

**THE IMPLICATIONS OF EVOLVING  
TECHNOLOGY ON MONETARY POLICY: A  
LITERATURE SURVEY**

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Working Paper

2004/02

December 2004

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The views expressed herein are those of the author and may not necessarily reflect the views of the Reserve Bank of Fiji. The author is grateful to colleagues for their comments on earlier drafts.

## **Abstract**

Advances in technology have catapulted many economies and businesses forward. It has given rise to electronic commerce, which in turn has led to the development of electronic money. Moreover, the information technology revolution has also enhanced financial innovation, with financial markets now more sophisticated and complex than ever before. These developments have questioned the ability of central banks and monetary policy's ability to survive the technological revolution. Through a literature survey, this paper attempts to highlight the main issues surrounding these questions. The main conclusion, though, is that monetary policy will continue to be necessary and effective in the new technology age.

## **1.0 Introduction**

Most economies are currently experiencing an irreversible trend toward increasingly conceptual and intangible forms of economic resources (Inoue, 1998). We can find this trend everywhere, including here in Fiji: modern factories are introducing computers to assist in manufacturing; most offices are now heavily dependent on computers for their daily operations; and more and more households are becoming connected through mobile phones and the Internet.

Since such changes pervade the economy, some observers think that we are in a Third Industrial Revolution, which follows the First Industrial Revolution, when machine production by a steam engine began, and the Second Industrial Revolution, when electric power and chemical engineering appeared. The driving force behind this movement is, of course, the rapid innovation in information technology (IT). It is a stylised fact in the fields of economic growth theory and economic history that innovation is the engine of economic growth. Like the steam engine and electric power, innovations in IT are expected to change all aspects of economic activity, bringing about a greater improvement in economic performance. (Inoue, 1998)

Globally, we can already see changes in trading patterns, with the proliferation of electronic commerce or E-commerce. The integration of computers and telecommunications networks has facilitated E-commerce over the Internet and E-commerce is rapidly expanding. Of particular interest to central bankers, observers have noted that E-commerce promotes price reductions, facilitates frequent price revisions and may lead toward the emergence of a so-called “perfect market” without any “market

friction” whatsoever (Institute for Monetary and Economic Studies, 2001; henceforth IMES). E-commerce has also led to the evolution of electronic money (E-money), raising questions over the inevitable demise of currency (notes and coins) and the survival of monetary policy. These issues will be examined in more detail later in the paper.

More importantly, the IT Revolution has played an influential role in the development of the financial sector and in stimulating financial innovation. The impact of IT, together with competition, deregulation and financial integration at an international level, has made modern financial markets interdependent, flexible, contestable and conductive (Podolski, 1986). However, at the same time, this has posed several challenges for monetary policymakers, who have had to adapt to this dynamic environment. The responses to these challenges will be discussed in ensuing sections of the paper.

With this so-called Third Industrial Revolution underway, questions on whether prospective advances in IT really threaten the effectiveness of monetary policy have been raised. This paper attempts to shed some light on these questions, by examining the pertinent issues, through a survey of the relevant literature. This study, by no means, is exhaustive and only serves to highlight the main concerns over the implications of technology on monetary policy. Therefore, any glaring omissions of significant literature are regretted.

The rest of the paper is structured as follows: Part 2 briefly looks at the nature of the IT Revolution, Part 3 details the spread and implications of E-Commerce, especially E-money (Part 4), while Part 5 discusses the impact of financial innovation on monetary policy, a prelude to the next

section. The effectiveness of monetary policy, in the face of technological progress is examined in Part 6. The last section concludes the paper.

## **2.0 The IT Revolution<sup>1</sup>**

The present IT revolution is exemplified by the rapid development of computer technologies and the Internet. The distinctive characteristics of this Revolution can be summarised as follows:

- The integration of information processing and telecommunications technologies;
- The consequent acceleration of the speed of information processing and transmission, reduction of information processing costs and increase of the geographical distance over which information can be transmitted; and
- The amazing speed at which information technologies are spreading among the public.

Through the extraordinary increases in information processing and data transmission performance and major cost reductions, the IT revolution is increasing the efficiency of the production of goods and services. Thus, these technological innovations are resulting in quality improvements and price reductions for existing goods and services, enabling the development of new goods and services that was practically impossible or costly in the past.

Because the emergence of the Internet has greatly reduced data

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<sup>1</sup> Sourced from IMES

transmission costs, the volume and variety of information transmitted and received by individuals has increased beyond comparison. This is vastly decreasing information collection costs, or search costs, so it is now possible to investigate a great number of goods and services provided by a wider variety of suppliers.

Furthermore, it is becoming increasingly easier for comparatively uncompetitive enterprises to suddenly enhance their competitiveness through the introduction of the latest technologies. This phenomenon is referred to as “leap-frogging” and the extremely rapid spread of mobile telephones provides a representative example. On the other hand, those enterprises that cannot introduce the latest technologies, for whatever reason, find themselves at a comparative disadvantage.

More significantly, the IT Revolution has given rise to E-commerce, which will be the focus of the next section.

### **3.0 E-Commerce<sup>2</sup>**

E-commerce is defined as “commercial transactions, such as the delivery of goods or services and the receipt of information or monetary value in relation with the commercial transfer of goods or services among economic agents, via electronic media-utilising networks.” Globally, E-commerce has grown at an astounding pace and even though it is yet to be a major feature of the Fiji economy, it will no doubt be in the near future.

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<sup>2</sup> Also sourced from IMES

### **3.1 Influence on Setting Prices**

One of the main issues concerning the spread of E-commerce is its influence on the price setting mechanism. Price levels on the E-commerce markets are lower than prices on traditional markets, and price revisions are conducted more frequently. In the real economy, there are differentials in the prices charged for the same products because of shortage of information regarding prices due to the existence of geographical distance and search costs. Since E-commerce lessens geographical restrictions, it greatly reduces search costs. Thus, it would be natural to assume that the differentials in the prices charged for the same products on the Internet would be smaller than price differentials on the conventional market.

Some even claim that the Internet effectively makes the constraints of time and distance less important, leading toward the emergence of a so-called perfect market without any market friction whatsoever, in other words, the Law of One Price. However, according to IMES, the Law of One Price does not hold on the E-commerce market, underpinned by three main factors.

The first factor relates to the credibility of the suppliers and their products. A large number of consumers feel that they cannot trust Internet sites offering the lowest prices and only conduct transactions with sites they can trust. The second factor is that switching costs are incurred when changing sites. Lastly, there is the case of suppliers' price discrimination. For example, an airline site may offer two options to consumers – the first is a channel whereby tickets are sold at fixed prices, and the second is a channel whereby tickets may be purchased at lower prices through on-line negotiations. In this case, the airline discriminates between those

consumers who want to purchase fixed-price tickets and those who want to negotiate for lower-priced tickets, thus, in effect, offering different prices.

Even if the Law of One Price does not hold, E-commerce still promotes price reduction and engenders price flexibility. This has implications for the conduct of monetary policy.

### **3.2 Monetary Policy Considerations**

Given the observations of the previous section, how, then, should monetary policy react, if at all? According to the IMES, the central bank, first, should recognise the reduction in price levels from the spread of E-commerce – this should be interpreted as a downward shift of the aggregate supply curve, arising from the simplification of the distribution process.

Secondly, the IT revolution is making it more difficult for central banks to accurately grasp price conditions, which are an important basis for making policy decisions. There are concerns that price indices may have an upward bias if the new products developed under the IT revolution and E-commerce transactions are not promptly incorporated. Consequently, for the future, policymakers will need to consider this whilst setting policy.

Lastly, price flexibility through E-commerce may reduce the effect of monetary policy on the real economy: For instance, central banks generally use short-term interest rates to influence borrowing costs, and thus the real economy. However, as E-commerce advances, coupled with price flexibility, the influence of monetary policy on prices could weaken. However, there is another view that this is no great cause for concern because the strengthening of the market mechanism through flexible price adjustments will reduce the necessity of monetary policy itself. This last

contention is related to other issues that will be examined in depth in section 5.

#### **4.0 Electronic Money (E-Money)**

The spread of E-Commerce has invariably brought about the development of E-Money. Over the recent years, a new phase in the application of IT to the financial sector has begun, with the invention of devices carrying electronic “money”. IT had previously been used simply to process, store and move money more efficiently, but now it is also being used to create new forms of currency. These include prepaid stored value cards and prepaid software products that can be used to make payments across computer networks, sometimes referred to as digital cash. (Helleiner, 1998)

In contrast to credit or debit cards, these devices do not access a bank account but represent general liabilities of the issuer. When money is spent with the issuer, there is usually an electronic link to the issuer which tracks balances and transactions. At the moment, E-money is only at an embryonic stage. (Helleiner, 1998) Even so, the emergence of E-money has given rise to some important questions, the two main ones being – Will E-money replace cash? Does E-money threaten the survival of monetary policy? The next sections will look into these two questions in turn.

#### **4.1 Will E-Money Replace Cash?**

“Cash is dirty... Cash is heavy ... Cash is inequitable ... Cash is quaint, technologically speaking ... Cash is expensive ... Cash is obsolete.”

(Gleick cited in Goodhart & Krueger, 2001). By contrast, E-money is clean, technologically advanced and supposedly cheap and convenient. For this reason, some are optimistic that currency will be replaced by technologically more advanced electronic transfers and E-money of assorted varieties. In a similar vein, monetary economists have predicted the looming disappearance of currency. (Goodhart & Krueger, 2001)

However, Goodhart and Krueger (2001) contend that the “demise of currency at the hands of IT will not happen”. They do concede that as E-money becomes more widely used, it may indeed substitute for currency in a wider range of possible uses. Nonetheless, they point out that E-money does not have the key characteristics of currency – it is not anonymous, and it is not legal tender. Instead, they argue that E-money will only replace cash, if a government decrees that it must happen.

Moreover, sellers will still want to be paid in cash. Digital currency represents changes in the way we spend and hold dollar-denominated balances, not moves toward money denominated in something other than dollars. Cash remains the fiat central bank liability and E-money is a redeemable claim to that fiat money. (White, 2001)

## **4.2 Does E-money Threaten the Survival of Monetary Policy?**

Market observers are also contemplating whether E-money challenges the central bank’s control over domestic monetary policy since anyone can potentially issue these new forms of money. If the potential demise of cash from the spread of E-money is easily overstated, so too is the threat to the state’s ability to pursue domestic monetary policy. That, at

least, is the conclusion reached by central bankers who have examined the issue. (Helleiner, 1998)

US Federal Reserve Chairman Alan Greenspan noted that, “in [his] judgement, some of the recent speculation about risks to monetary policy... has been a bit alarmist” (Smith & Wilson cited in Helleiner, 1998). Alan Blinder, also remarked that, “concerns have been expressed that introducing what amounts to a private currency might damage the Federal Reserve’s control of the money supply and lead to inflationary pressures. I can assure you this is most unlikely.” (Lorenz cited in Helleiner, 1998)

The lack of apparent seriousness among central banks is partly related to the belief that the size of E-money balances is unlikely to grow extremely large. The impact on the implementation of monetary policy is also not expected to be large, as implementation of monetary policy relies not on the direct control of the issuing of currency, but on such tools as open market operations (OMO), the discount rate and reserve requirements. (Helleiner, 1998)

Generally, monetary authorities do not see major threats to their ability to conduct monetary policy.

## **5.0 Financial Innovation**

The IT revolution has also facilitated financial innovation. Over the past two decades, financial markets have been undergoing a series of profound changes (Harrington in Cavanna, 1992). While there are substantial differences in the overall pace of financial innovation across countries, most countries have been experiencing a noticeable degree of change in their financial systems (Akhtar, 1983). It is not the fact of

change which is surprising – financial innovation in itself is not new (Harrington in Cavanna, 1992). What is new, however, is the acceleration since the 80s in the pace and range of financial innovation (Llewellyn in Cavanna, 1992). Advances in IT have assisted in this rapid development.

New technologies have particularly supported process innovation, making it possible to produce goods and services that were not conceivable before, and in a more efficient and faster manner. An example of this is the use of electronic funds transfer system (Tison, 1986). The IT revolution has also facilitated the provision of derivative products, the development of securitisation and the emergence of electronic payment and settlement means (IMES).

Improving technology and shifting institutional factors have also created hybrid assets with savings and transactions properties of varying degrees, like savings deposits or mutual fund balances. Consequently, it is increasingly difficult to demarcate between monetary and non-monetary financial assets. Like plate tectonics, technological forces can be expected to continue reshaping the financial landscape, but in ways that are difficult to predict. (Petersen, 1995)

These changes have had important consequences for monetary policy.

## **5.1 Monetary Policy Implications**

It is an important feature of monetary policy that it is not aimed at the financial system as such, but it uses the financial system as a means of achieving its objectives (Harrington in Cavanna, 1992). How then, does financial innovation affect the conduct of monetary policy?

During the 1970s, many countries had adopted the control of the money supply as the target of monetary policy (Harrington in Cavanna, 1992). However, financial innovation tend to make the existing relations between monetary and non-monetary variables much more unstable and unpredictable than before (Akhtar, 1983). Indeed, the broader range of financial assets available and their increased substitutability have made monetary aggregates more difficult to interpret. (Chouraqui in Cavanna, 1992) While this has affected different countries differently, there has been a trend towards downgrading quantitative targets and focusing instead on key prices, such as the level of interest rates and/or the level of the exchange rate (Harrington in Cavanna, 1992). Consequently, in a changing financial environment, it is inappropriate to use any one monetary variable as the sole guide for monetary policy (Akhtar, 1983).

Financial innovation has also reduced the effectiveness of non-price credit-rationing mechanisms in transmitting monetary policy changes (Akhtar, 1983). Historically, monetary policy operated in two ways – market transactions designed to influence market prices (OMO); and regulations designed to control quantities or to fix prices, such as credit controls, ceilings on interest rates etc. However, by the early 1980s, it had become apparent that many of the official controls and restrictions that, for so long, had been a feature of monetary policy in most countries had outlived their usefulness. (Harrington in Cavanna, 1992) The wave of financial changes has made these regulatory channels untenable in most

countries (Akhtar, 1983), including here in Fiji<sup>3</sup>.

On a positive note, the IMES contend that financial innovation is expected to increase the speed at which policy interest rates affect other interest rates. The reductions in information processing and transmission costs and the improvement in risk-management capabilities, from the development of derivatives and other new markets, are resulting in more active arbitrage trading among financial assets with various term structures. As a result, the transmission speed at which changes in policy interest rates affect short-term and long-term interest rates is believed to be increasing. Thus, the IT revolution is apparently raising the effectiveness of interest rate channels.

However, there are those that fear that improvements in the efficiency of financial markets will complicate the job of central banks, or more controversially, that the central banks' influence on the markets may be eliminated altogether (Woodford, 2001). This contention is discussed at length in the next section.

## **6.0 The IT Revolution and Monetary Policy Effectiveness**

### **6.1 Will Central Banks Become Obsolete?**

According to White (2001), advances in IT and financial markets will not be responsible for making central banks obsolete (no longer efficient). Rather, he contends that central banks *never have been* efficient.

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<sup>3</sup> See Waqabaca (2000) for a detailed account of financial sector development in Fiji.

Instead, he posits that the IT revolution increases the advantages of private monetary institutions.

White (2001) feels that private banks can issue better currency, particularly with the emergence of private issuers of E-money. He believes that once more consumers prefer digital currency to analog central bank currency, legislation restricting private banks from issuing their own forms of currency could eventually be relaxed.

He also believes that private clearinghouses can better serve as banker's banks. As in note-issue, central banks have taken on the role of banker's bank not because they are efficient at it, but because it is legislated. White (2001) reasons that if commercial banks did not have to legally hold account balances at the central bank, more of the clearing business may return to the private sector. He also states that central bankers should not fret about "systematic risk" as private clearinghouses are fully capable of assessing and internalising settlement risks.

White (2001) goes on to state that clearinghouses can better regulate commercial banks. His reasoning is that advances in information and communications technology are bringing financial innovations that are undermining central banks' ability to enforce a variety of legal restrictions on commercial banks. He asserts that an end to legal restrictions on banks will not be an end to all regulations, only an end to inefficient regulations. Those that survive will be those that are advantageous both to banks and to their customers. In particular, White (2001) maintains that clearinghouse associations have always found it useful to develop and to enforce solvency and liquidity standards for their members.

These ideas, however novel they may be, are quite unlikely to materialise. For the foreseeable future, the current view is that central banks and monetary policy will remain relevant and effective.

## **6.2 Monetary Policy To Remain Relevant and Effective?**

A frequently expressed concern about the effectiveness of monetary policy amidst the IT revolution has to do with the possible erosion of private sector demand for monetary liabilities of the central bank (Woodford, 2001). Friedman (1999)<sup>4</sup> had initially raised this alarm – he suggested that a declining reserve base could undercut central banks’ ability to affect prices and real activity in the future.

There are several reasons why improvements in IT could reduce the demand for base money. Probably the most discussed of these, is the prospect that E-money of various sorts might replace currency altogether. (Woodford, 2001) However, as we saw in Section 4.1, this is highly unlikely.

Even so, Woodford (2001) argues that a complete displacement of currency by E-money would in no way interfere with central bank control of overnight interest rates. He states that such a development, in principle, could result in a drastic reduction in the size of countries’ monetary bases, since currency is the largest component of base money. However, Woodford (2001) argues that neither the size nor the stability of the overall

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<sup>4</sup> See also Costa and De Grauwe (2001) and Mervyn King (1999).

demand for base money is of relevance to the implementation of monetary policy.

Woodford (2000) states that the overnight interest rate that most central banks seek to control is determined in the interbank market for bank reserves. The public's demand for currency affects this market insofar as it affects the supply of bank reserves. If demand for currency rises, banks reduce their reserves at the central bank in order to acquire the currency. To prevent a reduction in the supply of bank reserves, the central bank offsets the effect through OMO. Therefore, Woodford (2000) contends that the complete elimination of currency would only make monetary control under current operating procedures easier, by making it simpler for the central bank to control the supply of bank reserves.

In addition, improvements in IT may also reduce the demand for central bank balances (Woodford, 2001). The demand for these types of balances are largely because of regulatory reserve requirements, which pay little to no interest and are considered an expensive tax on the banks. Modern IT is making it increasingly easy for banks to avoid this tax by moving required deposit balances completely off the balance sheet at the end of the day (and back in the morning) so as to earn better interest (White, 2001).

Recognising that reserve requirements were an increasingly wasteful tax, the Canadian government abolished its statutory reserve requirements in 1994 (White, 2001). Other countries, including the UK, Sweden, Australia and New Zealand among others, have also eliminated reserve requirements. Yet, these countries continue to implement monetary policy through operating targets for an overnight interest rate, and continue

to have considerable success at achieving their operating targets. (Woodford, 2001)

The elimination of required reserves does not mean the disappearance of a market for overnight central bank balances. Instead, central bank balances are still used to clear interbank payments, becoming the sole source of demand for central bank balances. Given the existence of a demand for clearing balances, a central bank can still control the overnight rate through its control of the net supply of central bank balances. (Woodford, 2001)

Another possibility is that advances in IT might reduce the demand for central-bank settlement balances. The demand for these balances results from uncertainty about banks' end-of-day positions due to information asymmetries. With advances in IT, better information processing and communication technologies could lead to lower demand for overnight clearing balances.

However, Woodford (2001) argues that this poses no real threat to central bank control of overnight rates. Instead, he proposes that to offset the lower demand, central banks need to reduce the opportunity cost of overnight balances, by increasing the rate of interest paid by the central bank on such balances. Woodford (2001) asserts that only modifications of operating procedures is required to address this challenge, without any fundamental change in the way that central banks affect overnight rates.

The IMES also concurs with this view, stating that “the reduced demand for the monetary base is not expected to exert a significant influence on the present framework for money market operations.” The IMES adds that even if the demand for the monetary base decreases, as

long as the central bank is the monopoly supplier of the monetary base, the central bank will be able to conduct unlimited intervention in the interbank market. Therefore, the short-term interest rates among commercial banks will not be able to deviate from the rates announced by the central bank.

On the other hand, there is the possibility that the development of electronic networks, allowing payments to be settled without the involvement of central-bank settlement accounts, could eliminate the demand for settlement balances. However, this view is highly speculative at present (Woodford, 2000).

## **7.0 Conclusion**

The IT revolution, no doubt, has played a pivotal role in the development of most economies worldwide. Most importantly, it has enabled the efficient production of new goods and services than otherwise would be possible. Advances in technology have also supported businesses, even nations, “leap frog” traditional developmental stages. Of importance to central bankers, the IT revolution continues to remodel the financial landscape, from the proliferation of E-commerce to the spread of E-money to encouraging financial innovation. These developments have had important implications for monetary policy.

In the face of the technology revolution, some observers predict the demise of currency, while others question the effectiveness of monetary policy, even the existence of central banks. What is clear from the literature survey, though, is that these concerns are quite alarmist – monetary policy will continue to remain relevant and effective, even with the dynamic changes brought on by advances in IT. Of course, monetary

policy will need to implement operational changes in response to the dynamic financial environment, as it has done throughout its history. Alan Greenspan (1993) himself remarked, “Successful implementation of monetary policy ... is a dynamic process of learning about, and adjusting to, capital market innovations.”

Suffice to say, the IT revolution has made the process of formulating and implementing monetary policy more complex. Therefore, policymakers need to introduce greater pragmatism into their decision-making processes. Monetary policymakers should take advantage of the fact that advances in IT ensure market information is now more accessible and timely. Thus, monetary policy decisions must be based on a careful analysis of all relevant information, rather than focussing on any one variable.

In Fiji, the impact of technology on Fiji’s financial system has been steady over the years, although not to the extent of the pace of development in the industrialised/emerging economies. Nevertheless, policymakers should be aware of the challenges that IT could pose for monetary policy. After all, it is the job of a central banker to not only try to anticipate future events, but also to prescribe appropriate responses, if needed.

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