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# Alternative foreign exchange management protocols: an application of sensitivity analysis

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## Abstract

This paper considers the choice between two foreign exchange management protocols, namely whether to hold currencies received until required, or whether to convert foreign currencies into the home reporting currency and back as needed. The alternative protocols involve a tradeoff between saving transaction costs versus stability of home currency values and economies of scale in interest earned on working capital balances. Qualitative sensitivity analysis is applied to the currency management problem in this form to investigate sensitivities and interdependencies in sources of and needs for currencies. The analysis reveals several implications which are not apparent without viewing the problem in such a context. © 2002 Elsevier Science B.V. All rights reserved.

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## 1. Introduction

One way for a firm to deal with the foreign exchange cash management problem is to hold funds in all currencies in which business is done. This facilitates making payments in the different currencies and saves transaction costs, but is costly in foregone investment income; small amounts in each currency yield relatively lower

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returns than large amounts in a single currency, especially if this single currency is an important currency such as the U.S. dollar with a variety of interest-earning instruments. An alternative way of dealing with the multinational currency management problem is to convert everything into a major currency and then buy various foreign currencies as needed. This has benefits as far as interest earnings and choice of investment vehicles are concerned, but is costly in terms of transaction costs and uncertainties on timing of conversion when foreign banking systems are inefficient. As well as the trade-off between interest earnings and transaction costs, there are considerations involving uncertainties of changes in exchange rates; the centralized alternative of keeping funds in (say) the U.S. dollar has more certain value in dollars versus the holding of foreign-currency cash balances.

Understanding the trade-offs that exist in choosing between cash management protocols allows a company to choose a suitable system based upon its needs. Proper understanding requires knowing how events in one part of the global cash picture impact on the situation elsewhere. The analysis of such interdependencies between preferred positions in different currencies is the motivation of this paper.

We start by representing the multinational cash management problem as a generalized network flow problem with arc-gains or losses. The attractiveness of the network flow approach has long been recognized — see for example Christofides et al., (1979), Gautier and Granot (1992). We then apply qualitative sensitivity analysis developed by Gautier and Granot (1996) for generalized network flow problems to help money managers understand the interdependencies in the sources of and needs for different currencies.

The qualitative sensitivity analysis reveals how sales, purchases and holdings of different currencies respond to exogenous changes in cash flows from operations. Several interesting and revealing implications are discovered concerning, for example, how different currency trading and holding decisions interact. These implications would be difficult to determine without engaging in the type of analysis performed here. For example, we show that cash balances in two foreign currencies are *substitutes* only if these have similar characteristics in terms of exchange rates versus interest rate differences. The substitution property implies that if one is forced to, say, sell the first currency, the model will always recommend purchase of the other.

A striking finding is that minor modifications in some parameters of the model may have substantial consequences. For example, a small exogenous change in the required range of amount within which a given currency must be held can result in changes in levels of other currencies that are several times the magnitude of the imposed, exogenous change. This *amplification* effect is enhanced when foreign exchange transaction costs are small. Such an effect could help account for the high volatility of trading volumes and prices on the foreign exchange markets, since modest ‘shocks’ may lead to large, rippling effects.

Section 2 introduces the currency management optimization model first conceptually, then mathematically, and discusses several operational assumptions. Section 3 looks at the model as a network optimization problem, summarizes the relevant sensitivity analysis theory and discusses some limitations to its application. Section

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