91*
CRE does not G. C. **FOI**		1.85		0.63		0.08		0.26
FOI does not G. C. **COI**	6	0.12	2	0.05	6	1.41	4	4.91*
COI does not G. C. **FOI**		0.47		1.50		0.41		1.21

Table 3
Foreign Ownership Limit in Korea

Entries to the tables are the individual and aggregate foreign ownership restrictions for KSE-listed stocks and derivatives. Individual restrictions apply to investment holdings of individual foreign investors, while aggregate restrictions apply to the total investment holdings of all foreign investors for a particular stock or derivatives contract. According to the restrictions, both individual and aggregate foreign investment in stocks (derivatives) cannot exceed a certain percentage of the total outstanding shares of each company (average daily open interest for the last three months).

		Oct. '96	Nov. '96	May '97	June '97	July '97	Nov. '97	Dec. '97	May '98
Equities									
KSE-listed stocks	Individual	5%	5%	6%	6%	6%	7%	50%	100%
	Aggregate	20%	20%	23%	23%	23%	26%	50%	100%
Derivatives									
KOSPI200 futures	Individual	3%	5%	5%	5%	5%	5%	5%	100%
	Aggregate	15%	30%	30%	30%	100%	100%	100%	100%
KOSPI200 options	Individual				5%	5%	5%	5%	100%
	Aggregate				30%	100%	100%	100%	100%

Table 4
Descriptive Statistics of Intraday Shares of Trading Volume

Entries to the table are the mean, median and standard deviation for the daily share of trading volume by category of trader. The sample period is divided into two sub-samples: before the crisis (January-September 1997) and during the crisis (October-December 1997). The KSE trading day is divided into eight time slots. They are defined as follows: TS1 (the morning session opening batch auction), TS2 (9:30~10:30), TS3 (10:30~11:30), TS4 (the afternoon session opening batch auction), TS5 (13:00~14:00), TS6 (14:00~15:00), TS7 (the closing batch auction) and TS8 (the post-closing trading session). Note that TS2, TS3, TS5 and TS6 are continuous trading periods while the others are not. The post-closing session only applies to equities. The t-statistic before and during the crisis period tests the null hypothesis of equal means. * indicates statistical significance at the 5% level.

		TS1		TS2		TS3		TS4		TS5		TS6		TS7		TS8	
		Before	During	Before	During	Before	During	Before	During	Before	During	Before	During	Before	During	Before	During
A. All KOSPI 200 stocks																	
Korean	Mean	75.0	77.0	68.1	76.6	65.6	73.3	73.6	75.6	63.3	69.7	63.6	70.4	60.3	62.0	65.0	53.6
Individuals	Median	79.5	80.9	68.9	77.2	66.5	73.9	74.6	76.6	64.2	69.3	64.9	69.2	60.9	62.3	76.2	53.6
	Stdev	17.0	14.4	7.3	6.0	6.7	6.6	9.4	9.3	6.8	7.3	6.7	7.7	8.0	9.8	31.9	25.3
	(t-test)		0.8		8.2*		7.8*		1.4		6.2*		6.6*		1.4		-2.5*
Korean	Mean	15.9	11.3	21.6	13.5	22.9	14.8	14.9	11.9	23.5	16.3	23.4	16.3	24.4	20.5	19.7	18.3
Institutions	Median	11.9	9.1	20.6	13.2	22.3	14.2	12.6	9.4	22.9	15.6	22.7	15.9	22.6	19.1	4.7	11.9
	Stdev	14.3	8.6	5.4	3.3	5.5	3.4	8.3	7.6	5.0	4.3	5.0	3.4	7.1	7.7	26.5	19.0
	(t-test)		-2.4*		-11.0*		-11.0*		-2.5*		-10.0*		-10.2*		-3.6*		-0.4
Foreign	Mean	9.1	11.8	10.3	9.9	11.4	11.9	11.5	12.5	13.2	14.0	13.0	13.3	15.3	17.5	15.3	28.1
Investors	Median	6.8	8.4	9.4	9.7	10.7	12.6	10.2	11.4	12.4	14.1	12.5	13.8	14.7	17.8	6.9	28.1
	Stdev	8.9	10.9	4.7	4.8	4.9	5.2	7.1	7.3	4.9	5.8	4.7	6.2	5.6	8.3	19.6	19.6
	(t-test)		1.9		-0.6		0.7		0.9		1.0		0.4		2.3*		4.4*
B. Near-month KOSPI 200 Futures Contract																	
Korean	Mean	31.4	52.5	26.7	49.7	23.7	49.1	27.3	54.9	23.2	48.8	24.4	56.9	23.1	53.7		
Individuals	Median	28.7	47.0	26.8	48.0	23.0	48.7	22.0	57.2	22.5	46.3	23.1	18.8	20.5	22.0		
	Stdev	18.9	21.2	7.3	11.7	7.6	14.2	21.4	24.8	8.5	14.8	7.2	54.0	12.1	50.0		
	(t-test)		7.3*		18.0*		17.7*		8.3*		16.5*		7.9*		7.6*		
Korean	Mean	59.3	40.8	69.8	44.1	73.5	45.5	66.4	40.0	73.6	44.6	72.6	37.8	65.0	32.2		
Institutions	Median	62.4	40.9	69.7	46.2	74.5	47.2	70.9	40.9	74.8	47.5	73.9	38.9	66.0	33.0		
	Stdev	19.6	21.8	7.5	13.0	7.8	17.0	23.5	25.7	9.0	17.8	7.4	19.8	13.3	19.9		
	(t-test)		-6.2*		-18.8*		-17.4*		-7.4*		-16.5*		-19.9*		-14.5*		
Foreign	Mean	9.3	6.7	3.5	6.2	2.8	5.4	6.3	5.1	3.2	6.6	3.1	5.3	11.9	14.1		
Investors	Median	4.4	4.1	2.8	4.0	2.6	4.4	0.0	1.1	2.5	3.9	2.4	2.8	9.8	9.5		
	Stdev	12.1	7.2	2.7	7.4	2.2	7.0	12.5	9.4	2.8	8.5	2.4	9.9	10.4	16.0		
	(t-test)		-1.6		4.2*		4.4*		-0.7		4.7*		2.8*		1.2		

Table 5
Herding Measures (in Percent) for Equities and Futures

Herding measures for equities (using by all KOSPI 200 stocks) and futures (using by near- month KOSPI 200 futures contracts) following the method proposed by Lakonishok et al. (1992) are reported. The herding by group *i* on day *t* is measured as follows:

$$H_{it} = \left| B_{it} / N_{it} - P_{it} \right| - E\left[\left| B_{it} / N_{it} - P_{it} \right| \right]$$

where B_{it} / N_{it} is the observed ratio of buys to trades by group *i* on day *t* and P_{it} is the expected value of the ratio. The sample estimate of P_{it} for equities was computed as the ratio of buys to the total transactions by group i for all stocks traded on day t. As the sample estimate of P_{it} for futures, the same ratio with equities is used to make comparisons with equities. The herding measures of each group of investors are computed every day respectively for equities and futures and averaged across days before (January-September 1997) and during (October-December 1997) the crisis period. t-statistics for the differences in means (assuming unequal variances) before and during the crisis period are also provided. * indicates statistical significance at the 5 % level.

	Pre-crisis (Jan.-Sept.'97)	Crisis period (Oct.-Dec.'97)	t-test for mean difference
A. All KOSPI 200 Stocks			
Korean individuals	1.2118	1.8913	(3.20)*
Korean institutions	3.9245	4.7109	(1.83)
Foreign investors	3.4635	1.4756	(-8.23)*
B. Near-month KOSPI 200 Futures Contracts			
Korean individuals	3.8209	3.1406	(-1.39)
Korean institutions	6.4441	13.8824	(4.08)*
Foreign investors	16.1616	25.8105	(3.98)*

Table 6
Price-setting Order Imbalances for Equities and Futures

Entries to the tables are price-setting order imbalances for each group of investors. The daily price-setting order imbalances for a group of investors, PSOI(i,t) are computed as their buy price-setting volume minus sell price-setting volume normalized by their average daily price-setting volume across the entire sample period. The figures represent average price-setting order imbalances conditional on the sign of cash or futures returns of the previous trading day. A group of investors are regarded as positive (negative) feedback traders in either stock or futures market, if they show net buying (selling) pressure following a positive market return and show net selling (buying) pressure following a negative market return. * indicates statistical significance at the 5% level. 1) t-test for mean differences between the days with positive market returns and the days with negative market returns. 2) t-test for mean differences between two types of investors.

Conditional on the sign of cash or futures return of the previous day	**All KOSPI 200 Stocks**					**Near-month KOSPI 200 Futures Contracts**				
	Korean Individuals (1)	Korean Institutions (2)	Foreign Investors (3)	t-test of [2] (3)-(1)	t-test of [2] (3)-(2)	Korean Individuals (1)	Korean Institutions (2)	Foreign Investors (3)	t-test of [2] (3)-(1)	t-test of [2] (3)-(2)
Pre-crisis(Jan.-Sept. '97)										
$R_{t-1} > 0$	-0.102	-0.805	5.456	(1.62)	(1.58)	-0.138	1.398	6.435	(1.89)	(1.48)
< 0	0.888	-9.587	-7.565	(2.84)*	(0.51)	-1.428	-0.999	-8.412	(-1.99)*	(-2.06)*
t-test for mean differences[1]	(0.72)	(-2.43)*	(-3.02)*			(-1.00)	(-1.84)	(-3.10)*		
Crisis Period(Oct.-Dec.'97)										
$R_{t-1} > 0$	1.059	-44.918	-64.823	(-4.10)*	(-0.83)	-12.582	-8.348	-27.251	(-0.47)	(-0.61)
< 0	13.161	-26.777	-47.878	(-5.16)*	(-1.59)	8.533	2.943	20.334	(0.42)	(0.65)
t-test for mean differences [1]	(1.32)	(0.96)	(0.98)			(1.88)	(2.41)*	(1.16)		
t-test for Mean Differences Between the Two Periods										
$R_{t-1} > 0$	(0.28)	(-4.02)*	(-7.18)*			(-3.95)*	(-5.44)*	(-2.01)*		
< 0	(3.17)*	(-2.51)*	(-5.17)*			(1.74)	(1.36)	(1.62)		

Table 7
Temporary and Permanent Price Impacts of trade for Equities and Futures

Temporary and permanent price impacts of trade for equities (all KOSPI 200 stocks) and futures (near-month futures contracts), using the real-time data. Temporary price impacts (τ) and permanent price impacts (π) are defined as follows: $\tau = -\ln(P_{t+1}/P_t)$, $\pi = \ln(P_{t+1}/P_{t-1})$. Each trade is classified into two types: sell price-setting trades and buy price-setting trades. For each type of trade executed by Korean individuals, temporary and permanent price impacts are computed each day and averaged across days before (January-September 1997) and during (October-December 1997) the crisis. The temporary and permanent price impacts of Korean institutions and foreign investors are represented as percentages of the corresponding Korean individuals' entries. t-tests for the differences in means are also reported. Note that all t-tests were performed on raw price impacts. * indicates statistical significance at the 5 % level. 1) t-test for mean differences between the pre-crisis and crisis period. 2) t-test for mean differences between two types of investors.

		A. Temporary Price impacts (τ)					B. Permanent Price impacts (π)				
		Korean Individuals (1)	Korean Institutions (2)	Foreign Investors (3)	t-test of [2] (3)-(1)	t-test of [2] (3)-(2)	Korean Individuals (1)	Korean Institutions (2)	Foreign Investors (3)	t-test of [2] (3)-(1)	t-test of [2] (3)-(2)
Sell Price-setting Trades											
Pre-crisis	Equities	-0.00049	9.37%	11.19%	-54.63*	0.98	-0.00058	168.92%	123.46%	30.79*	-4.24*
	Futures	-0.00012	25.32%	57.47%	-3.01*	2.36*	-0.00008	147.18%	144.46%	1.56	-0.10
Crisis Period	Equities	-0.00045	28.37%	15.74%	-13.20*	-22.22*	-0.00082	114.01%	81.75%	-9.33*	-14.95*
	Futures	-0.00027	27.79%	25.07%	-8.70*	-0.43	-0.00014	139.40%	187.50%	4.36*	3.03*
t-test [1]	Equities	-11.41*	7.98*	1.43			45.84*	-2.75*	-2.83*		
	Futures	17.90*	8.04*	-0.12			5.83*	10.26*	3.74*		
Buy Price-setting Trades											
Pre-crisis	Equities	0.00040	192.10%	140.79%	21.12*	-21.47*	0.00073	53.99%	64.06%	-10.80*	10.29*
	Futures	0.00006	102.09%	107.71%	0.25	0.18	0.00012	87.23%	101.05%	0.06	0.71
Crisis Period	Equities	0.00044	179.80%	134.26%	26.27*	-6.31*	0.00083	55.27%	59.61%	-18.28*	1.51
	Futures	0.00013	210.74%	155.54%	3.42*	-3.27*	0.00018	67.37%	58.61%	-2.65*	-0.55
t-test [1]	Equities	9.38*	1.67	2.37*			17.17*	3.60*	1.72		
	Futures	10.23*	29.86*	3.93*			6.09*	1.35	-0.46		

Liste des publications au CIRANO *

Cahiers CIRANO / *CIRANO Papers* (ISSN 1198-8169)

99c-1 Les Expos, l'OSM, les universités, les hôpitaux : Le coût d'un déficit de 400 000 emplois au Québec — Expos, Montréal Symphony Orchestra, Universities, Hospitals: The Cost of a 400,000-Job Shortfall in Québec / Marcel Boyer

96c-1 Peut-on créer des emplois en réglementant le temps de travail? / Robert Lacroix

95c-2 Anomalies de marché et sélection des titres au Canada / Richard Guay, Jean-François L'Her et Jean-Marc Suret

95c-1 La réglementation incitative / Marcel Boyer

94c-3 L'importance relative des gouvernements : causes, conséquences et organisations alternative / Claude Montmarquette

94c-2 Commercial Bankruptcy and Financial Reorganization in Canada / Jocelyn Martel

94c-1 Faire ou faire faire : La perspective de l'économie des organisations / Michel Patry

Série Scientifique / *Scientific Series* (ISSN 1198-8177)

2000s-10 Productivity Trends and Employment across Industries in Canada / Pierre Mohnen et Thijs ten Raa

2000s-09 Nouvelle économie, nouvelle organisation et technologies de l'information / Suzanne Rivard

2000s-08 Semi-Stationary Equilibrium in Leader-Follower Games / Ngo Van Long et Koji Shimomura

2000s-07 Strategic Behavior under Intertemporal Production Externalities / Richard Cornes, Ngo Van Long et Koji Shimomura

2000s-06 Preemption and Rent Dissipation with Multiple Investments / Marcel Boyer, Pierre Lasserre, Thomas Mariotti et Michel Moreaux

2000s-05 A Monte-Carlo Method for Optimal Portfolios / Jérôme Detemple, René Garcia et Marcel Rindisbacher

2000s-04 Cooperation in Public Goods Experiments / Claudia Keser (with comment by Claude Montmarquette)

2000s-03 The Illusion of Trust and Performance / Benoit A. Aubert et Barbara L. Kelsey

2000s-02 Risques à grande échelle dans les systèmes en réseau : quelques interrogations / Erwann Michel-Kerjan

2000s-01 Wealth Distribution, Moral Hazard, and Entrepreneurship / Sanjay Banerji et Ngo Van Long

99s-48 A New Class of Stochastic Volatility Models with Jumps: Theory and Estimation / Mikhail Chernov, A. Ronald Gallant, Eric Ghysels et George Tauchen

---

* Vous pouvez consulter la liste complète des publications du CIRANO et les publications elles-mêmes sur notre site Internet à l'adresse suivante :

http://www.cirano.umontreal.ca/publication/documents.html