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Financial Liberalisation and International Trends in Stock, Corporate Bond and Foreign Exchange Market Volatilities

Paul Kupiec

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by

Paul Kupiec

Board of Governors of the Federal Reserve System
Washington DC

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This paper is one of four in this Working Paper series, focusing on financial liberalisation, along with those by Miller and Weller, Driscoll, and Blundell-Wignall and Browne. It examines the historical volatilities of stock, bond and foreign currency markets over alternative periods differing roughly by the degree of financial innovation and globalisation. It characterises trends in gross volatility, and the degree and manner in which volatility in financial markets has changed, the real economic consequences of transitory periods of excess volatility, and discusses some of the financial policies proposed to limit volatility. The results suggest that the past two decades have coincided with a world-wide increase in the average levels of volatility in stock returns, corporate bond yields and exchange rates, accompanied by a general increase in the strength of the positive correlations among national stock returns and the conditional volatilities of these returns. Evidence suggests that the increase in volatility has had little negative effect on economic activity.

Le présent document constitue l'une des quatre études de cette Série consacrée à la libéralisation financière avec celles de Miller et Weller, de Driscoll, et de Blundell-Wignall et Browne. Il examine le concept de volatilité historique observée sur les marchés d'actions, d'obligations et de change au cours de plusieurs périodes caractérisées par un état d'avancement différent du processus d'innovation et de globalisation financière. Il cherche à caractériser les tendances de la volatilité brute, l'ampleur et la forme des changements survenus dans la volatilité sur les marchés financiers, les conséquences sur l'économie réelle des périodes temporaires de volatilité excessives. Il traite également de quelques unes des politiques financières proposées pour restreindre la volatilité. Les résultats suggèrent que les deux dernières décennies ont coincidé avec une augmentation mondiale du niveau moyen de la volatilité de la rentabilité des actions, du rendement des obligations d'entreprises et des taux de change. et avec un renforcement général du caractère positif des corrations existant entre le taux de rendement national des actions et la volatilité implicite de ces rendements. L'expérience semble montrer que l'accroissement de la volatilité a eu peu d'effet sur l'activité économique.

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Paul Kupiec

Board of Governors of the Federal Reserve System

Washington DC

The author is an economist in the Capital Markets Section, Division of Research and Statistics, Board of Governors of the Federal Reserve System, currently on leave at the Bank for International Settlements. This paper was written while he was working as a consultant to the Monetary and Fiscal Policy Division of OECD. He is grateful to Adrian Blundell-Wignall, Frank Browne, and Marcus Miller for helpful discussions. The analysis and conclusions of this paper are those of the author, however, and do not necessarily represent those of the OECD or of the governments of its Member countries.

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INTRODUCTION

The guiding rationale for financial liberalisation, the optimality of returns determined in free and efficiently functioning markets, once the conventional characterisation of financial markets, has increasingly become a theoretical model of questionable relevance. The efficient markets paradigm accepts asset price volatility as a necessary cost and a desirable consequence of allowing markets to operate freely. A growing body of evidence indicates that financial markets may not be models of efficiency, but rather may be characterised by prices that deviate from fundamental values for long periods of time and exhibit excess volatility over that which is justified by economic fundamentals.

Perhaps the broadest evidence on the apparent dysfunction of financial markets can be found in a recent paper by Cutler, Poterba and Summers (1990) (CPS). CPS examine the time series properties of the financial asset returns on major international stock, bond, and foreign exchange markets as well as returns on gold, silver, real estate and collectable assets. From their investigation they conclude:

> "First returns tend to be positively serially correlated at high frequency. Second, returns tend to be (weakly) negatively serially correlated over long horizons. Third, deviations of asset values from proxies for fundamental value have predictive power for excess returns. These patterns appear difficult to explain on the basis of time-varying required returns. In contrast, the similarity of these patterns in a wide range of asset markets suggest the possibility that they are best explicable as a consequence of the speculative process itself." (p.36)

The findings of CPS are reinforced by the results of Schwert (1988, 1989) who focuses his analysis on the historical volatility of U.S. bond and stock returns. He compares historical returns volatility to the historical volatility of both real and financial economic fundamentals. Schwert's results reinforce the findings of earlier studies that have found that episodes of heightened stock-price volatility are not easily attributable to the volatility of observable macroeconomic fundamentals. Indeed the findings of a study by French and Roll (1986) strongly suggest that trading activity generates price volatility in excess of that which is justified by the release of fundamental information.

Deviations from market efficiency are reflected in financial asset prices in two ways: first, asset price levels may deviate from their equilibrium fundamental values; secondly, market inefficiencies are also reflected in financial assets' price volatilities. In an inefficient market, asset prices are more volatile, as asset values change as a result of both changes in fundamentals and changes induced by market mispricings. The two effects are not independent. If investors are risk averse, the excess volatility generated by market inefficiency raises required rates of return, depressing financial asset prices, and affecting real consumption and investment decisions [De Long et al. (1990)]. Excess financial market volatility may also have indirect real affects through its influence on expectations. If financial market volatility is a leading indicator of the

uncertainty of the future economic environment, then transitory excess volatility -- volatility not induced by changing economic fundamentals -- may translate into greater consumer uncertainty about the economic climate. Changes in consumer confidence levels may indirectly affect consumption and investment decisions.

In a world where financial markets are not completely efficient processors of information, it is possible that the creation and maintenance of a regulatory framework may minimise any inefficiencies caused by financial market trading. Subsequent to the October 1987 market crash, there have been many regulatory changes proposed to improve the functioning of financial markets. The majority of these policies are concerned with reducing transitory volatility and mitigating its effects on the financial market infrastructure. Even if justified, it is much less clear how financial market policy could correct fundamental long-term mispricing of financial assets.

Given the potentially complex interactions among financial markets, it is important to consider the potential effects that a change in financial regulation in one market may have on other financial markets, both domestically and internationally. Because financial products are probably the most mobile of all traded goods and services -- advances in telecommunications permit electronic trading world-wide virtually instantly and at a trivial cost -- domestic financial policy is often constrained by competitive pressures related to the financial policies of foreign nations. "Regulatory arbitrage" is a reality that heightens the importance of financial liberalisation and policy coordination.

This paper attempts to provide a backdrop for discussion by characterising in a gross sense the historical experience of volatility in financial markets during the recent period of liberalisation and financial innovation. We estimate historical volatilities of stock, bond and foreign currency markets over alternative periods which include fixed and floating exchange rate regimes and periods in the 1980s differing roughly by the degree of financial innovation and globalisation. We characterise trends in gross volatility, we do not control for any of the myriad of events that have contributed to financial returns volatility. From this analysis we characterise the degree and manner in which volatility in financial markets has changed. After reviewing historical volatility, we consider its real economic consequences and consider some of the financial policy programmes often proposed to limit volatility. In particular, we discuss proposals that attempt to limit volatility by limiting price movements with temporary trading halts, by limiting the legal leverage available to investors in the financial assets, by changes in exchange trading practices designed to accommodate trading volume, and by proposals that attempt to lower volatility by raising the transactions costs of financial trading.

Our results suggest that financial liberalisation and the accompanying financial market innovations and integration that have occurred over the past two decades have coincided with a world-wide increase in the average levels of volatility in stock returns, corporate bond yields and exchange rates. We do not attempt to identify the contributing causes of the increased volatility nor do we assign a causal role to financial liberalisation. Indeed the results of studies by Schwert (op. cit.) suggest that the contributing sources of volatility are not easily identifiable. Although average volatility has

increased, we find little evidence to suggest that the increase has had negative real economic effects. Given the apparent non-importance of short-term "excess" financial market volatility to real economic activity, we take a critical view of some of the regulatory proposals designed to limit financial market volatility.

FINANCIAL MARKET VOLATILITIES

Measuring volatility

A conventional measure of financial asset returns volatility is the sample standard deviation of returns estimated over a particular time period. If daily data were available, estimates of average daily volatility, calculated by month, might serve as a useful measure for characterising the evolution of volatility over time. Unfortunately, for most financial assets, extended samples of daily data are not available. An alternative estimator for the volatility of returns over a monthly period has been proposed by Schwert (1989). The Schwert volatility estimator produces monthly volatility estimates from monthly return data. The technique is based upon the robust variance estimators of Davidian and Carroll (1987). The Schwert estimator has properties similar to the autoregressive conditional heteroscedasticity (ARCH) estimator of Engle (1982) in that the volatility estimator is dynamic. Volatility estimates evolve over time in response to unexplained variations in the conditional mean return relationship.

The Schwert volatility estimator is calculated by first, regressing monthly returns on monthly dummy variables and 12 lagged return values. Using the absolute values of the estimated residuals from this regression, these absolute values are regressed on monthly dummy variables and 12 lagged values of the transformed residuals. The predicted values from the second step scaled by a constant (1.2533 under the assumption of monthly returns normality) are estimates of the standard deviation of monthly returns.

STEP 1: Estimates e_t from the model,

$$\tilde{R}_t = \sum_{i=1}^{12} \alpha_i D_i + \sum_{i=1}^{12} \beta_i R_{t-1} + \tilde{e}_t$$

where D_i is a dummy variable that takes the value of 1 if R_t occurs during the month i, and 0 otherwise.

STEP 2: Estimates the predicted values from the model,

$$|\hat{e}_t| = \sum_{i=1}^{12} \delta_i D_i + \sum_{i=1}^{12} \delta_i |\hat{e}_{t-1}| + \tilde{v}_t$$

The rescaled predicted values from this model.

$$1.2533\ |\hat{e}_t|.$$

are estimates of the monthly return standard deviations under the assumption that monthly returns are normally distributed. A comparison of the

characteristics of the Schwert volatility estimator to alternative estimators for daily U.S. stock market data is provided in Appendix A1.

Market structure and volatility

Even if the underlying fundamental volatility of stock or bond returns were identical across countries, different markets may exhibit different return volatilities simply as a consequence of differences in the depths and market structures of the different markets. For example, the depth of liquidity in a market will determine the size of the bid-asked spread which, in turn, can affect the observed stock-index returns volatility (1).

Consider two countries, A and B, identical in every way except country A has more liquidity trades and consequently a lower average bid-asked spread. Assume country A has an average bid-asked spread of 1/8 and country B of 1/4. Assume both countries' stocks start at an identical bid price and move up 1/8 of a point for some number of consecutive days. For country A, recorded stock prices would increase by 1/8 a day and, in this hypothetical example, measured volatility would be zero. However, in country B, trades would only take place on every other day when the underlying true stock value increased through the bid-asked non-trading interval. Countries A and B would have identical average daily price appreciations (equal to an eighth of a point), but Country B would have a positive daily return standard deviation (equal to an eighth of a point). This example illustrates that even if the basic economic fundamentals are identical, there are sound economic reasons for expecting markets to differ in their recorded returns volatility.

Relationships among national stock market returns and volatilities

Before examining international stock data, it is appropriate to summarise the results from some existing studies regarding the interrelationship among national stock markets. Overall, the existing evidence suggests that in normal circumstances, international stock return correlations have become only slightly stronger through time; however, during times of unusually large volatility, international correlations appear to have become substantially stronger.

Recent studies by Dwyer and Hafer (1988) and Bennett and Kelleher (1988) investigate the correlations among global stock market indices. Except for the period of the 1987 global crash, Dwyer and Hafer find evidence of only small increases in the return correlations among United States, United Kingdom, Japanese, and German, stock indices. Their results, reproduced in Table 1, show that the markets were more closely linked in the recent, flexible exchange-rate period.

The changes reported in Table 1 probably overstate the magnitude of the increase in correlation in periods of normal price volatility, as other evidence discussed below indicates that markets become much more closely linked when they are abnormally volatile. Dwyer and Hafer's flexible exchange rate sample includes three periods of uncharacteristic volatility: the oil-crisis period of 1973-1974, the October 1979 change in Federal Reserve operating procedures, and the October 1987 global equity "correction". Because of this, the sample correlation estimates are biased upward from the estimates of normal intermarket correlations.

Bennett and Kelleher estimate intermarket return correlations in the 1970s and the 1980s (2). These results also indicate that the international linkages among equity markets have become slightly stronger in the 1980s.

There is empirical evidence that the correlations between market returns increase when returns volatility is abnormally large. Bennett and Kelleher present evidence of a statistically significant positive linear relationship between the correlations of international markets' returns and the volatility of returns in markets that open and trade earlier in the day. Dwyer and Hafer also present evidence that intermarket correlations increase during periods of high volatility (specifically the October 1987 crash) (3). Hamao, Masulis and Ng (1990) present evidence that large price changes in a market tend to transfer or "cause" large price changes in markets temporally following it in the trading day.

There are currently two alternative economic explanations for the empirically observed positive relationship between market correlations and volatility. One explanation offered by Neumark, Tinsley and Tossini (1988) (NTT) attributes the positive relationship to transactions costs that limit the profitability of international arbitrage activities. Since transactions cost have some lump-sum component, profit opportunities must exceed a threshold level before arbitrage is undertaken. Without the international arbitrage, returns are less highly correlated than they would be in a transaction-costless market. There are many arbitrage trade dead-zones when markets are relatively calm. In instances of large price changes, arbitrage between markets becomes profitable and intermarket returns become more highly correlated.

An alternative explanation for the relationship between volatility and correlation is advanced by King and Wadhwani (1990). This explanation is based upon a model of how investors react in their domestic markets to price changes they observe in foreign markets. King and Wadhwani set up a model where information arrives throughout the trading day, but markets in different countries are only open part of the day. Information arriving to an individual market has two components: one component is economic information that has implications for global equity prices; the second component is market specific information that is "noise" from the perspective of other markets around the world. Information is revealed sequentially as markets open and close throughout the trading day.

Consider an investor in an equity market that is about to open "midday" in the 24 hour trading day. He could analyse all the information announcements that have cumulated from the last close of his domestic market and estimate the impact on his home market's opening price. Alternately, he could use the price changes in the markets that have opened and traded earlier in the trading day to estimate the likely price impact of the new information on his domestic market opening.

In the second approach, the optimal estimate is formally a signal extraction or so-called filtering problem. Simply put, the result is a statistical estimate of the predicated response of the domestic market to a foreign price change, where the estimates depend on the historical relationship between the amount of signal (global fundamental information) to noise (market specific information) in the cumulated information. Using this procedure, with a fixed filter, small foreign price changes are interpreted largely to be a

consequence of noise whereas large foreign price changes imply a large global fundamental information component and a correspondingly large domestic market price change. With a fixed filter, a large price change in previously open foreign markets will translate into a large estimate of the global fundamental content of information. Since investors do not examine or analyse the foreign information independently, large foreign price changes caused by abnormally large country-specific information components will have the same estimated domestic market price impact as the release of a comparable amount of global-fundamental information. Because of this, large price changes tend to be transmitted from market to market. Volatility is infectious. In order to explain the positive observed relationship between volatility and the correlations among market indices internationally, King and Wadhwani's hypothesis requires a time varying filter. The market participants must adjust their estimated statistical relationship in response to uncommonly large price changes.

Although average international correlations may not have changed substantially over time, the international correlations during extremely volatile "crisis" periods may have changed. The correlations among returns during uncharacteristically high volatility periods, might be considered a measure of systemic risk in financial markets. Although there is no direct empirical evidence on the effect of the globalisation of equity markets and financial liberalisation on this measure of systemic risk, some indirect evidence is available from interpreting the results of studies of global market linkages in alternative "heightened risk" environments. The alternative periods correspond to the 1973-74 oil crisis and the October 1987 stock market crash. Two studies have examined correlations between indices during the 1987 crash period and the spectral coherence between market indices during the 1973-74 oil crisis period.

Bennett and Kelleher (op. cit.) provides estimates of international market correlations during the month of October 1987. The correlations are calculated using daily returns, in local currency, with the trading day starting in different national markets. Hilliard (1979) provides estimates of the average coherence between major industrial indices during the OPEC oil embargo period (daily data from July 7, 1973 to April 30, 1974). In the Hilliard study, all prices were converted to U.S. currency using reported daily exchange rates. Although the data and the statistical techniques of estimated market interrelationships are very different, the estimates of the intermarket relationships can be transformed to be approximately comparable. The details of the transformation are in Appendix A3.

The estimates of the correlations between daily returns in the United States, the United Kingdom, Japan, and Germany for the alternative sample periods appear in Table 2. Except for the correlation between Germany and the United States equity markets, the results in Table 2 suggest that the correlations between equity markets during periods of heightened uncertainty have substantially increased since the 1970s. Financial liberalisation appears to have been associated with strengthened interrelationships during crisis periods and so increased systemic risk.

The increase in correlation in crisis times in consistent with the hypothesis proposed by NTT. Since 1974, the costs of international communications and equity transactions have dramatically decreased, while the

efficiencies of both services have increased (4). The total transactions cost of international arbitrage has correspondingly declined and so the frequency of the "trading dead-zones" predicted by NTT should have declined as well. The reduction in transactions costs should be expected to produce the increased correlations observed independent of other measures associated with financial liberalisation.

INTERNATIONAL TRENDS IN STOCK, BOND, AND EXCHANGE RATE VOLATILITIES

The data

The data used for the analysis are from the OECD's financial data base. The data base contains monthly observations on many Member country stock price indices, corporate bond yield indices, and bilateral exchange rates. Stock-index returns are calculated as the first differences of the logarithms of the monthly price indices. The coverage and method of index calculation differs across countries and these differences may be important in cross-country comparisons of volatility levels. For the stock price data, country index observations not only differ in timing and coverage -- industrial companies for some countries and all-traded shares for others -- but some indices reported are monthly averages of daily prices, whereas others are based upon a single day's closing prices. When making cross-country comparisons of levels of returns volatility, the returns calculated from countries whose price indices are monthly averages of daily prices will understate volatility relative to the monthly close-to-close return calculations. Although the differences in stock index composition may affect cross-country stock return volatility comparisons, they should have little impact on the cross-country volatility correlations. A more complete discussion of the data is given in Appendix A4.

Bonds

The results from the cross-country bond yield comparison suggest that international bond yields are higher and exhibit larger month-to-month variation after the introduction of floating exchange rates. Under floating exchange rates, the correlations among monthly yield volatilities have fallen. The evidence from the 1980s does not indicate any notable change in these patterns. The details follow.

Table 3 reports the means and correlations for corporate bond index secondary market yields for fixed and floating exchange rate periods. Table 4 reports the means and correlations of these bond yields' monthly standard deviations by fixed and floating exchange rate period (5).

An examination of the results reported in Tables 3 and 4 suggests that the floating exchange rate regime is characterised by higher annual corporate bond yields and higher average monthly variation in these yields. The correlation among corporate bond yields (Table 3) are, for the most part, lower in the floating exchange rate regime (6).

This reduction in correlations among corporate bond yields is consistent with the findings of Browne (1988). Browne finds that, under a floating exchange rate regime, monetary shocks that increase the slope of the domestic

term structure have the opposite effects on foreign nation's term structure slopes.

> "Tests conducted within the context of the OECD's INTERLINK model of the term structure support the inverse relationships between term structures under floating-exchange rates ... there is a tendency for the U.S. yield curve and other OECD yield curves to move in opposite directions." (p.30)

This tendency for opposite movements in long-term rates would reduce the positive correlations of corporate bond yields from the fixed to the floating rate sample.

The correlations among corporate yield volatility estimates (Table 3) indicate that the correlations among monthly yield volatilities are, in many cases, substantially smaller under floating exchange rates. The estimates imply that the probability that different national corporate bond markets are more (less) volatile than average at the same time has decreased during the floating exchange rate regime.

Table 5 reports average bond yield volatilities and volatility correlations for two sample periods in the 1980s. The estimate indicate no clear pattern in either average volatility levels or the correlations among monthly yield volatilities over the decade (7).

Stocks

The statistical evidence seems to suggest that the process of financial liberalisation has been associated with an increase in the correlations among national stock market returns, and also an increase in the correlations among the conditional volatility of these returns. Not only has the average correlation among returns during "normal" periods likely increased, but the evidence suggests that in highly volatile periods, national markets' returns are much more correlated. This evidence may suggest that global systemic risk or the financial fragility of global financial markets is potentially greater than in earlier periods characterised by higher transactions costs and more restrictive financial policies. The details of the analysis follow.

The average monthly stock-index return volatility estimates for the fixed and floating exchange rate samples appear in Table 6. Although not uniform, there is a tendency for stock indices to exhibit higher average volatility in the floating exchange rate sample. This tendency is consistent with previous findings that average stock return volatility is higher in the 1980s for the United States (see, for example, Duffee, Kupiec and White, 1990). Given the higher volatility in the floating exchange rate sample and the NTT transaction costs hypothesis (other things equal), we would expect international market returns to be more strongly correlated in the floating exchange rate period. The correlations among the 15 OECD country indices for fixed and floating exchange rate periods appear in Table 7. These results indicate that stock returns are generally more highly (positively) correlated across nations' markets in the floating exchange rate period.

Table 8 reports monthly average levels of stock-index returns and their volatilities for the first and second half of the 1980s. It is perhaps not

surprising, given the extreme volatilities recorded during the autumn of 1987, that for most countries, the latter half of the 1980s brought higher average monthly volatilities to their stock markets. Although the latter half of the 1980s exhibits, for the most part, higher average volatilities, studies by Edwards (1988), and Duffee et al. op. cit. present evidence that the elevated average is caused by transitory increases in volatility and measures of volatility based upon higher frequency data quickly revert toward much lower average volatility levels. This tendency is evident in estimates of intraday volatility for the United States S&P 500 presented in Duffee, Kupiec and White and reproduced in Chart 1. During the 1980s, volatility in the United States stock market exhibited no upward trend, and intermittent periods of extreme volatility quickly reverted to lower levels characteristic of "normal" market environments. Indeed it is the increase in the occurrence of transitory periods of excessive volatility which has given many the impression that average volatility levels have substantially increased.

Table 9 reports monthly stock-index volatility correlations for 15 OECD countries' stock-price indices for fixed and floating exchange rate periods. Table 10 reports the major international market subset of Table 9. The general pattern evident in Table 10 is true of the entire international sample: in moving from the fixed to the floating exchange rate environment, there is a tendency for the monthly volatility of returns to be more positively correlated across markets.

In summary, the floating exchange rate sample is characterised by higher average monthly stock-index return volatility, stronger positive correlations between the monthly volatility of returns across national markets, and stronger positive correlation among the stock index monthly returns.

Chart 2 plots the Schwert volatility estimates for five major national markets for the decade of the 1980s. Tables 11 and 12 report the return and volatility of return correlations for the entire 15 country samples for the first and second half of the 1980s. Tables 13 and 14 report the sample estimates for the major international market subset of countries reported in Tables 11 and 12. Focusing initially on the major markets (Table 13), it appears that the major markets' returns have become slightly more positively correlated over the 1980s. This general tendency is exhibited and magnified in the larger sample estimates reported in Table 11. In particular, it appears as if the correlations between the returns of non-major market indices with the returns of the major markets, and the correlations among the non-major markets' returns, have increased in the later period. Consider, for example, the sub-matrix of Table 11 defined by Finland and the Netherlands. The increase in the strength of the positive volatility correlation from early to late 1980s is notable. Another example of the tendency can be found by examining the return correlations for Spain, Sweden and Switzerland. The increase in correlations during the 1980s is consistent with the increase in the average level of volatilities and the NTT transaction cost hypothesis.

In contrast to return correlations, the results for the volatility correlation in Table 14 show that the major markets' return volatilities appear to be much more strongly positively correlated in the second half of the decade. In other words, the probability that the major markets simultaneously experience above average volatility appears to be higher in the late 1980s. This characterisation remains true even if the 1987 October crash is omitted

from the sample. Upon examination, the results for the 15 country sample reported in Table 12 show similar characteristics for the correlations among international stock return volatilities.

Foreign exchange

In the analysis of foreign exchange rate volatility, we consider end of month data on four bilateral exchange rates: the Deutschemark-dollar, yen-dollar, French franc-dollar and pound Sterling-dollar. Exchange rate volatility is measured by the estimated standard deviation of the month-to-month changes in the logarithms of the exchange rates. The standard deviation estimates are from the Schwert estimator. We compare the estimated average volatility levels and volatility correlations over the floating exchange rate period of the 1970s to the 1980s, and again make the comparisons for the first and second halves of the 1980s. The estimates appear in Tables 15 and 16.

The results reported in Table 15 suggest that exchange rate volatility was higher in the 1980s when compared to the 1970s. By the Schwert measure, monthly volatility in these foreign exchange markets is approximately 25 per cent higher in the 1980s. These results are consistent with the findings of previous studies. For example, Becketti and Sellon (1989), and Frenkel and Goldstein (1988) find evidence of increased exchange rate volatility in the 1980s.

Turning attention to the correlations among monthly volatility estimates, the behaviour of the yen-dollar exchange rate volatility across these periods is notable. During the 1970s, the yen-dollar monthly volatilities were strongly positively correlated with the other bilateral exchange rate volatilities. During the 1980s, this strong correlation dissipated to the point that there is no significant correlation with any exchange rate volatility during the 1980s.

The results reported in Table 16 suggest that although exchange rate volatility was higher in the 1980s, there is no strong evidence that volatility was increasing throughout the decade. Average monthly volatility levels were about the same over the first and second halves of the decade. The pattern among monthly volatility correlations identified in Table 15, also appears in Table 16. In particular, although other exchange rate volatility correlations remain strong throughout the 1980s, the yen-dollar exchange rate monthly volatility is not correlated with any of the other bilateral exchange rates in either half of the 1980s.

REAL AND FINANCIAL MARKET CONSEQUENCES OF FINANCIAL MARKET VOLATILITIES

Excessive financial market volatility may have important effects on real economic activity and the functioning of capital markets. Periods of extreme volatility may strain the financial market clearing and settlement infrastructure, causing a loss of investor confidence in the solvency of trading counterparties, and thereby reduce market participation and liquidity at a time it is most needed. Such a loss of confidence would intensify volatility and could potentially lead to a temporary breakdown in organised trading. Indeed some attribute the "free fall" in U.S. stock prices on

October 19, 1987 to such investor concerns (see Genotte and Leyland, 1990). Such a severe loss of investor confidence would certainly have effects on the cost and availability of investment capital. The October 1987 stock market crash heightened governmental interest in the integrity of financial markets, and subsequently measures designed to reduce the systemic risk of financial markets have been proposed and implemented (8).

Aside from the issues of market integrity and counterparty risk management, excessive volatility affects the prices of, and required rates of return on, financial assets. Theoretical asset pricing models indicate that risky assets' equilibrium risk premia are increasing functions of their nondiversifiable conditional return volatility. Higher required rates of return imply lower financial asset values. Empirical evidence supports the theoretical predictions, finding that ex post rates of return are positively related to non-diversifiable return variability. The higher discount rates implied by excess volatility imply higher corporate costs of capital and a corresponding reduction in real investment spending, other things constant.

Although stock return volatility may have important effects on required rates of return and corporate costs of capital, empirical evidence suggests that, in the aggregate, accelerator-based models of investment explain investment spending at least as well as neoclassical cost-of-capital models (see, for example, Clark 1979). More direct micro-level evidence on the cost of capital's effect on financing plans exists from survey results.

A recent study by the New York Stock Exchange (9) includes a survey of investors' and corporations' attitudes and opinions about the conditions and investor climate in the stock market. Given the intense media and regulatory attention given recently to stock market volatility, the survey's results are surprising. When corporate representatives were asked their concerns about the stock market, only 15 per cent of those responding expressed a concern about the level of market volatility: 50 per cent responded that the level of market volatility will not affect their equity or debt offering plans, and only 20 per cent indicated that the current stock market condition would affect their future financing plans. It may be that the cost of capital effects on financing and investment plans are more subtle than neoclassical investment theory suggests.

Table 17 reports the results of a regression of monthly non-financial equity issuance on its lagged value, and the deviations of the S&P 500's price-earnings ratio and monthly stock returns volatility from their sample averages. The results suggest that equity issuance increases when market price-earnings ratios are relatively high, and issuance is reduced by above-average market volatility, although the latter effect is not statistically significant. These results do not suggest that temporary periods of volatility have strong effects on firms' ability to raise equity capital.

Financial market volatility may have indirect effects on the real economy through its effects on consumer and investors expectations. Financial price volatility will reflect the volatility of the underlying economic fundamentals, and as some have suggested, it may reflect excess trading-induced factors as well. If the contributing sources of volatility are not identifiable -- and it would appear that they are not given intense debate in the financial economics profession -- then episodes of heightened volatility

may be interpreted as an indication that the uncertainties regarding the values of future economic fundamentals have increased. Increased financial market volatility could induce a loss of consumer confidence and indirectly affect real consumption and investment decisions.

Table 17 reports the results of a regression of the University of Michigan's Survey Research Center's consumer sentiment index for all families on the lagged index's value, the contemporaneous month's U.S. stock market return, volatility, and 3 lagged values of monthly stock returns volatility. The regression results show no evidence of an association between higher stock returns volatility and reduced consumer confidence. Although only preliminary at best, these results do not indicate that transitory periods of volatility stock prices are likely to have major impacts on consumer confidence.

The lack of a strong link between temporary periods of heightened financial market volatility and significant real effects is illustrated by events subsequent to the October 1987 and October 1989 stock market crashes. Estimates of aggregate consumption models indicate that an extra "permanent" dollar of stock market value translates into an extra 3 to 7 cents of real consumption expenditures (10). Apparently the recent episodes of transitory excess volatility have not altered agents' expectations of the permanent value of their stock holdings. Although these two crashes represent the highest volatility periods since the 1930s, neither stock market crash has been associated with significant deterioration in real consumption or investment activity. When investigating the impact of the 1987 stock market crash on real consumption spending, economists find only minor effects (Garner, 1988).

Although theory may predict a linkage between volatility in financial markets and real economic activity, the empirical evidence and survey results, to date, do not indicate that the levels of volatility experienced thus far have had appreciable detrimental influences on aggregate real economic activity. Without any strong evidence that recent levels of financial volatility "matter" when measured by their affects on real economic activity, financial policies designed to attenuate transitory spikes in return variability should be critically examined. There appears to be no compelling evidence to date that short-term periods of heightened volatility have detrimental impacts on economic activity. Indeed the volatility of the market itself may be creating new financial instruments that could be used to insulate an investor from temporarily excessive volatility (see, for example, Brenner and Galai, 1989).

POLICY MEASURES TO REDUCE VOLATILITY

Aside from foreign exchange or monetary policy operations, financial policy rarely takes the form of direct government purchases or sales intervention in a market. Financial policy generally takes the form of rules for exchange trading and dealer market-maker behaviour, rules of disclosure and sales practice, approval of new product trading, rules of prudential lending requirements and the level of direct taxes for transacting in financial instruments or on financial exchanges. Since the October 1987 stock market crash, rules and proposals aimed at reducing volatility have been offered in virtually all of these areas. This discussion focuses on proposals regarding U.S. financial markets.

October 1987 was the catalyst for new rules for the exchange trading of stocks, options and index futures. Among these rules are coordinated circuit breakers, and exchange rules governing the trading of "exchange stock portfolios," ESPs.

Circuit breakers

Circuit breakers are a series of predetermined temporary price limits. When the market falls to the limit amount, trading is halted for a predetermined period of time. In the stock market, all trading is halted when a price index reaches the limit. In the futures markets, trades can occur only above the limit price. The Brady Commission, the presidential commission formed to study the October 1987 market crash, strongly recommended circuit breakers:

> "First, they limit credit risks and loss of financial confidence by providing a time-out amid frantic trading to settle up and ensure that everyone is solvent. Second, they facilitate price discovery by providing a "time-out" to pause, evaluate, inhibit panic, and publicize order imbalances to attract value traders to cushion violent movements in the market. Finally, circuit breaker mechanisms counter the illusion of liquidity by formalizing...that markets have a limited capacity to absorb massive one-sided volume." (11)

There are several theoretical arguments, based on market efficiency that suggest price limits or circuit breakers are undesirable rules. They interfere with the market's price discovery function and deprive traders of hedging options. Once trading causes prices to approach the limit, they may encourage prices to move to the limit more quickly as traders rush to beat market closure in order to eliminate the corresponding uncertainty about the value of their holdings. Arguments in favour of circuit breakers are based on the premise that substantial intra-day market price swings are not consistent with underlying fundamentals or efficiency. If large price movements are due to illiquidity or irrationality, the circuit breakers are supposed to give rational traders and providers of liquidity time to enter the market.

The current (as of June 1990) system of co-ordinated circuit breakers appears in Table 18. While the circuit breakers are roughly co-ordinated across markets in terms of equivalent price movements, in practice futures prices adjust much more quickly than do cash market indices. Consequently, futures circuit breakers are triggered while the cash and options markets remain open. This is exactly what occurred on October 13, 1989, the only day to date when both S&P 500 index futures price limits have been triggered.

Did circuit breakers attenuate volatility in their maiden trial in October 1989? There is no consensus evaluation. The SEC's report on the events of October 13, 1989 contends that the temporary closing of the futures market reduced the volatility in the cash market.

> "The imposition of the CME's 12-point price limit for the S&P futures coincided with a sharp drop-off in the level of program selling on the NYSE and a reduction in the rate of price decline in NYSE stocks. After the price limit expired at 3:30, the rate

> of the price decline in NYSE stocks increased substantially. While a direct casual relationship is difficult to establish, at a minimum, the Division's findings do not indicate any harm to the markets attributable to the imposition of the circuit breaker mechanisms...." (U.S., 1990)

The CFTC report on the "mini-crash" does not concur,

> "Shock absorbers [circuit breakers] do not appear to have moderated intraday volatility. The average levels of volatility did not decrease in the limit periods... Instead, there is evidence that a binding circuit breaker in one market is associated with increased volatility in unconstrained markets." (U.S., 1990a)

What is clear from the October 1989 experience is that when the futures market closed, volume was transferred to the cash market, options markets, and the remaining futures contracts open for trading. The closure of the futures market also impaired the function of the option market as option market makers were unable to hedge their positions using stock-index future contracts. In addition, when the options markets did close, attempts to re-open them late in the afternoon were unsuccessful. From this single incident, it would appear that the coordination of the timing of the circuit breakers might be as important a consideration as the co-ordination of the magnitudes of the moves that trigger temporary price limits.

Despite the mixed evidence on the effectiveness of circuit breakers, the New York Stock Exchange's Report to the Board of Directors, "Market Volatility and Investor Confidence," recommends increasing the number of circuit breakers.

Recommendation 1: Coordinated "circuit breakers" should be introduced to halt or limit trading in times of markets. Enhanced price and trade information should be made available during times when circuit breakers are triggered (12).

The NYSE panels recommendations for revised circuit breakers appear in Table 19.

Exchange stock portfolios

One of the major lessons of the October 1987 market crash was the illiquidity of the cash market in the face of large institutional sell orders. It is unrealistic to entertain the idea that a specialist could have access to capital sufficient to stabilise prices in a market dominated by institutional sell programmes. The large price reversals in S&P 500 stocks attributable to order imbalance on October 19 and 20 documented by Blume, MacKinley and Turker (1989) are direct evidence of the short-term lack of liquidity in this market. In order to relieve the specialists of some of the institutional trade-induced pressures on volatility, the NYSE created the "exchange stock portfolio" (ESP). The ESP is an instrument that allows an investor to purchase or sell (buy) the entire S&P 500 stock index portfolio of shares with one order. Within the NYSE, ESPs are unique in their market maker structure. Unlike individual stocks that have a simple specialist, the market for ESPs is made continuously by competing dealers. In contrast to a programme trade that sends individual stock orders to specialist posts, an ESP order is satisfied at the competitive

market maker quote avoiding the direct stock order flow to exchange specialist posts (13).

It is the intention of the NYSE that ESPs would become a preferred vehicle for institutional portfolio trades, and the unique competitive market maker system would take the institution-generated liquidity pressures off the individual stock specialists. By any measure, the success of ESPs to date has been discouraging. Trading in ESPs began in October 1989. Even on relatively volatile days, days on which there is heavy volume of index arbitrage program trading, ESP volume has been light.

The ESP represents both a new product and a new market making structure for the NYSE. The ESP is notable in that it is an innovation designed to accommodate trading, not limit it.

Sunshine trading

Another set of proposals aimed at limiting the volatility impacts of transitory periods of heavy institutional selling are so-called "sunshine trading" disclosure requirements. Dynamic hedging strategies, (portfolio insurance programmes), are positive feedback trading rules. Because of the existence of such strategies, otherwise modest market declines may trigger sales by large insured institutional portfolios. Gennotte and Leland (1990) develop a model where dynamic hedging strategies produce discontinuous jumps in stock prices similar to the experiences of the October 1987 stock market crash. The discontinuous price movements are a consequence of informational problems caused by dynamic hedging strategies.

Grossman (1988) discusses the externalities associated with the trading of synthetic financial assets. When an investor purchases a stock-index option, his expectations are reflected in the market price, strike price, and change in open interest for the option purchased. If alternatively the investor were to synthetically create the desired option's cash flow using stock-index futures and treasury securities, there is no observable market price or volume data to signal his expectations and implied demand for insurance to other market participants. In effect, if all investors were to insure their portfolios with put options, the aggregate demand for insurance would be represented in the market data on these options; whereas if all investors insure their portfolios synthetically, there is insufficient information for investors to estimate the aggregate demand for insurance. Because investors cannot determine the demand for insurance, expectations are not efficient and price discontinuities like those in the Gennotte and Leland model may develop.

Sunshine trading proposals are designed to reduce the informational problems associated with dynamic hedging by requiring dynamic hedgers to disclose their demands for insurance. Although popular following the October 1987 crash, "sunshine trading" proponents seem to have faded from view, in large part because dynamic hedging strategies have fallen in popularity. The October 1987 crash brought the realisation that dynamic hedging strategies cannot work when everyone is trying to dynamically hedge. Subsequent to the October 1987 crash, it is reportedly much more common for investors to insure their portfolios by purchasing index-put options. Although, in theory, this type of insurance should not create the informational problems associated with

dynamic hedging, in practice, insured investors are apparently purchasing individualised over-the-counter index options, not exchange-traded options (14). Because data on these options prices and open interest are not public, it would appear that the information problem associated with portfolio insurance may still exist, especially if the over-the-counter index options writers are hedging their positions dynamically.

Transactions tax

In contrast to proposals designed to accommodate trading volume and attenuate its potential effects on volatility, there are alternative proposals designed to increase the cost of financial transactions in the hope of reducing speculative trading volumes. These proposals are essentially of two types: direct transactions taxes on financial transactions and increased minimum margin requirements on leveraged transactions.

Direct taxation of financial transactions has been proposed to increase the cost of short-term speculation and encourage longer average holding periods among investors (15). Proponents of transactions taxes argue that the volume of financial transactions is not justified by informational or real investment considerations.

> "What is clear is that very little of the work of the securities industry, as gauged by the volume of market activity, has to do with the financing of real investment in any direct way." (Tobin, 1984).

Proponents argue that a small transactions tax will not significantly affect long-term investors while it will discourage short-term "noise-trader" speculators from trading. Reducing "noise-trader" generated volatility may reduce costs of capital and offset any detrimental impacts that the transaction tax might have on the supply of long term investment capital, and the alleged perverse impacts on liquidity have not been empirically documented.

Although these arguments are appealing, the practical experience with financial transaction taxes has not been positive. Many major industrialised countries have some form of securities transactions tax, and these international differences provide some basis for the analysis of transactions tax effects. As Roll (1989)documents, during the October 1987 crash, in countries with transactions taxes, stock prices fell as much or more than stock prices in countries without them. Round trip transactions taxes and average daily returns and standard deviation of returns for the 15 trading days surrounding the October 1987 crash are taken from Roll and reproduced in Table 20. In further analysis of the volatility transactions tax relationship, Roll concludes.

> "Transactions taxes are inversely but insignificantly correlated with volatility across countries, and the effect is too questionable for taxes to be used with confidence as an effective policy instrument". (p.143)

Although proponents of a transfer tax argue that its effects on stock market prices, volume and liquidity would be minor, a study by the Congressional Research Service (see Kiefer, 1987) does not support this

contention. This study estimates that the imposition of a 0.5 per cent transaction tax on stock sales would cause a 9.3 per cent reduction in the market value of stocks. In addition, the study suggests that the tax would be associated with a reduction in trading volume and an increase in market volatility due to reduced liquidity.

Further evidence from international experience suggests that unilaterally increasing a transaction tax can have undesirable outcomes. The recent experience of Sweden is illustrative. In 1984, Sweden imposed a transaction tax on financial market transactions and significantly increased the tax in 1988. Subsequently, domestic market volume, particularly on financial futures, drastically declined. Securities market transactions migrated to foreign markets, effectively destroying the domestic Swedish futures market (16)(17). If international experience is any guide, nations seem to be reducing not increasing securities transaction taxes. Sweden has recently substantially reduced its securities transactions tax and the United Kingdom is considering similar reductions on equity transactions.

Evidence from other financial markets does not support the efficacy of transactions taxes in promoting market efficiency. Real estate transaction are among the highest cost asset transactions, yet the evidence on the efficiency of real estate markets does not suggest that they are immune from volatility, "fad" expectations, or fundamental mispricing. Indeed the evidence of CPS quoted in the introduction to this paper, as well as recent historical experiences in the United Kingdom, Tokyo, or the United States would suggest that real estate markets are not any more immune to "fads" than are stock markets (18).

Margin requirements

Following the October 1987 stock market crash, there have been proposals to increase margin requirements and thereby reduce leverage in financial instruments. Increased margins are alleged to reduce volatility by restricting the behaviour of destabilising speculators. Under debate are initial margin requirements on both stocks and stock index futures. For these instruments, the required margin takes alternative forms and the required margin levels are set by alternative authorities.

Initial required margins on stocks are set by the Federal Reserve Board. The margin requirement determines the maximum legal amount that may be lent by a broker-dealer or a bank to an investor to enable him to purchase a marginable security. For example, an initial margin requirement of 60 per cent prohibits a broker-dealer or a bank from lending in excess of 40 per cent of the security's value. The Federal Reserve Board has changed initial margin requirements 23 times since their introduction in 1934. The current initial margin rate is 50 per cent and has not been altered since 1974.

Initial margin in the futures markets takes the form of a security deposit or performance bond. Initial margin is a fixed dollar amount per contract that, at the customer level, may be satisfied by depositing cash, treasury securities, securities listed on the AMEX or NYSE (valued at a 30 per cent discount), or an acceptable bank letter of credit with the Futures Commission Merchant. The dollar amount of the margin depends on the underlying contract, the type of trader posting margin (speculator, hedger, intramarket or

intermarket spreader) and the economic conditions prevailing at the time. Initial margins are set by the futures exchange's margin committee with the intent of insuring the performance of a futures position. Given an estimate of the recent and expected volatility in the underlying futures contract price, the margin committee of the futures exchange sets initial margin deposits at levels that, with a high degree of confidence, exceed a large single-day's price change of a contract, but not so large as to limit market participation.

The literature investigating the effects of margin requirements on financial asset volatility is largely focused on the effects of the Federal Reserve Board's initial margin requirement on stock price volatility. Until recently, it was accepted that no relationship of any consequence, economic or statistical, exists between initial margin requirements and stock market price volatility. A recent controversial paper by Hardouvelis (1988) disputed this position and thereby rekindled interest in this area. Since the Hardouvelis study, Schwert (1989), Kupiec (1989), Hseih and Miller (1989), and Salanger (1989) have empirically investigated the hypothesis that initial margin requirements and stock price volatility are inversely related. Without exception, they find no support for Hardouvelis's findings.

The United States is not unique in its regulation of the initial margin required to purchase stocks. Roll (op. cit.) investigates the international relationship between margin requirements and stock price volatility. He concludes,

> "For the pre-crash and post-crash periods, [the estimates] contain absolutely no evidence that margin requirements have an influence on volatility, regardless of whether returns are measured in local currency or in dollars and regardless of the length of the holding interval". (p.140)

Unlike an investment in a common stock which generates positive cash flow only at the time of sale (or dividend payment), an index futures contract generates cash flow daily as the open futures positions are marked to market. The daily mark to market and corresponding payment of variation margin (the one day gains or loss on the contract) on futures contracts resets the value of a futures position to zero at market open each day. As such, a futures margin payment is a performance bond for a one day futures position, and margins must be posed again the following day.

From a prudential standpoint, the performance bond necessary to establish a futures position need only be large enough to protect against the largest probable one-day movement in contract value (19). Based upon this prudential standard, margin in the stock-index futures market averages around 4.0 per cent for institutional investors who are generally classified as hedgers. The lower level of required prudential margin creates a substantial leverage advantage in favour of stock-index futures. Table 21 illustrates the differences in leverage between a position in an S&P 500 index-future position and an equivalent cash position in these stocks. As illustrated, for an equivalent move in the cash and futures index, the index-futures position yields twelve times the return of the maximally leveraged cash position.

Although the degree of leverage available in index-futures products relative to cash markets is often cited as prima facie evidence that futures

markets are the conduit of speculation and excess volatility, there is little statistical evidence that supports this view. Kupiec (1990) investigates the proposition that the level of cash market volatility is related to the degree of leverage in stock index-futures contracts. After extensive analysis, he concludes that the only evidence of any relationship indicates the relationship is positive, that is, high margin rates in the futures markets tend to be associated with periods of above-average volatility in the cash markets. Although the positive statistical relationship is consistent with prudential behaviour of the futures margin committee, the results indicate that it is likely to be a consequence of the heteroscedasticity observed in cash market returns. After linearly controlling for the heteroscedasticity using lagged market returns, the positive futures-margin volatility relationship is diminished. The upshot is that there is a lack of any statistically significant evidence of a relationship between the degree of leverage available in stock-index futures and cash market volatility. Consequently there is no evidence that initial margin requirements in the futures markets can be used to attenuate volatility in the cash market.

SUMMARY

Financial liberalisation and the accompanying financial market innovations that have occurred over the past twenty years appear to coincide with world-wide increases in average levels of volatility in stock returns, bond yields and exchange rates. We do not attempt to suggest the causes of the increased volatility nor do we assign a causal role to financial liberalisation policies. Accompanying this general increase in the level of financial asset price volatility, is a general increase in the strength of the positive correlations among national stock returns and the conditional volatilities of these returns. The statistical evidence indicates that nation's stock markets are more likely to record above (below) average returns simultaneously, and exhibit above (below) average return volatility concurrently. In contrast to stock markets, the yield volatilities in national corporate bond markets appear to be less correlated in the current environment, and the correlation of monthly exchange rate volatilities appear to be little changed over the last decade.

Although the average levels of volatility appear to be higher in financial markets in the 1980s, there is little evidence that suggests that the increase in volatility has had negative effects on economic activity. The world-wide stock market crash of 1987 did not significantly impact economic activity, nor has the October 1989 U.S. stock market "mini-crash" had strong real side effects.

Although recent episodes of "excess" volatility have not had obvious real economic influences, regulatory reform and reform proposals designed to limit "excess" volatility have proceeded apace. The evidence from the U.S. October 1989 mini-crash indicates that reforms designed to enhance the integrity of the financial infrastructure, that is trading capacity additions and clearing and settlement reforms, performed satisfactorily. However, the experience with "circuit breaker" temporary price limits suggests that the existing series of coordinated price limits may benefit from reforms that better address the timing of co-ordinated price limits.

NOTES

1. For an intuitive explanation of the relationship between market liquidity and the size of bid-asked spread see Appendix A2.

2. Op. cit.

3. Op. cit.

4. For example, fixed regulated equity commissions were abolished in both the United States and the U.K. subsequent to the Arab oil embargo.

5. These correlations are among yields to maturity and the month-to-month variability in yields to maturity, not correlations among bond returns. The longer the duration of a bond, the large the implied bond return volatility for a given monthly yield volatility estimate.

6. Some of the estimated reductions in correlations are substantial. especially those for the United Kingdom.

7. A particularly striking change. is the change in the U.S.-Germany correlation which changed from strongly positive in the early 1980s to strongly negative in the last half of the decade.

8. For a summary of the U.S. market changes see U.S. (1989). For international proposals see FIBV (1989). or Group of Thirty (1989).

9. "Market Volatility and Investor Confidence," Report to the Board of Directors of the New York Stock Exchange. June 1990.

10. See, for example, Pearce (1983) or Brayton and Mauskopf (1987).

11. "Report of the Presidential Task Force on Market Mechanisms," The Brady Commission, January 1988, p. 66.

12. "Market Volatility and Investor Confidence", Report to the Board of Directors to the New York Stock Exchange, June 1990, p. 3.

13. This is true for the primary quote on the ESP. Secondary quotes are also posted and are calculated from ESP-required quotes from the individual stock specialists. If a large ESP order were placed, it could involve directly sending individual orders to specialists, posts.

14. See Duffee, Kupiec and White. op. cit.

15. See, for example, Summers and Summers (1990), Stiglitz (1990) and other references therein.

16. See, for example, "Why Did SOFE Have to Die." Euromoney. March. 1989. pp. 49-51.

17. The Stockholm Stock Exchange estimates that about 1/3 of the Swedish companies, share volume was driven offshore. See, Moore (1989).

18. See Shiller (1990) for evidence on the fad expectations operative in real estate markets.

19. In fact, margins are calculated and collected multiple times a trading day, so in practice, the margin need not cover a full day's potential price move.

Table 1

CORRELATIONS OF MAJOR STOCK MARKET RETURNS +
UNDER FIXED AND FLOATING EXCHANGE RATES

	United States	Germany	Japan	United Kingdom
United States	1.0	0.35	0.20	0.38
Germany	0.42	1.0	0.16	0.26
Japan	0.39	0.48	1.0	0.17
United Kingdom	0.56	0.41	0.42	1.0

+ Adapted from Dwyer and Hafer, "Are National Markets Linked?", Federal Reserve Bank of St. Louis Review, November/December 1988.

Correlations are of the logarithms of price-index changes where prices are measured in a common currency.

The fixed exchange rate correlations appear above the main diagonal; the floating exchange rate correlations below the diagonal.

Table 2

APPROXIMATE CORRELATIONS OF CHANGES IN STOCK PRICE
INDICES DURING ALTERNATIVE CRISIS PERIODS +

	United States	Germany	Japan	United Kingdom
United States	1.0	0.36	0.32	0.44
Germany	0.29	1.0	0.29	0.41
Japan	0.77	0.59	1.0	0.37
United Kingdom	0.59	0.72	0.68	1.0

+ 1973 oil embargo crisis period correlations estimates appear above the diagonal; 1987 stock market crash period correlations appear below the diagonal. The correlation estimates are adapted from Bennett and Kelleher (1987 crash period, op. cit.) and Hilliard (the 1973 oil embargo period, op. cit.). The estimates taken from Bennett and Kelleher correspond to the start of the trading day producing the largest estimated correlations.

Table 3

CORPORATE BOND YIELD CHARACTERISTICS UNDER
FIXED AND FLOATING EXCHANGE RATES

AVERAGE NOMINAL ANNUAL YIELDS

	Fixed	Floating
France	7.21%	12.06%
Germany	6.79	8.04
Italy	6.66	14.16
United Kingdom	7.66	13.08
United States	5.28	10.33

CORPORATE BOND YIELD CORRELATIONS +

	France	Germany	Italy	United Kingdom	United States
France	1.0	0.80*	0.60*	0.93*	0.94*
Germany	0.50*	1.0	0.67*	0.69*	0.72*
Italy	0.83*	0.46*	1.0	0.63*	0.68*
United Kingdom	0.29*	0.78*	0.38*	1.0	0.95*
United States	0.79*	0.43*	0.72*	0.08	1.0

Notes: Fixed exchange rate sample is 1/60 to 12/70.
Floating exchange rate sample is 1/74-2/90.
A description of the bond indices is included in Appendix A4.

+ Fixed exchange rate sample return correlations appear above the diagonal; floating rate sample return correlations appear below the diagonal.

* Indicates statistical significance at the 5 per cent level.

Table 4

CORPORATE BOND YIELD VOLATILITY CHARACTERISTICS
UNDER FIXED AND FLOATING EXCHANGE RATES

AVERAGE NOMINAL YIELD STANDARD DEVIATION

	Fixed	Floating
France	0.31%	0.49%
Germany	0.14	0.19
Italy	0.22	0.44
United Kingdom	0.19	0.36
United States	0.09	0.25

CORRELATIONS OF MONTHLY CORPORATE BOND
YIELD VOLATILITY ESTIMATES +

	France	Germany	Italy	United Kingdom	United States
France	1.0	0.20*	0.14*	0.15	0.14
Germany	0.16*	1.0	0.43*	0.23*	0.37*
Italy	-0.05	0.01	1.0	0.08	0.01
United Kingdom	0.15*	0.13	-0.02	1.0	0.37*
United States	-0.06	0.41*	0.07	-0.09	1.0

Notes: Fixed exchange rate sample is 1/60 to 12/70.
Floating exchange rate sample is 1/74-2/90.
Volatility estimates are monthly estimates of the standard deviation of returns from the Schwert estimator.

+ Fixed exchange rate sample return volatility correlations appear above the diagonal; floating rate sample return correlations appear below the diagonal.

* Indicates statistical significance at the 5 per cent level.

Table 5

CORPORATE BOND YIELD VOLATILITY ESTIMATES
FOR 1980-84, 1985-90 +

AVERAGE LEVEL OF BOND YIELD VOLATILITY PER MONTH

	1980-84	1985-89
France	0.35%	0.38%
Germany	0.24	0.14
Italy	0.40	0.58
United Kingdom	0.33	0.27
United States	0.41	0.23

BOND YIELD VOLATILITY CORRELATIONS

	France	Germany	Italy	United Kingdom	United States
France	1.0	0.09	0.21	0.04	-0.02
Germany	0.26*	1.0	0.13	-0.16	0.54*
Italy	0.10	-0.05	1.0	0.01	0.18
United Kingdom	0.28*	-0.25*	0.07	1.0	0.23
United States	0.05	-0.34*	-0.16	0.25*	1.0

Notes: + Volatility estimates are estimates of monthly standard deviations of bond yields based on the Schwert estimator. The 1990 data is through February. A description of the bond indices is included in the text.

* Indicates statistical significance at the 5 per cent level.

Table 6

AVERAGE MONTHLY STOCK INDEX RETURN VOLATILITY *
(per cent standard deviations)

	Fixed Exchange rate (1961-1970)	Floating Exchange rate (1974-1989)
Belgium	3.28%	3.60%
Canada	3.85	4.26
Finland	3.15	3.18
France	4.83	5.66
Germany	3.94	3.52
Ireland	3.42	5.13
Italy	5.08	5.43
Japan	3.48	3.01
Netherlands	3.97	3.94
Norway	4.20	5.83
Spain	2.98	5.14
Sweden	3.46	4.65
Switzerland	4.30	3.92
United Kingdom	3.68	4.32
United States	3.10	3.43

* For index descriptions, see Appendix A4.

Table 7

MONTHLY RETURN CORRELATIONS +
(Fixed and Floating Exchange Rates)

	Belgium	Canada	Finland	France	Germany	Ireland	Italy	Japan	Netherlands	Norway	Spain	Sweden	Switzerland	United Kingdom	United States
Belgium	1.0	0.30*	0.10*	0.54*	0.28*	0.07	0.22*	0.17*	0.43*	0.03	0.24*	0.28*	0.44*	0.33*	0.47*
Canada	0.36	1.0	0.13	0.23*	0.39*	0.11	0.14	0.14	0.57*	-0.17	0.06	0.29*	0.49*	0.36*	0.59*
Finland	0.26*	0.09	1.0	0.24*	0.05	0.02	-0.03	0.20*	0.03	0.26*	0.21*	0.16	-0.04	0.14	0.04
France	0.53*	0.45*	0.13	1.0	0.31*	-0.02	0.30*	0.15	0.31*	0.00	0.36*	0.10*	0.44*	0.22*	0.28*
Germany	0.41*	0.19*	0.20*	0.32	1.0	0.10	0.13	-0.02	0.45*	0.17	0.11	0.19*	0.50*	0.24*	0.39*
Ireland	0.00	-0.07	0.14	-0.01	0.06	1.0	-0.01	0.07	0.09	0.25*	0.10	0.08	0.10	0.09	0.09
Italy	0.25*	0.22*	0.18*	0.19*	0.33*	0.03	1.0	0.24*	0.08	0.07	0.10	-0.02	0.30*	0.11	0.21*
Japan	0.24*	0.21*	0.17*	0.36*	0.31*	0.16*	0.28*	1.0	0.17*	0.00	0.20*	0.21*	0.12	0.21*	0.19*
Netherlands	0.50*	0.56*	0.23*	0.44*	0.47*	-0.05	0.26*	0.21	1.0	0.02	0.03	0.31*	0.67*	0.42*	0.46*
Norway	-0.05	-0.25*	0.20*	-0.02	0.02	0.45*	-0.07	0.03	-0.17	1.0	0.19	-0.11	-0.25*	0.04	-0.09
Spain	0.32*	0.27*	0.20*	0.29*	0.26*	-0.02	0.27*	0.24*	0.34	-0.30*	1.0	0.24*	0.16	0.10	0.05
Sweden	0.23*	0.35*	0.24*	0.24*	0.24*	-0.07	0.20*	0.19*	0.44*	-0.10	0.30*	1.0	0.27*	0.18*	0.24*
Switzerland	0.50*	0.56*	0.14	0.46*	0.49*	-0.02	0.23*	0.18*	0.70*	-0.01	0.28*	0.44*	1.0	0.38*	0.41*
United Kingdom	0.35*	0.33*	0.09	0.24*	0.39*	0.02	0.32*	0.37*	0.41*	-0.21	0.23*	0.27*	0.36*	1.0	0.45*
United States	0.45*	0.60*	0.11	0.38*	0.42*	0.05	0.31*	0.40*	0.53*	-0.13	0.32*	0.33*	0.52*	0.53*	1.0

+ The fixed exchange rate sample is 1/61-12/70. The floating exchange rate sample is 1/74-12/89. Fixed exchange rate corrlations appear above the main diagonal; floating exchange rate correlations appear below the diagonal.

* Indicates that the correlation coefficient is significantly different from zero at the 5 per cent level of the test.

Table 8

MONTHLY AVERAGES OF STOCK INDEX RETURNS AND VOLATILITIES

	Returns (per cent)		Return volatilities * (per cent standard deviations)	
Sample Period	1980-1984	1985-1989	1980-1984	1985-1989
Belgium	0.88%	1.38%	3.68%	3.72%
Canada	0.65	0.95	4.71	3.81
Finland	1.79	1.73	3.16	3.50
France	1.21	2.03	5.39	5.90
Germany	0.73	1.22	3.18	4.02
Ireland	0.67	2.37	4.69	5.44
Italy	1.65	2.39	5.25	5.65
Japan	1.16	2.04	2.63	3.47
Netherlands	1.46	0.99	3.90	3.85
Norway	1.61	1.78	5.95	5.79
Spain	1.12	2.66	4.52	5.61
Sweden	2.41	2.20	4.88	4.81
Switzerland	0.38	0.98	3.53	4.37
United Kingdom	1.62	1.31	3.79	4.31
United States	0.78	1.38	3.30	3.56

* Monthly return volatilities are estimates of the standard deviation of returns, by month, from the Schwert volatility estimator. The composition of the indices appears in the notes to Table 6.

Table 9

FIXED AND FLOATING EXCHANGE RATE STOCK RETURN VOLATILITY CORRELATIONS +

	Belgium	Canada	Finland	France	Germany	Ireland	Italy	Japan	Netherlands	Norway	Spain	Sweden	Switzerland	United Kingdom	United States
Belgium	1.0	-0.08	0.13	0.10	-0.16	-0.28*	-0.10	-0.15	-0.09	0.26*	0.13	0.25*	0.01	0.06	0.02
Canada	0.02	1.0	0.07	0.13	0.26*	0.07	-0.08	0.06	0.38*	-0.16	0.51*	0.32*	0.48*	0.21*	0.29*
Finland	0.11	-0.04	1.0	0.16	0.03	-0.15	-0.03	-0.19*	-0.02	0.17	-0.04	0.13	-0.03	0.19*	0.19*
France	0.19*	0.17*	0.22*	1.0	-0.03	0.13	0.18	-0.11	0.06	0.05	0.41	0.10	-0.26*	-0.21*	-0.24*
Germany	0.14*	0.19*	0.23*	0.20*	1.0	-0.19*	-0.01	0.13	0.14	0.14	0.21*	0.28*	0.29*	0.16	0.20*
Ireland	-0.08	0.06	0.01	0.30*	0.20*	1.0	0.10	0.04	0.15	0.09	0.35*	-0.02	0.16	-0.10	-0.01
Italy	0.12	-0.02	0.02	0.13	0.02	0.01	1.0	-0.03	-0.03	-0.07	-0.11	-0.08	-0.12	-0.16	-0.04
Japan	0.11	0.00	0.14*	0.02	0.19*	0.20*	-0.06	1.0	0.05	-0.19	0.08	-0.07	0.13	0.16	0.24*
Netherlands	-0.04	0.27*	0.07	-0.03	0.23*	-0.01	-0.01	0.10	1.0	-0.16	0.36*	0.21*	0.28*	0.15	0.11
Norway	0.14	0.02	0.00	0.32*	-0.09	0.49*	0.16	0.01	-0.29*	1.0	-0.05	-0.03	-0.27*	0.18	0.04
Spain	0.04	0.22*	0.09	0.26*	0.31*	0.33*	0.18*	0.21*	0.20*	0.19	1.0	0.27*	0.18	-0.05	0.07
Sweden	0.16*	0.11	0.19*	0.16*	0.27*	0.01	0.11	0.16*	0.14*	0.02	0.19*	1.0	0.29*	0.33*	0.19*
Switzerland	0.21*	0.38*	0.03	0.00	0.42*	0.16*	0.13	0.33*	0.24*	-0.09	0.31*	0.33*	1.0	0.23*	0.24*
United Kingdom	0.13	0.11	0.02	0.03	0.26*	0.21*	0.01	0.22*	-0.09	0.16	0.08	0.20*	0.22*	1.0	0.31*
United States	0.01	0.26*	0.16*	0.02	0.06	0.06	0.02	0.38*	0.12	0.29*	-0.02	0.09	0.27*	0.27*	1.0

+ Fixed exchange rate sample correlations (1961-1970) appear above the main diagonal; floating exchange rate sample correlations (1974-1989) appear below the diagonal.

* Indicates that the correlation coefficient is significantly different from zero at the 5 per cent level of the test.

Table 10

FIXED AND FLOATING EXCHANGE RATE STOCK RETURNS VOLATILITY CORRELATIONS +

	United States	United Kingdom	Japan	France	Germany
United States	1.0	0.31*	0.24*	-0.24	0.20*
United Kingdom	0.27*	1.0	0.16	-0.21	0.16
Japan	0.38*	0.01	1.0	-0.11	0.13
France	0.02	0.03	0.02	1.0	-0.03
Germany	0.06	0.26*	0.19*	0.20*	1.0

+ Sample correlation estimates for the period 1961-1970 (fixed) appear above the main diagonal; correlation estimates for the sample period 1974-1989 (floating) appear below the diagonal.

* Indicates that the correlation coefficient is significantly different from zero at the 5 per cent level.

Table 11

MONTHLY RETURN CORRELATIONS +
(1980-1984, 1985-1989)

	Belgium	Canada	Finland	France	Germany	Ireland	Italy	Japan	Netherlands	Norway	Spain	Sweden	Switzerland	United Kingdom	United States
Belgium	1.0	0.19	0.21	0.43*	0.31*	-0.10	0.16	0.26*	0.39*	0.18	-0.16	-0.09	0.38*	0.31*	0.28
Canada	0.48*	1.0	-0.06	0.24	0.37*	-0.08	0.31*	0.31*	0.47*	0.24	0.01	0.30*	0.63*	0.46*	0.67*
Finland	0.23	0.03	1.0	0.02	0.21	0.12	0.07	0.09	0.28*	0.13	0.10	0.14	0.07	-0.10	-0.14
France	0.62*	0.59*	0.11	1.0	0.21	-0.08	0.02	0.38*	0.30*	0.38*	0.07	0.05	0.36*	0.24	0.35*
Germany	0.46*	0.23	0.28*	0.40*	1.0	0.08	0.13	0.37*	0.48*	0.25*	0.24	0.15	0.48*	0.36*	0.47*
Ireland	0.08	-0.13	0.26*	0.07	0.12	1.0	-0.04	0.18	0.04	-0.09	0.05	0.08	-0.10	-0.10	-0.00
Italy	0.24	0.22	0.24	0.23	0.45*	0.12	1.0	0.18	0.30*	0.17	0.17	0.16	0.12	0.35*	0.21
Japan	0.25	0.22	0.27*	0.32*	0.29*	0.15	0.28*	1.0	0.36*	0.39*	0.27*	0.16	0.38*	0.50*	0.37*
Netherlands	0.53*	0.75*	0.10	0.54*	0.48*	-0.12	0.33*	0.26*	1.0	0.14*	0.13	0.24*	0.59*	0.44*	0.46*
Norway	0.21	0.08	0.38	0.13	0.57*	0.09	0.20	0.26*	0.26*	1.0	0.13	0.23*	0.20	0.34*	0.33*
Spain	0.52*	0.58*	0.20	0.47*	0.26*	0.00	0.38*	0.25	0.49*	0.02	1.0	0.06	-0.01	-0.03	0.09
Sweden	0.39*	0.45*	0.27*	0.44*	0.34*	-0.14	0.27*	0.19	0.65*	0.26*	0.40*	1.0	0.31*	0.08	0.18
Switzerland	0.53*	0.67*	0.06	0.59*	0.54*	0.00	0.32*	0.10	0.80*	0.19	0.46*	0.55*	1.0	0.36*	0.53*
United Kingdom	0.40*	0.43*	0.35*	0.31*	0.43*	-0.14	0.35*	0.33*	0.52*	0.50*	0.43*	0.46*	0.37*	1.0	0.51*
United States	0.57*	0.67*	0.19*	0.44*	0.45*	-0.01	0.31*	0.42*	0.67*	0.48*	0.49*	0.52*	0.53*	0.59*	1.0

+ Monthly return correlations calculated over the sample period 1980-84 appear above the main diagonal; return correlations over the sample period 1985-89 appear below the diagonal.

* Indicates that the correlation coefficient is significantly different from zero at the 5 per cent level.

Table 12

MONTHLY VOLATILITY CORRELATIONS +
(1980-1984, 1985-1989)

	Belgium	Canada	Finland	France	Germany	Ireland	Italy	Japan	Netherlands	Norway	Spain	Sweden	Switzerland	United Kingdom	United States
Belgium	1.0	0.00	-0.01	0.08	-0.10	-0.19	-0.03	-0.14	-0.10	-0.03	0.00	-0.03	0.08	0.04	0.00
Canada	0.00	1.0	-0.11	0.13	0.26*	-0.19	-0.03	-0.04	0.26*	0.19	0.19	-0.11	0.43	-0.11	0.21
Finland	0.26*	0.02	1.0	0.24	0.08	0.17	-0.13	0.08	0.12	0.43*	0.14	0.20	-0.07	-0.06	-0.04
France	0.35*	0.31*	0.27*	1.0	-0.11	-0.03	0.29	-0.20	-0.08	-0.08	0.20	-0.06	-0.41*	-0.24	-0.11
Germany	0.28*	0.25*	0.29*	0.41*	1.0	-0.10	-0.12	-0.13	0.38*	0.36*	0.15	0.29*	0.46*	0.22	-0.09
Ireland	-0.07	0.29*	-0.01	0.46*	0.34*	1.0	0.02	0.27*	0.07	0.10	0.36*	0.17	0.05	-0.15	-0.06
Italy	0.25*	-0.03	0.12	0.21	0.06	-0.01	1.0	-0.16	0.12	-0.02	0.13	0.08	0.10	0.00	0.04
Japan	0.09	0.24	-0.01	0.21	0.36+	0.26*	-0.11	1.0	0.07	0.17	-0.11	0.05	0.07	0.02	0.19
Netherlands	0.09	0.22	0.01	0.06	0.23	-0.10	-0.10	-0.17	1.0	0.28*	0.36*	0.13	0.46*	-0.11	0.20
Norway	0.27*	0.99*	0.22	0.39*	0.28*	0.18	0.00	0.15	0.24	1.0	0.17	0.29*	0.15	0.10	0.09
Spain	0.16	0.44*	0.08	0.34*	0.41*	0.39*	0.24	0.22	0.05	0.10	1.0	0.23	0.26*	-0.21	-0.05
Sweden	0.29*	0.38*	0.11	0.34*	0.29*	-0.04	0.12	0.47*	0.12	0.34*	0.24	1.0	0.27*	0.19	-0.09
Switzerland	0.22	0.47	-0.01	0.25*	0.37*	0.21	0.07	0.40*	0.18	0.24	0.36*	0.50*	1.0	0.02	0.13
United Kingdom	0.20	0.37*	0.10	0.23	0.33*	0.17	-0.03	0.31*	-0.15	0.39*	0.16	0.40*	0.30*	1.0	0.06
United States	-0.07	0.35*	-0.04	0.22	-0.05	0.24	-0.11	0.42*	-0.05	0.46*	-0.13	0.32*	0.18	0.42*	1.0

+ Sample correlation estimates for the period 1980-1984 appear above the main diagonal; correlation estimates for the sample period 1985-1989 appears below the diagonal. Volatility estimates are estimates of monthly return standard deviations from the Schwert estimator.

* Indicates that the correlation coefficient is significantly different from zero at the 5 per cent level of the test

Table 13

MONTHLY RETURN CORRELATIONS +
(1980-1984, 1985-1989)

	United States	United Kingdom	Japan	France	Germany
United States	1.0	0.51*	0.37*	0.35*	0.47*
United Kingdom	0.59*	1.0	0.50*	0.24	0.36*
Japan	0.42*	0.33*	1.0	0.38*	0.37*
France	0.44*	0.31*	0.31*	1.0	0.21
Germany	0.45*	0.43*	0.29*	0.40*	1.0

+ Sample correlation estimates for the period 1980-1984 appear above the main diagonal; correlation estimates for the sample period 1985-1989 appear below the diagonal.

* Indicates that the correlation coefficient is significantly different from zero at the 5 per cent level of the test.

Table 14

MONTHLY RETURNS VOLATILITY CORRELATIONS +
(1980-1984, 1985-1989)

	United States	United Kingdom	Japan	France	Germany
United States	1.0	0.06	0.19	-0.11	-0.09
United Kingdom	0.42*	1.0	0.02	-0.24	0.22
Japan	0.42*	0.31*	1.0	-0.20	-0.13
France	0.22	0.23	0.21	1.0	-0.11
Germany	-0.05	0.33*	0.36*	0.41*	1.0

+ Sample correlation estimates for the period 1980-1984 appear above the main diagonal; correlation estimates for the sample period 1985-1989 appear below the diagonal. Volatility estimates are estimates of monthly return standard deviations from the Schwert estimator.

* Indicates that the correlation coefficient is significantly different from zero at the 5 per cent level of the test.

Table 15

BI-LATERAL EXCHANGE RATE VOLATILITIES
(1974-1979, 1980-1989)

Average monthly volatility (+)

	1974-79	1980-89
	(Per cent)	
DM/$	2.02	2.50
Yen/$	2.05	2.60
FF/$	1.95	2.54
£/$	1.78	2.33

Monthly volatility correlations (++)

	DM/$	Yen/$	FF/$	£/$
DM/$	1	0.56 (*)	0.83 (*)	0.16
Yen/$	-0.06	1	0.49 (*)	0.24 (*)
FF/$	0.78 (*)	-0.01	1	0.29 (*)
£/$	0.34 (*)	-0.07	0.28 (*)	1

+) Monthly volatility estimates are estimates of the monthly standard deviations of logarithmic difference of exchange rates estimated using the Schwert volatility estimator.

++) Correlations for the 1974-79 sample period appear above the main diagonal; correlations from the 1980-89 sample period appear below the diagonal.

*) Indicates that the correlation is significantly different from 0 at the 5 per cent level.

Table 16

BI-LATERAL EXCHANGE RATE VOLATILITIES
(1980-84, 1985-89)

Average monthly volatilities (+)

	1980-84	1985-89
	(Per cent)	
DM/$	2.48	2.53
Yen/$	2.54	2.66
FF/$	2.53	2.56
£/$	2.07	2.60

Monthly volatility correlations (++)

	DM/$	Yen/$	FF/$	£/$
DM/$	1	0.02	0.77 (*)	0.17
Yen/$	-0.14	1	0.09	-0.01
FF/$	0.81 (*)	-0.09	1	0.18
£/$	0.50 (*)	-0.16	0.36 (*)	1

+) Monthly volatility estimates are estimates of the monthly standard deviations of logarithmic difference of exchange rates estimated using the Schwert volatility estimator.

++) Correlations for the 1980-84 sample period appear above the main diagonal; correlations from the 1985-89 sample period appear below the diagonal.

*) Indicates that the correlation is significantly different from 0 at the 5 per cent level.

Table 17

ECONOMIC EFFECTS OF TEMPORARY INCREASES IN EQUITY MARKET VOLATILITY

Sensitivity of Equity Issuance to Market Volatility Conditions

Variable	Estimate	T-Statistic	P-Value
Constant	596.50	5.41	0.01
P/E ratio	38.99	2.21	0.03
Volatility	-53.76	0.74	0.46
Lagged equity issuance	0.62	9.78	0.01
R^2	0.48		

Equity issuance is monthly non-financial equity (May 1976-December 1989) from the Federal Reserve Bulletin. P/E ratio is the deviation from the sample average of the S&P 500's price-earning ratio. Volatility is the deviation from the sample average of the Schwert monthly volatility estimate for the U.S. equity market estimated from OECD data.

Estimate of stock returns volatility effects on consumer confidence

Regressor	Estimate	T-Statistic
Constant	78.28	9.67
Market return	0.153	0.46
Market volatility	-0.71	0.42
Market volatility lagged one month	-0.21	0.13
Market volatility lagged two months	-0.12	0.1
Market volatility lagged three months	-0.14	-0.1
R^2		0.02

Consumer confidence is measured by the University of Michigan's Survey Research Center's Consumer Confidence Index for all Families. The data is monthly from January 1976 through May 1990.

Table 18

SUMMARY OF CO-ORDINATED CIRCUIT BREAKERS

Dow Jones Industrial average price	Approximate S&P 500 price price move	NYSE circuit breaker	Chicago mercantile exchange circuit breaker
-25.0	-3.0	Small orders given priority in order flow.	
-40.0	-5.0		Opening price limit* binding for 10 minutes.
-50.0	-6.25	All programme trades separated to "sidecar" and delayed for 15 minutes.	
-90.0	-11.25	All programme trades separated and delayed for 30 minutes.	
-96.0	-12.00		Price limit for 30 minutes or until 2.30 p.m. CT.
-250.0	-30.0	1 hour trading halt.	1 hour** trading halt.
-400.0	-50.0	2 hour trading halt, NYSE may reopen.	2 hour trading halt and maximum daily price limit.

* If within the first 10 minutes of trading, the S&P 500 contract moves more than 10 points, trades outside these bonds are prohibited.

** Trading resumes when 50 per cent of the S&P 500 index stocks have resumed trading on the cash market.

Table 19

S&P 500	DJIA	Duration of halt
	Up or down movement	
12 points	100 points (3.5 per cent)	60 minutes
24 points	200 points (7.1 per cent)	90 minutes
36 points	300 points (10.7 per cent)	120 minutes
48 points	400 points (14.2 per cent)	120 minutes

Table 20

ROUND TRIP TRANSACTION TAXES AND VOLATILITY DURING THE OCTOBER 1987 WORLD STOCK MARKET CRASH

	Round-trip transaction tax	Local currency average daily return over 12-30 Oct.1987	Daily return standard deviation
Australia	0.6	-3.51%	8.31%
Austria	0.3	-0.83	1.66
Belgium	0.375	-1.65	4.32
Canada	0.00	-1.52	5.41
Denmark	1.0	-1.12	2.68
France	0.3	-1.65	4.57
Germany	0.5	-1.59	4.18
Hong Kong	0.6	-5.42	12.07
Ireland	1.0	-2.63	5.25
Italy	0.3	-1.39	3.18
Japan	0.55	-0.98	5.57
Malaysia	0.03	-3.61	6.03
Mexico	0.00	-3.41	6.89
Netherlands	1.2	-1.60	5.68
New Zealand	0.00	-2.05	5.30
Norway	1.0	-2.59	7.44
Singapore	0.5	-3.97	10.18
South Africa	1.5	-2.04	3.62
Spain	0.11	-2.42	3.29
Sweden	2.0	-1.90	4.53
Switzerland	0.9	-2.07	5.41
United Kingdom	0.5	-2.08	4.94
United States	0.00	-1.41	7.25

Table 21

STOCK-INDEX FUTURES LEVERAGE EXAMPLE

Close (t)	Close (t+1)	Change	Cash payment
360.00	361.80	1.80	$900

	Required margin	1-day return on investment
Stock-index Futures	$7500	12%
Stock Equivalent	$90,200	1%

Chart 1

S&P 500 Intra-Day Volatility Estimates

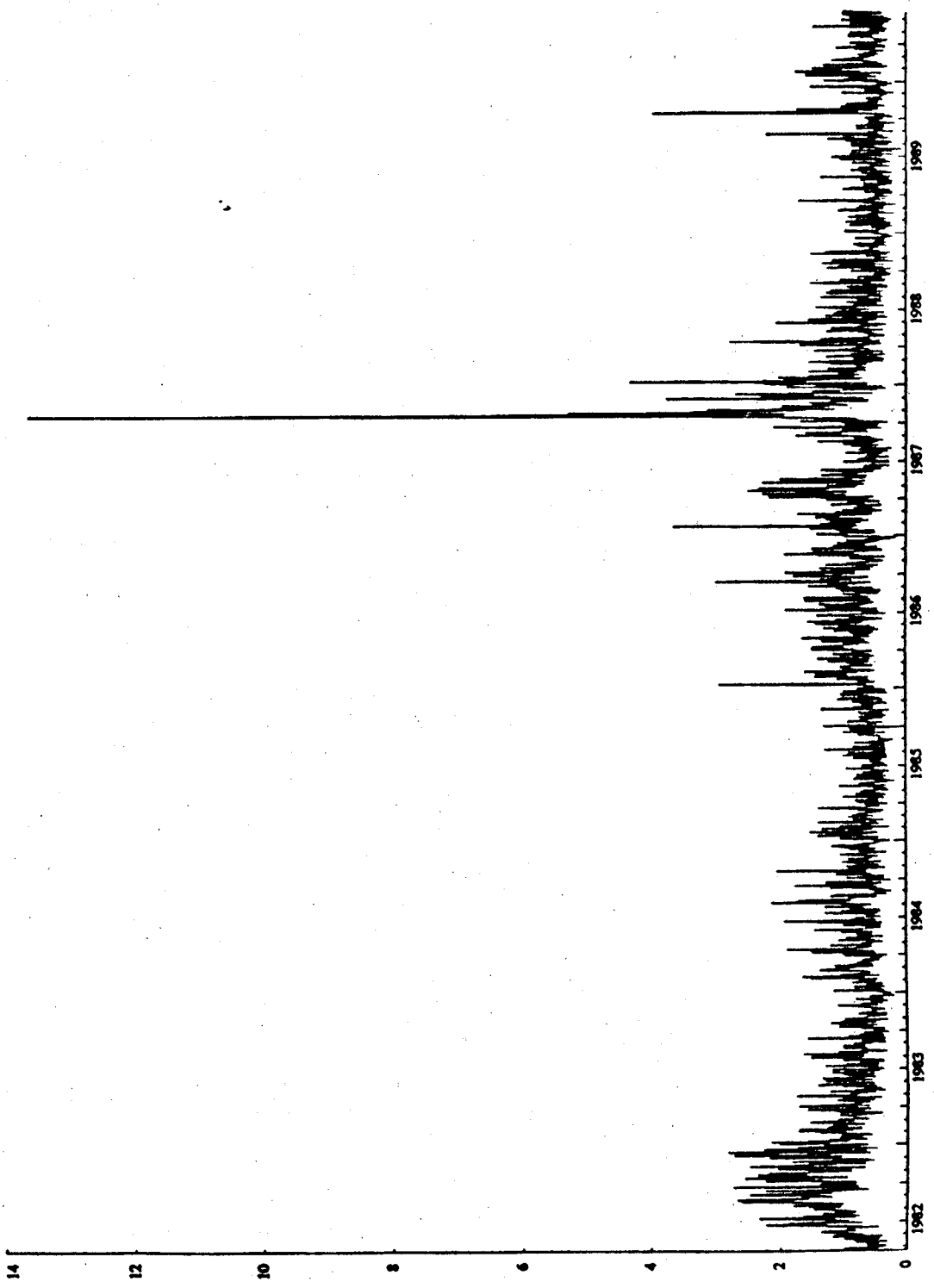
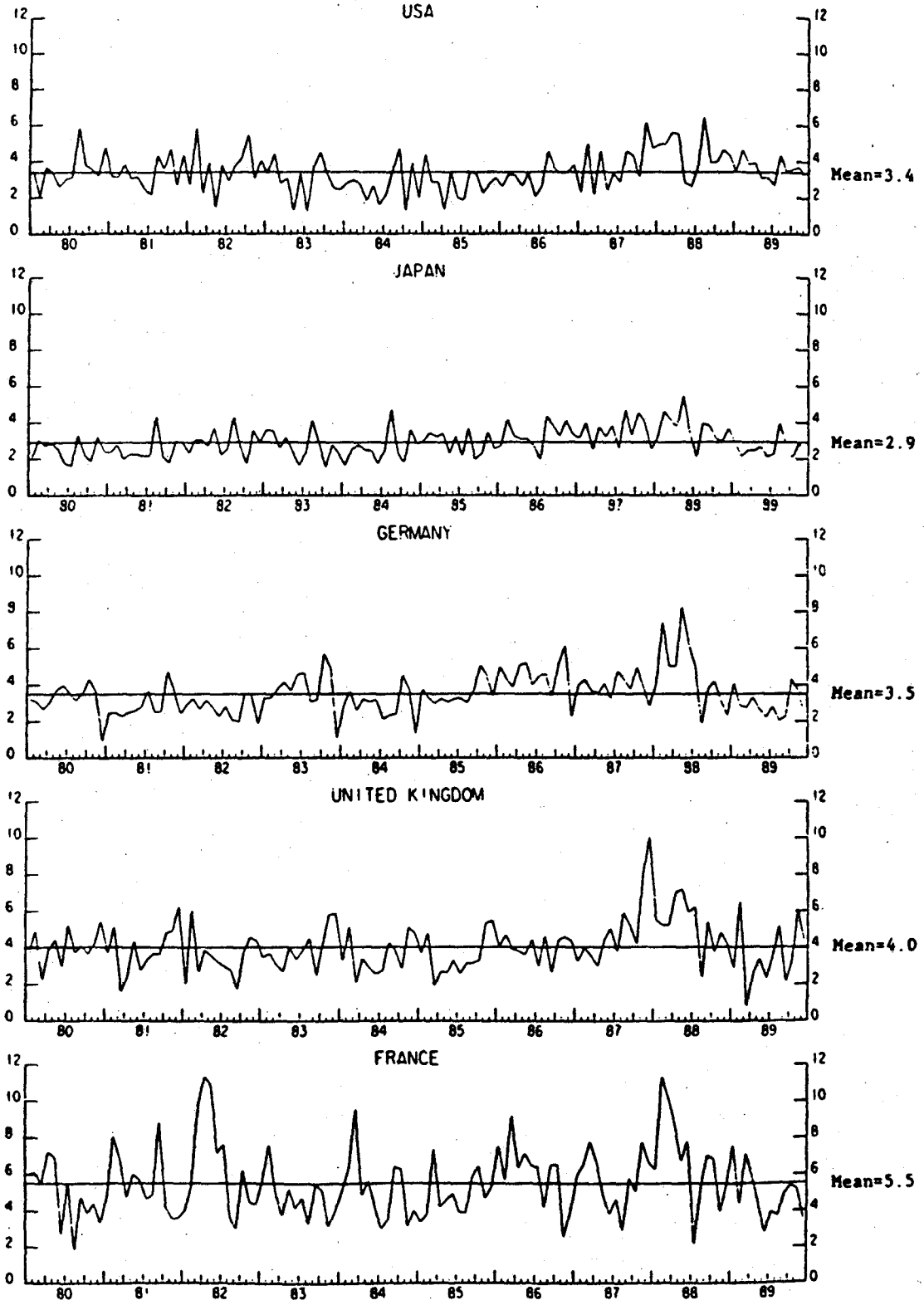


Chart 2

Monthly Stock Returns Volatility



APPENDIX A1

A COMPARISON OF ALTERNATIVE VOLATILITY ESTIMATORS

In this appendix, we provide a comparison of the characteristics of the Schwert volatility estimator to alternative estimators. We estimate daily conditional return volatilities using the Schwert estimator, the GARCH-T (1,1) model of returns, and by using a 30-day moving standard deviation estimate.

The 30-day moving standard deviation of returns on day t is given by:

$$\hat{\sigma}_t = \left(\frac{1}{29} \sum_{i=t-30}^{t} (R_i - \bar{R}_t)^2\right)^{1/2}$$

$$\bar{R}_t = \frac{1}{30} \sum_{j=t-30}^{t} R_j$$

where R_i is the return on day i.

The GARCH-T (1,1) -- Generalised Autoregressive Conditional Heteroscedasticity T-distribution -- estimate is given by the maximum likelihood estimate of σ_t from the specification,

$$R_t = \alpha_0 + \alpha_1 R_{t-1} + \tilde{e}_t$$

$$\tilde{e}_t \sim T_v (0, \sigma_t^2)$$

$$\sigma_t^2 = \gamma_0 + \gamma_1 \sigma_{t-1}^2 + \gamma_2 e_{t-1}^2$$

where the mean equation error is assumed to follow a student's T distribution with v degrees of freedom.

The daily analogue for the Schwert estimator involves using 5 lagged values and daily dummy variables in place of the 12 monthly dummys and 12 lagged values.

These alternatives are estimated using daily data on the log-differences of the S&P 500 price index over the period August 21, 1982 through August 8, 1989. Sample characteristics of the time series of volatility estimates appear in Table A1. Daily volatility estimates are converted to monthly estimates by multiplying by the square-root of 20. As is evident from the sample characteristics, the Schwert estimator has properties similar to these alternative estimators.

Table A1

COMPARISON OF ALTERNATIVE RETURN VOLATILITY ESTIMATORS
FOR THE UNITED STATES S&P 500 INDEX

(21 August 1982 - 8 August 1989)

	Daily average	Implied monthly average	Standard deviation of daily volatility estimates	Minimum daily volatility estimate	Maximum daily volatility estimate
GARCH-T (1.1)	0.98%	4.38%	0.42%	0.70%	4.8%
Schwert	0.90	4.02	0.43	0.44	7.8
30 day roll	0.97	4.34	0.63	0.47	5.3

CORRELATIONS OF ALTERNATIVE DAILY VOLATILITY ESTIMATES

	GARCH-T (1,1)	Schwert	30 day roll
GARCH-T (1,1)	1.0		
Schwert	0.76	1.0	
30 day roll	0.95	0.64	1.0

APPENDIX A2

RELATIONSHIP BETWEEN LIQUIDITY AND THE BID-ASKED SPREAD

Consider a stock market dominated by dealers who facilitate trading by maintaining an inventory and providing liquidity. In order to make the appropriate expected economic return on his inventory investment, the dealer will purchase inventory at a bid price lower than the asked price at which he will sell into the market. The size of the dealer's bid-asked spread depends upon the cost of carrying inventory and the expected proportion of informed traders with whom he must trade. The intuition for the second component follows. A dealer does not know the motivation of the counterparty trading. If the counterparty is motivated by a demand for liquidity, then his trade conveys no information and the stock price is unlikely to change based upon the information motivating the trade. If however the counterparty trading is motivated by information that is expected to alter the price of the stock, then on average the dealer will suffer a loss by trading. If the information motivated trader buys at the dealer's asked, the dealer's asked is too low and he suffers a loss relative to the stock's true underlying value. Similarly, the dealer suffers a loss if the information motivated trader sells at the dealer bid price. Consequently, for a given number of information trades, the larger the number of liquidity trades on average, the smaller the bid-asked spread required to offset the information trading generated expected losses. The upshot of this discussion is that for two countries with identical fundamentals and with an identical number of informed trades on average per period, the country with larger volume will have smaller average bid asked spreads, other things equal.

APPENDIX A3

MEASURES OF RETURNS COHERENCE AND IMPLIED RETURN CORRELATIONS

Coherence is a time-series spectral measure which provides information about the "correlation" between two series at a specific harmonic frequency. If the coherence function is appropriately normalised, the average coherence -- that is the average value of the coherence function across all frequencies -- is related to the simple correlation between the two series. The relationship follows (1). Consider two time series X and Y. Fit an auto-regressive moving-average model to explain the X series. Take the residuals from this model and regress them on Y and its lagged values. The R^2 of the second regression is the average coherence of the X and Y series. It is also the square of the multiple correlation coefficient of X with Y and its lagged values.

If X and Y represent different national stock-index returns, the lagged values of X will have very little power in predicting current values of X and similarly for Y. That is, X and Y are martingale series. Therefore the best-fitting ARIMA for X would likely be a constant, or at least to a close approximation. The corresponding R^2 of the regression of deviations of X about its mean on Y and lagged values of Y would be approximately equivalent to the squared multiple correlation coefficient between X and Y and Y's lagged values. Because markets adjust very quickly, lagged values of Y will add little explanatory power to the second stage regression. Using this reasoning. The R^2 of the multiple regression should be very close to the R^2 from the univariate relationship and so the average coherence should be roughly equivalent to the square of the simple correlation coefficient for equity returns.

We make this transformation in order to compare the resulting correlation estimates to those directly calculated for the October 1987 crash period. Any bias which results from these simplifying assumptions should work to overstate the estimated correlations. In other words, the true correlations are likely to be smaller than those reported in Table 2.

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1. I am indebted to David Pierce for explaining this relationship.

APPENDIX A4

STOCK PRICE AND BOND RETURN DATA

For the OECD stock price indices, compositions differ by country. For the United States, Belgium, Finland, France, Germany, Norway and the United Kingdom the indices are calculated using only industrial share prices. For the remaining markets, the indices are calculated using all listed shares. The Belgian stock index is calculated using closing prices from the end of the month. The stock indices for Canada, Finland, Japan, the Netherlands, Spain, Sweden, and the United Kingdom are calculated from closing prices on the last trading day of the month. The French and Swiss stock-indices are calculated from closing prices on the last Friday of the month. The stock indices for Germany and the United States are averages of monthly prices. Ireland and Norway's indices are calculated from closing prices at the beginning of the month, and to correct for this timing difference we lag these countries returns and volatilities one month.

The OECD bond data are weighted averages of secondary market yields on corporate bonds. The maturity and composition of the bond indices differs by country. For France, the corporate bond yield is a monthly average of end-of-week quotes on bonds with maturities greater than seven years. Until 1986, the bond index weights were proportional to weekly volume. After 1986 the weights are proportional to the value outstanding. The German corporate bond index is comprised of secondary market yields on non-convertible industrial bonds. The Italian index is the simple average of daily yield to redemption on private enterprises bonds. The Italian index has an average maturity of about 2.1 years, and as such, has substantially shorter duration than the comparison indices. The United Kingdom bond index is composed of the average yield on quoted industrial and financial company bonds with an average of 25 year to maturity The index is taken from the "Financial Times Actuaries" series, and is an index based on the simple average of daily closing yields calculated from the average of the bid and asked quotas. The corporate bond index for the United States is a simple average of 30, long-term, taxable, non-convertible seasoned corporate bonds as calculated by Moody's Investor Service.

The return analysis on stocks and bonds was restricted to those markets for which the OECD financial data base included data from 1960 to 1990. Markets not meeting this requirement are excluded due to sample size limitations for the fixed exchange rate period.

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