"The Micro Structure of Foreign Exchange Risks in Commercial Banks in the Caribbean."

By

Mr. Dave Seerattan

Reseach Fellow

Caribbean Centre for Monetary Studies

University of the West Indies

Paper presented at the XXXIV Annual Monetary Studies Conference

Georgetown, Guyana

November 12-16, 2002

THE MICROSTRUCTURE OF FOREIGN EXCHANGE MARKETS IN THE CARIBBEAN

By

Dave Seerattan
Research Fellow
CCMS

November, 2002

1.0 Introduction

At the beginning of the 1990s a number of Caribbean countries sought to liberalise their foreign exchange markets[1]. This involved the elimination of exchange controls, the removal of restrictions on both the current and capital transactions, the widening of the number of market players in the foreign exchange markets (brokers (inter-dealers), dealers and cambios) and the move from a fixed to a floating exchange rate regime. These developments were of course precipitated by the severe imbalances that had built up in these economies in the 1980s, especially with respect to the over-valuation of the foreign exchange rate and the huge imbalances between demand and supply in the foreign exchange markets in these jurisdictions. This of course resulted in "black markets" for foreign exchange where foreign exchange transactions were executed at a much more realistic exchange rate.

The changes to the foreign exchange markets were therefore introduced in the context of crisis, which militated against an orderly progression to the new regime. These developments represented a fundamental change in the way some of the foreign exchange markets in the region were organized and this together with the shaky start to the new regime raised serious concerns in the region about the efficiency, stability and viability of these new systems. These markets have since established a degree of stability as agents in the market (the central banks, the public and financial institution) became more familiar with the new dispensation. The microstructure of these markets have also evolved since the regime change and, given the amount of attention that is now devoted to market microstructure in the financial literature and its relative absence in the Caribbean, it is a fruitful area for research in this region.

Traditionally, much of the attention in the market microstructure literature has been devoted to equity markets but increasingly attention is now being directed to the foreign exchange market, especially since much of the macro analyses of the foreign exchange markets have not provided satisfactory explanations of the operational features of these markets[2], except possibly over the long-term (Flood and Taylor (1996), Meese and Rogoff (1983)). Market microstructure research has important implications for the functioning of the foreign exchange markets. In particular, microstructure features such as information asymmetry (Gennotte and Leland (1990)) and agent heterogeneity (Bagliano, Beltratti and Bertola (1996)), which is often assumed away for simplification in macro analysis, can help in explaining the mechanical and self-reinforcing herd behavior often observed in the foreign exchange markets.

Market microstructure theory can therefore help to solve many puzzles in the foreign market that macro theory of foreign exchange has not adequately explained. More importantly though, the study of the microstructure of the foreign exchange market, that is not linked to the macro-economy, is in itself a fruitful area for research because it can

[1] Guyana and Jamaica started the process of liberalization in 1990 while Trinidad and Tobago started its programme of liberalization a little later in 1993.

[2] These features include the weak correlation between "market fundamentals" and exchange rate movements, the high volatility and overshooting of exchange rates.

help to identify the economic effects of its design structure. The issues that are addressed in this approach include transparency, decentralisation, the number and range of players in the market, the efficiency of the clearing mechanism, the relationship between the spot and derivative market and the importance of systemic risks in the market.

In the context of the Caribbean, issues such as the pricing efficiency, volatility in bid-ask spreads and the way in which the volume of transactions on this market impact liquidity and prices are all important to the effective functioning of the foreign exchange market. In many instances the design features of the market infrastructure such as whether the market is based on an auction or an inter-bank system, the trading mechanism utilized, market transparency, regulations on open positions, the number and variety of dealers in the market, all have serious implications for the efficiency, stability and viability of the foreign exchange market. These issues are even more important for the jurisdictions in the Caribbean (which are still in the process of developing their foreign exchange markets) since they impact on the ability of the market to provide liquidity and pricing efficiency.

In this context, this paper seeks to explore the impact that the microstructure of the foreign exchange markets has on the efficiency and stability of these markets in select Caribbean Countries. The paper is structured as follows. Section 2 reviews the theory of market microstructure. Section 3 reviews the evolution of the microstructure of the foreign exchange market in select Caribbean countries. Section 4 looks at how the foreign exchange market performed as the microstructure of the foreign exchange market evolved in select Caribbean countries. Section 5 concludes by highlighting some policy implications that flow from the theory, as well as the experience and the performance of these markets.

2.0 Market Microstructure Theory

The term market microstructure was used by Garman (1976) to describe the transactions based nature of realistic exchange processes. German examined dealership and auction market-maker models and how bid-ask spreads, inventories of market-makers and the degree of market power of the market-makers interacted with each other to affect outcomes in the market. One possible definition of market microstructure is the one used by O'Hara (1995, p. 1) which states "Market microstructure is the process and outcomes of exchanging assets under explicit trading rules". Admati (1991 p. 355) defines market microstructure as "the literature on asset markets with asymmetric information and especially on trading mechanisms". Microstructure therefore focuses on the mechanics of trading and how these affect the price formation process.

Much of the literature focuses on the problem facing intermediaries of determining market-clearing prices. Demsetz (1968) was one of the first economists to study this problem. He argued that while a trader may be willing to wait to trade at the market-clearing price some may wish to trade immediately and pay a higher price for access to liquidity sooner. The heterogeneity of the traders therefore creates a situation where there may be more than one equilibrium price. In such cases the size of the price

concession needed for immediate liquidity would depend on the number of traders, therefore the structure of the market could affect the market-clearing price. This price-setting problem for market clearance was first analysed in inventory models. There are three distinct strands to the inventory model approach. The first strand of this research started by Garman (1976) is based on the impact order flow has on trading prices. The second strand looks at the dealer optimization problem (Stoll (1978), Ho and Stoll (1981)). The third strand is based on the impact multiple dealers on liquidity and prices (Cohen, Maier, Schwartz and Whitcomb (1981)). The single unifying factor in these approaches is the uncertainty in order flow, which result in inventory and execution problems. This approach therefore boils down to how prices are set by dealers in different settings and how these prices change as we introduce different types of uncertainties.

An alternative approach to the market-clearing price is based on the impact of asymmetric information (Easley and O'Hara (1987). This approach is based on the information dichotomy between informed and liquidity traders (uninformed) where the superior information of informed traders mean that their trades could signal the underlying value of the asset and affect the behavior of prices. The information-based approach has helped to improve our understanding of markets by focusing on the information implicit in market data and the Bayesian learning process that translates this information into prices. The information-based approach is especially useful because they allow for the examination of market dynamics and strategic behavior from informed and uninformed traders.

The ability of the market to meet the diverse liquidity needs of heterogeneous agents without huge swings in price, the most important objective, is therefore dependent on a number of market microstructure elements. In particular, it depends on information dynamics in the market, the design of the trading mechanism (whether quote driven, order driven continuous auction or batch order systems), the number and range of market players, the anonymity of trading and, regulatory and tax systems. Madhaven (1992) shows that if information asymmetry is not severe then equilibrium will exist in quote driven systems as prices follow a Martingale and are semi-strong form efficient. In this scenario market makers will offer a schedule of prices for different trade sizes, rather than a quote for a single trading price. On the other hand, if information asymmetry is too large, it may not be possible to find such a price schedule and equilibrium may not exist. Madhaven also demonstrates that with free entry, continuous auction order driven systems converge to quote driven systems. More importantly, Madhaven shows that when equilibrium does not exist in the quote or continuous auction order driven systems it may exist in a batch order system. This reflects the aggregation ability of batch systems as traders information becomes averaged over all trades, allowing market-clearing prices to work on average rather than for individual trades. Aggregation reduces transparency but it can help to create equilibrium in difficult circumstances.

The above discussion highlights how access to trade information (information dynamics) is inextricably linked to the trading mechanism and to market outcomes. An understanding of these links is at the heart of the debate about whether to allow brokers to

only submit customers orders or to trade for their own account. The central concern in this regard is that if brokers are allowed to trade for their own account they will exploit information contained in client orders for personal gain.

These theoretical issues have generated a number of empirical studies on market microstructure. Foreign exchange markets provide a very interesting arena for developing and testing market microstructure theories. In particular, foreign exchange markets are in large part decentralised, quote driven dealer markets rather than a centralised order driven system. Currency dealers, unlike other financial asset market dealers, do not only serve as market makers and therefore hold currency for their clients needs, but also are engaged in activities which require that they hold positions in currencies on their own account, thus complicating the market. Central banks also frequently intervene directly in the market affecting order flow and prices. These features of the foreign exchange market microstructure have generated a number of empirical studies measures how the market behaves.

These studies are based on main tenets of market microstructure theory such as information dynamics, the design of trading mechanisms and the number and type of dealers in the market. These studies have looked at the determinants of the bid-ask spreads in foreign exchange markets (Bessembinder (1994), the relationship between volume and volatility (Frankel and Froot (1990), Tauchen and Pitts (1983)) and the increase in volatility in the run up to non-trading periods (Lyons (1995)). These issues are of course all inter-connected. In the case of bid-ask spreads, it seemed that these spreads varied positively with inventory carrying costs such as interest rate on assets denominated in the currency in which the dealer has an open position and risk proxied by price (exchange rate) volatility. The relationship between volume and volatility in the microstructure setting is driven by agent heterogeneity and asymmetric information where informed traders gain at the expense of uninformed traders or customers who trade to eliminate exposure, especially when new information flow into the market. This is related to the mixture of distributions hypothesis (MDH). In this framework volume and volatility in prices are positively related as new information comes into the market during normal periods, however, during periods of market turmoil traders withdraw from the market and there is a negative relationship (Galati (2000)). The greater volatility in the run up to non-trading periods is driven by the greater sensitivity of prices to liquidity before non-trading periods as traders try to reduce their exposure to avoid high inventory cost over these periods.

The features that distinguish the microstructure approach are therefore threefold. Firstly, microstructure theory recognizes that information asymmetry impacts on the operation and outcomes in the market. The degree to which the market structure lends itself to transparency and information disclosure is therefore important to market outcomes. Secondly, this theory recognizes that heterogeneity plays a big role in determining market outcomes and trading mechanisms that increase the ability to trade at different prices is therefore crucial to the efficiency of the market and; Thirdly, microstructure models recognizes that trading mechanisms differ in ways that affect prices. This means that markets can be designed to affect the realization of particular outcomes. The key insight

that emerges from market microstructure theory is that market design can impact on market outcomes in terms of pricing and liquidity and therefore cannot be assumed away as is done in most of the macro approaches to the foreign exchange market. We turn next to a review of the microstructure of the foreign exchange markets in selected Caribbean countries.

3.0 The Microstructure of the Foreign Exchange Markets in the Caribbean

The basic microstructure of foreign exchange markets consists of a number of core elements. These include the major players in the market, the mechanisms for trading and the regulatory and management systems in place for the smooth operation of the market. The major players in the foreign exchange market include dealers who facilitate trade and who may double as market makers, central banks which structure the policy regime for the market and the public. The public includes individuals but also corporations and speculators that drive demand and supply in the markets. The mechanisms for trading are critically important to the operation of the market. The trading mechanism could be based on auctions or inter-bank markets, as well as on traditional and non-traditional price discovery mechanisms. Last but by no means least is the regulatory and management systems on which the market is based. These include systems such as internal risk management systems, the exchange rate regime and prudential standards on open positions. The foreign exchange markets of the selected Caribbean countries, Jamaica and Trinidad and Tobago, have many of these elements and these are outlined below.

Jamaica

Jamaica liberalised its foreign exchange market substantially during the 1990s. In this period exchange controls were eliminated in 1990, the exchange rate regime changed from a fixed to a floating regime in 1991 and the number of dealers increased in 1994 as cambios and merchant banks were included. The institutional structure of the market in 2001 consisted of 15 authorised dealers and 136 cambios (which include about 88 bureaux de change). The non-financial firms and individuals which underlie the demand and supply conditions in the market is fairly heterogeneous and the supply of foreign exchange is fairly evenly distributed among sources such as export of goods and services, remittances, direct investment flows, private portfolio flows and official loan inflows. There are some dominant players in the market who can have a significant impact on the market from the supply side.

Cambios are only permitted to buy and sell foreign exchange and there are limits of US$250,000 on cheques and drafts and US$10, 000 on cash transactions. These combios are licensed by and monitored by the Bank of Jamaica (BOJ) to ensure compliance with the BOJ's operational guidelines and the Money laundering Act. Cambios are also required to report to the Director of Public Prosecution any cash transaction greater than or equal to US$8,000. Cambios currently sell 5% of their gross daily purchases of foreign exchange to the BOJ by mutual agreement. The major difference between

cambios and authorised dealers is that they are not permitted to grant loans or take deposits.

There are currently approximately 88 bureaux de change in operation which exist primarily to facilitate the exchange of currency for hotel guests. These institutions sell 10% of their gross daily purchases to the BOJ.

The authorised dealers in the market consist of all commercial banks, merchant banks and the two largest building societies. These authorised dealers are engaged in all types of foreign exchange transactions, they buy and sell, intermediate and make a market in foreign exchange by posting bid and ask quotes for foreign exchange. No limits are placed on the value of transactions, however, under the Money laundering Act, these financial institutions are required to report to the Director of Public Prosecution any cash transaction at or above US$50,000. The authorised dealers, though not statutory bound, have also agreed to sell 5% of their daily gross purchases of foreign exchange to the BOJ. These institutions are monitored and regulated by the BPJ under the Financial Institutions Act and the Building Societies Act.

The commercial banks also make up the inter-bank market on which the system is based and which facilitates price discovery and trading. The information transmission mechanisms in the market are relatively unsophisticated consisting of informal contacts and telephone calls. Authorised dealers are, however, discussing the establishment of an electronic platform which will list two way bid and ask quotations to facilitate trading. The trading mechanism is therefore largely based on a floating exchange rate regime. In this system an interbank system makes a market in foreign exchange through indicative bid and ask quotes and where information on these quotes are expedited largely through telephone contacts and where demand and supply and the intervention strategy of the BOJ determines prices. When spot transactions (transactions settled within 2 business days) between dealers and the public and between the two categories of dealers are executed different spot rates are realised. The official exchange rate is computed as a weighted average of all trades. A forward market for foreign exchange to hedge foreign exchange rate risk has also been in existence in Jamaica for several but the volume of transaction and price data is not readily available.

The BOJ undertakes market surveillance, collects and disseminated information on the foreign exchange market and intervenes directly in the market to control volatility. It information dissemination function is important part of the market microstructure as it helps the price discovery process in the market, especially since private mechanisms for price discovery are not well developed. The BOJ intervenes in the market directly to prevent excessive price (exchange rate) fluctuations by selling (buying) foreign exchange through authorised dealers and cambios since these institution dominate the market and can affect liquidity condition and the rate very quickly. The rate at which the bank intervenes is usually mirrors the weighted average buying or selling rates in the market.

Trinidad and Tobago

In April 1993 exchange controls on current and capital transactions were abolished in Trinidad and Tobago. The exchange rate regime was also changed from a fixed to a floating regime. The market for foreign exchange consists of commercial banks, the public (both firms and individuals) and the Central Bank. The system is based on an interbank market where demand and supply and the interventions of the Central Bank in the spot market drive the performance of the market. In this system, commercial banks act as market makers by post indicative bid and ask quotes for foreign exchange. Spot trades are then executed for particular transactions at prices based on the initial bid/ask quotes. The exchange rate is, therefore, generated by the demand and supply for foreign exchange, and the rate is computed as a weighted average of the spot rates of all transactions. The market also has a forward market for foreign exchange, which though small has shown signs of growth.

The major players in the market are commercial banks (and their correspondent international bank), bureaux de change, the public (which include a few large suppliers of foreign exchange (John (1994)) and the Central Bank. The commercial banks are the heart of the systems as they are the market makers in the foreign exchange market. Commercial banks trade with the public and among themselves to meet the liquidity needs of the market. The interbank system in particular was used to good effect to deal with peaks and valleys in individual banks' liquidity. This is buttressed by the Central Bank's intervention when the swings in liquidity are too large. The characteristics of the banks themselves affect the operation of the market. Some may have large corporate clients whereas some may concentrate on the retail market, some banks have a large branch network while others do not. These features impact on the price discovery process and the exchange rate that is eventually generated by the market. The bureaux de change acts in a supportive role to the dominant commercial banks. The market is comprised of 7 autorised dealers, all commercial banks except one non-bank financial institution whose bureaux de change license was upgraded to authorised dealership status in 1999. The number of bureaux de change remains at 5. These institutions are licensed by the Central Bank and monitored and regulated under the Financial Institution Act of 1993.

The trading mechanism in this market, like the Jamaican market, is based on a quote driven interbank system. The commercial banks acts as market makers by quoting indicative bid/ask prices in the spot market which act as a guide for the prices at which trades are executed. These quotes also are important parts of the price discovery process. The actual systems in place for price discovery in the interbank market are underdeveloped. Most trading are still done over the telephone and transactions are confirmed by fax. This weakness in the system has been recognised and there are plans to introduce a common electronic platform so the two way bid/ask quotes could be posted to facilitate interbank activity.

The Central Bank also collect and disseminates information on the foreign exchange market which helps the process of price discovery in the market. More importantly, the

Central Bank intervenes directly in the market to smooth out volatile swings in liquidity to prevent high volatility in the exchange rate. The central bank also provides a venue for commercial banks to meet and share information, which helps to manage the interbank system.

A Comparison of the Microstructure of the Foreign Exchange Markets in Jamaica and Trinidad and Tobago

There are many similarities in the form of the foreign exchange markets in these two jurisdictions. They are both organised as interbank markets where commercial banks act as market makers rather than auction markets, although Jamaica experimented with an auction market. Both markets are quote driven systems rather than order driven systems. The central banks in both jurisdictions intervene in the market to smooth out volatility. The systems in place for the price discovery process in the interbank markets in both jurisdictions are also underdeveloped.

There are, however, some important differences. The number of dealers in the Jamaican market is much greater than in Trinidad and Tobago, even if one adjusts for the different size of these countries. Dealers in the Jamaican market also by mutual agreement have to sell a small percentage ranging from 5% to 10% percent of their gross daily purchases of foreign exchange to the BOJ. To the extent that purchases by the BOJ under this agreement are below market rate, this arrangement could be thought of as a tax.

Most importantly, however, is the fact that in Trinidad and Tobago the conduit for the major part of the foreign exchange that is supplied to the market by a few companies and comes in through the Central Bank since these flows in large part represent government's petroleum tax revenue. This gives the Central bank of Trinidad and Tobago a degree of market power and leverage that the BOJ does not have. The ability to intervene is therefore greater, as well as less costly. We turn next to a rough analysis of the performance of these two markets in an attempt to determine if these differences affect the performance of the markets.

4.0 The Performance of the Foreign Exchange Markets in Jamaica and Trinidad and Tobago

The performance of the foreign exchange market in both Jamaica and Trinidad and Tobago has improved over the 1990s as agents became more familiar with the new arrangements in the foreign exchange market. In Jamaica, the increase in the number of dealers in the market and the increasing use of the official markets for transactions led to an increase in the sales and purchase of foreign exchange through the market and a decrease in the spread between the buying and selling rate for foreign exchange from 0.84% in 1993 to 0.28% in 2002. There was some fall back in 1998 and 1999 as bank failure and economic recession weakened the market but the improvements have continued as these problems have faded. Substantial shortages of foreign exchange has not really been a problem for a while. The BOJ has managed market conditions and expectations relatively well through its intervention strategy in the foreign exchange

market. The ability of the BOJ to intervene to ensure stability has however been driven by increases in government external debt obligations and high domestic interest rates. Managing this situation in the future in the context of weak international conditions could prove to be very challenging. In large part, however, the BOJ has managed to reign in excessive speculative behavior through active intervention and agents' expectations are now more stable. This has manifested itself in a relatively stable exchange rate over the last three years in what could be described as difficult economic conditions. One area of concern however remains the problems with respect to price discovery. The underdeveloped system in place to disseminate bid/ask prices from market makers to the rest of the market continues to be a problem. This is reflected in the wide spread between the highest and lowest buying rate and the highest and lowest selling rate. This is something that will have to be addressed to improve the efficiency of the market.

In the case of Trinidad and Tobago, a similar pattern to Jamaica emerged as the market continued to settle as market participants got accustomed to the new system. The Central also intervened aggressively in the market in the early stages of the new regime. In fact the Central bank sold approximately US$104.3 million in an effort to smooth out speculative pressures at the onset of the new regime. The Central Bank has continued to intervene when demand conditions in the market became tight selling approximately US$132.6 million in 1997 and US$85 million in 2000. This strategy has ensured that despite the excess demand for foreign exchange that there has really been no liquidity crisis. The active intervention in the market is reflected in the fact that the average selling rate has been much more stable than the average buying rate over the 1990s. This has also manifested itself in the fact that there has been virtually no change in the average annual selling rate since 1998.

The spread between selling and buying rates have also come down form a high of approximately 1.9% in 1993 to a low of 0.59% in 1998 from which it has climbed up to 0.98% in 2001. The interbank system has also become more adept at managing the changing seasonal patterns of foreign exchange demand as time progressed. This has been facilitated in a small but increasingly important part of the market – the forward market for foreign exchange. This part of the market has increased its share of the market from roughly 3.2% in 1996 to an estimated 8% in 2001. Market participants can now hedge their foreign exchange rate risk a little better and this help to smooth out some of the liquidity swings.

The volume of funds flowing through the market has also steadily increased as evidenced by the data on sales and purchases of foreign exchange by commercial banks. This reflects the fact that agents are increasingly willing to transact their business through the market as confidence increases and speculative activity wanes. This of course has been driven by the relative stability of the market after the first three years of the new regime. The only area for concern has been the relatively wide spreads between the highest and lowest buying and selling rates, which is a signal that the price discovery is not working well. This is not surprising, given the underdeveloped nature of the systems in place for price discovery in the interbank foreign exchange market. Another problem is the fact that although the spread between the average buying and selling rate has come down, the

spread is still higher that those recorded in Jamaica. This may be due to the fact that the institutional arrangements for the foreign exchange market is more competitive in Jamaica relative to Trinidad and Tobago, however, this is the costs attached to operating a much more concentrated interbank market for greater stability.

5.0 Conclusions

It is evident from a review of market microstructure theory and the experiences of Jamaica and Trinidad and Tobago that the microstructure design of the foreign exchange markets can predispose the market to certain outcomes. For example, if the systems in place for price discovery are not well developed in an interbank foreign exchange market it is likely that pricing efficiency will be low. This is likely to result in wider spreads between the best and worst prices for foreign exchange in the market as has apparently happened in both Jamaica and Trinidad and Tobago. This has real consequences in terms of certain agents who are disadvantage in terms of information paying a higher price for foreign exchange.

The other example of the microstructure impacting on market outcomes relates to the number of dealers in the market. The fact that Trinidad and Tobago has higher spreads between the selling and buying rates for foreign exchange could be attributed to the fact that it has a much more closed interbank system than Jamaica with fewer market makers and dealers and therefore less competition. The tradeoff, however, is that in a more open interbank system, intervention to smooth volatility is more difficult and therefore there is a cost in terms of stability.

The fact that the design of the market microstructure can impact on market outcomes requires that policy makers in the region be careful in the design of policy regimes. This is so especially in an area such as the foreign exchange market which is so important to Caribbean economies, given our extremely open economies. The foreign exchange market in particular, and market makers in particular, offers services which are quasi-public goods in nature to get the design wrong can therefore create real problems for regional economies. Attention to market microstructure details could go some way in ensuring that we avoid making that mistake.

Selected References

Admati, A. "Sunshine Trading and Financial Market Equilibrium" Review of Financial Studies, vol.4 no. 3, 1991, pp. 443-482.

Bessembinder, H. "Bid-Ask Spreads in the Interbank Foreign Exchange Market" Journal of Financial Economics, vol. 34, 1994, pp.317-348.

Cohen, K., S. Maier, R. Schwartz and D. Whitcomb. "Transaction Cost, Order Placement Strategy and the Existence of the Bid-Ask Spread" Journal of Political Economy, vol.89, 1981, pp.287-305.

Demsetz, H. "The Cost of Transacting" The Quarterly Journal of Economics, vol. 82, pp.33-53.

Easley, D. and M. O'Hara. "Price, Trade Size and Information in Securities Markets" Journal of Financial Economics, vol. 19, pp.69-90.

Frankel, J and K. Froot. "Exchange rate forecasting Techniques, Survey Data and Implications for the Foreign exchange Market" NBER Working Paper no. 3470, 1990.

Galati, G. "Trading Volumes, Volatility and Spreads in Foreign Exchange markets: Evidence From Emerging Markets" BIS Working Paper No. 93, 2000.

O'Hara, M. Market Microstructure Theory. Blackwell Publishers, Oxford England, 1995.

John, J. "The Experience of Liberalisation" Central Bank of Trinidad and Tobago, Quarterly Economic Bulletin (Supplement) vol. 19 No. 2, June 1994, pp9-11.