School of Business,
Economics and Law
GÖTEBORG UNIVERSITY

Measuring macroeconomic exposures through commercial cash flows - A case study of selected firms in the communication equipment industry

Anh Ngo and Cuong Nguyen

Graduate Business School

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Supervisor: Anders Axvärn

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Cuong Nguyen Anh Ngo

ABSTRACT

Firms, especially multinational firms, nowadays are facing various sources of macroeconomic risks. We employ the cash flow approach to estimate the macroeconomic risks for five leading multinational firms namely Nokia, Ericsson, Motorola, Alcatel and Siemens in the communication equipment industry for the period from 1998 to 2005. Firms' quarterly commercial cash flows are used as dependent variable. Explanatory variables are macroeconomic variables including foreign exchange rates, interest rates, consumer price indices, producer price indices, world oil prices, world non-energy commodities prices and industry relative prices. We run the multiple regression between those variables. The results indicate that firms are exposed to at least one of the selected macroeconomic variables. However, the exposure is not consistent among sampled firms. Euro currency does not play an important role in firms' commercial cash flows. We examine two possible elements that may affect our regression results including potential drawbacks in the use of accounting cash flows data to measure macroeconomic exposures and the existence of potential mispricing.

Key words: economic and cash flow corporate exposure; exchange rate risk; macroeconomic exposure; communication equipment; Nokia; Ericsson; Motorola; Siemens; Alcatel.

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CPI	Consumer price index
PPI	Producer price index
Real CCF	Real commercial cash flows
Real ST interest rate	Real short-term interest rate
Real LT interest rate	Real long-term interest rate

1. INTRODUCTION

This section provides readers brief information on the topic of this paper and discusses methods and results of previous studies on measuring the foreign exchange rate risk and other macroeconomic risks. In addition, the purpose and the objective of the paper as well as its potential contribution are presented.

1.1. Background

Business world consists of many uncertainties or so-called risks. These cause the burden for firms when it comes to plan or strategy. More and more firms are operating globally, extending their networks all over the world. With such a broad network, firms are clearly exposed to many certain risks. Foreign exchange risk plays an important role in management of a firm as it may affect the cash flows of the firm and ultimately the value of the firm. However, besides foreign exchange risk, firms nowadays are also facing other kinds of risks such as inflation risk and interest rate risk. How can firms successfully manage such risks? In order to handle these risks, firms need to know which kind of risks they are dealing with and how to measure them. In practice, there have been several risk measurement approaches. The most popular and widely used approaches are the capital market approach, the cash flow approach, the transaction exposure approach, the translation exposure approach and the economic exposure approach. Each method has its own plus side. In this study, we emphasize the cash flow approach as we would like to address those who are most concerned with the firm's cash flow such as the firm's executives, bondholders, and employees. Meanwhile, the cash flow approach may be used to assess the value of the firm as the capital market approach does.

1.2. Problem discussion

Like water to human, cash flows and stock prices are vital to firms. As most of firms are exposed to foreign exchange risk, over the past 20 years, a number of academic literatures have tried to study the effect of foreign exchange risk on a firm's cash flows

and stock prices. The exposure to this risk is a key concern for investors, analysts, and the firm's management. The capital market approach was first mentioned in general by Dumas (1978) and Adler and Dumas (1980, 1984). This approach suggested that foreign exchange exposure could be quantified as the sensitivity of stock returns (or value of the firms) to exchange rate movements. Following Dumas and Adler, a number of studies have been adopting and developing this method with sample from various countries (e.g., Jorion, 1990; Bodnar and Gentry, 1993; Bartov and Bodnar, 1994; Khoo, 1994; Choi and Prasad, 1995; Chow et al., 1997a,b; He and Ng, 1998; Martin et al., 1999; Nydahl, 1999; Williamson, 2001; among others). However, not all studies can successfully detect the exposure of foreign exchange rate to the firm's value significantly. While Jorion (1990), Bodnar and Gentry (1993), Bartov and Bodnar (1994), Khoo (1994), He and Ng (1998) found little evidence on impact of exchange rate fluctuations over stock returns, Choi and Prasad's study on 409 U.S multinational firms (1995) and Nydahl's study on 47 Swedish firms (1999) found more significant relationship between foreign exchange rate fluctuations and stock returns. The inconsistency in results, as suggested by Choi and Prasad (1995), was due to the research design. Choi and Prasad (1995) conceived that each firm has its own operating profile, financial strategies and firm specific variables, so a study on an aggregate level would be difficult to detect the exposure. However, according to Bartov and Bodnar (1994), the existence of mispricing led to a different result. Mispricing arises because the stock price adjustments to changes in foreign exchange rates may not be instantaneous (Bartov and Bodnar, 1994) and they suggested including the lagged changes of foreign exchange rates in the model, which resulted in a more significant correlation between one-period lagged changes and stock abnormal returns.

An alternative way to estimate the exposure of foreign exchange rates on the firm is the cash flow approach. As its name suggests, the cash flow approach measures the sensitivity of the firm's cash flows to the fluctuations of foreign exchange rates. Several studies such as Garner and Shapiro (1984), Walsh (1994), Chow et al., (1997a), Martin and Mauer (2003) have been adopting this method. Walsh (1994) found that a two-quarter lagged relation between foreign exchange rate changes and operating incomes

potentially rest with firms that show either a contemporaneous or a lagged relation between stock returns and exchange rate changes. The study by Chow et al (1997), examined a sample of firms in 65 compustat industries in the U.S, showed that the unexpected changes in real foreign exchange rates on the firm's earnings have negative impacts over the short horizon (1-3 months), but positive over the long horizon. Martin and Mauer (2003) continued to use the cash flow approach to study 105 U.S banks over period 1988-1998 and found out that 88% of domestically oriented banks and 72% of internationally oriented banks in the U.S reveal significant exposure to at least one of five currencies, namely British pound, Canadian dollar, German mark, Japanese yen, and Mexican peso. This result is expected as it is reasonable to argue that internationally oriented banks have advantages in economy of scale, and due to their experience in international markets, they are well aware of potential exposures and perform better in risk management.

Traditional approaches used to measure the foreign exchange rate risk are translation exposure approach, transaction exposure approach and economic exposure approach, which will be discussed in detail in section two. Conventionally, the effect of foreign exchange rate exposures is classified as either transaction exposure or economic exposure. Translation exposure is the difference between assets and liabilities that are exposed to currency fluctuations. Transaction exposure is the effect of foreign exchange rate changes on the firm's cash flow from the time the transaction is "booked" till the time the transaction is "settled", often in short-term (Chow et al, 1997b). Economic exposure is the effect off exchange rate changes on firm's long-term cash flow (Chow et al, 1997b). These are the accounting approaches and widely used tools by firms as there is no need of statistical models that are employed in the cash flow approach and capital market approach.

Looking at previous studies, it is easy to realize foreign exchange rate risk was the center of most studies. Occasionally, other elements were touched by a few studies, such as the interest rate effect, which was mentioned by Chow et al (1997). In reality, firms however may be exposed not only to foreign exchange rate movement but also to several other

factors like interest rates, inflation, oil prices, and firm specific factors. All of these factors are macroeconomic factors. It should be noted that these macroeconomic exposures interact with each other and they may have the same movements. Thus, our study aims to measure the macroeconomic exposures of a specific industry through a sample of firms. Being able to identify the right exposures enables firms to develop and employ appropriate risk management plans and/or strategies.

There is a relevant study done by Oxelheim and Wihlborg (1995) that could assist our paper. Oxelheim and Wihlborg (1995) carried a case study of Volvo Cars to measure its macroeconomic exposures by using the quarterly cash flows (and sales revenues) for 9 years from 1981 to 1989. Independent variables include exchange rates, short/long term interest rates, consumer price levels, producer price levels, and industry relative prices. Multiple regression analysis was used in the study. The study found that a 1% appreciation of effective exchange risk causes a 2% decrease in real sales revenue. An appreciation to DEM of 1% leads to a 2.4% decrease in real sales revenue. Also, changes in German producer price index have an impact on the cash flows and net sales of Volvo.

In addition, most of the studies in this area were done before the introduction of euro currency in 1999. As such, the exchange rate movements of euro compared with other currencies have not been considered in any study, even the most recent ones. Since its introduction in 1999, euro has been used by 15 highly developed countries and continuing to appreciate against other strong currencies such as U.S dollar and Japanese yen. In this study, we also wish to examine the impact of euro movement on the firm's cash flows.

1.3. Research questions

Our study aims to answer the following questions:

- What are the main exposures of the selected firms?
- Do the main exposures vary across competing firms in the chosen industry?

– What are the economic underlying assumptions behind these exposures?
– Does euro currency have substantial impacts on the firms' commercial cash flows?

1.4. Potential contribution

By considering other macroeconomic exposures in addition to the foreign exchange exposure in the cash flow model, and also the impact of euro currency on the selected firms, we believe our study will enrich the literature in this area. Besides, by focusing on a specific industry through illustration of several firms, the study will surely benefit the chosen industry and firms.

2. THEORETICAL FRAMEWORK

The section aims to familiarize readers with the concept of macroeconomic risks and explains why it is important that firms know how to handle them. This section starts with the definition of macroeconomic risks and a brief discussion on the macroeconomic environment of the firms. Then a throughout review on the traditional approaches and the regression coefficient approaches used to measure macroeconomic risks as well as their limitations is carried out.

2.1. Definition of macroeconomic exposures

Firms, especially multinational firms are facing various sources of risks caused by uncertainties in the macroeconomic conditions. In other words, firms are exposed to different kinds of macroeconomic risks. Throughout this paper, we strive to measure and evaluate such risks. In order to accomplish this task, we need to have a basic understanding about macroeconomic exposures. In this sub-section we simply define macroeconomic exposure and distinguish between the different kinds of macroeconomic exposures.

Macroeconomic exposure or macroeconomic risk is defined as the risk caused by "uncertainty in the macroeconomic environment of all firms in a country" (Oxelheim & Wihlborg 1987, p.8). Oxelheim and Wihlborg (1987, p.9) divided macroeconomic risks into three different types: financial risk, currency risk, and country risk. Financial risk refers to the magnitude and likelihood of unanticipated changes in interest rates and costs of different sources of capital in a particular currency denomination. In our paper we emphasize interest rate risk. Currency risk refers to the magnitude and likelihood of unanticipated changes in exchange rates and inflation rates in the value of foreign and domestic currency (Oxelheim & Wihlborg 1987, p.9). Country risk refers to the likelihood and magnitude of unanticipated changes in a country's productive development, and of changes in "the rules of the games" including laws, regulations and policy regimes selected by monetary and fiscal authorities (Oxelheim & Wihlborg 1987,

p.9). These three kinds of macroeconomic risks should be distinguished from the firm's commercial risk, which is the firm specific and industry specific risk that "arises as a result of uncertainty in the firm specific and industry specific prices and demand conditions" (Oxelheim & Wihlborg 1987, p.9). Despite different definitions, these four categories of risks are not independent from one another. Oxelheim and Wihlborg (1987, p.12) claimed that the interdependence among financial risk, currency risk, country risk and commercial risk is attributable to "the simultaneous adjustment of exchange rates, inflation rates, interest rates, as well government intervention in markets".

Macroeconomic risks can influence different kinds of firms, not only the multinational firms with export and import, but also the strictly domestic firms. We list in table 2.1 the channels through which macroeconomic risks can impact on firms of different kinds.

Table 2.1: **Types of firm and channels of risks**

	Types of Firm			
Channels of risk	**Multi-national with export and import**	**Domestic with export and/or import**	**Domestic with financial operations in foreign currencies**	**Strictly domestic**
Monetary and negotiable securities in foreign subsidiaries	X			
Real assets in foreign subsidiaries	X			
Current and future remittances from foreign subsidiaries	X			
Export and Import	X	X		
Claims and debts in foreign currencies	X	X	X	
Inventory	X	X	X	X
Domestic sales and purchases	X	X	X	X
Loans and deposits in domestic currency	X	X	X	X

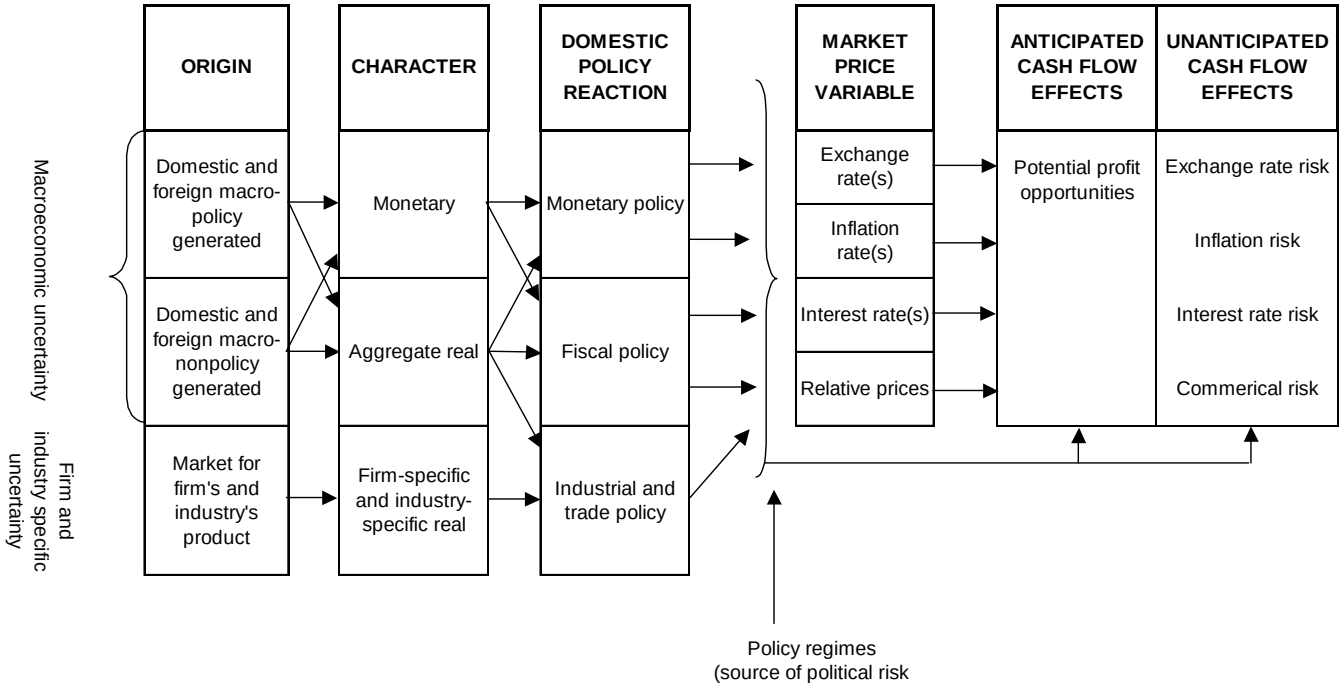
Source: Oxelheim (1984)

2.2. Macroeconomic environment of the firms

It can be reasonably assumed that firm has an economic objective. Lessard (1979) defined such an objective as "the net present value of future expected cash flows." With this objective, firm is ultimately concerned with the exposure of its cash flows to unanticipated changes in macroeconomic conditions.

Figure 2.1 below demonstrates the general relationship between uncertainty about the macroeconomic disturbances and cash flow effects on a firm, as well the categories of risks and their sources. The major sources of macroeconomic uncertainties come from the policy and non-policy disturbances in both domestic and foreign countries in the first column. Ideally, stakeholders would like to link the cash flow effects and the risks directly to these fundamental disturbances. However, the possibility of tracing cash flow changes to these fundamental disturbances depends on the decree of uncertainty about policy reaction to disturbances in the form of monetary and fiscal as well as industrial and trade policy in the third column. Such policy regimes influence the decree to which exchange rates, interest rates, inflation rates, and relative prices in the fourth column adjust to a particular macroeconomic disturbance. Uncertainty about how these policies response constitutes political and country risk. The fourth column lists relevant market price variables namely exchange rates, inflation rates, interest rates and relative prices. Profit opportunities may arise if firms can anticipate the changes in market price variables. Otherwise, firms are exposed to different kind of macroeconomic risks and commercial risks as shown in the last column.

Figure 2.1: External shocks and the cash flows of the firm



Source: Oxelheim & Wihlborg (1987)

2.3. Traditional approaches in measuring macroeconomic exposures

In previous section, we defined and distinguished between different kinds of macroeconomic risks. We also mentioned that macroeconomic risks influenced all kinds of firms, from a strictly domestic to a multinational firm with import and export. In order to be competitive and stay ahead, firms should be concerned about how to handle these risks. For decades, firms have employed a number of different methods to measure and manage risks in the international monetary system. The most frequently used traditional approaches however are "the transaction exposure approach, the translation exposure approach, and the economic exposure approach" (Shapiro 1996). In this section, we briefly describe each type of the traditional approaches and discuss several drawbacks associated with these approaches.

2.3.1. Transaction exposure approach

Transaction exposure refers to uncertainty about the domestic currency value of a specific future cash flow in a foreign currency (Oxelheim & Wihlborg 1987, p.37). Transaction exposure, therefore, refers to uncertainty about cash profits due to unanticipated exchange rate fluctuations. In reality, a transaction exposure arises whenever a company is committed to a foreign currency-denominated transaction. Since the transaction will result in a future foreign currency cash inflow or outflow, any change in the exchange rate between the time the transaction is entered into and the time it is settled in cash will lead to a change in the domestic currency amount of the cash inflow or outflow.

Due to its nature, most often the concept of transaction exposure is reserved for the contracted flows in foreign currencies. Contracted flows, as a rough approximation, are the financial flows while non-contracted flows are the commercial flows. This limitation is not necessarily true however. Some future commercial cash flows can naturally be contracted for in money terms in advance of delivery of goods and it is possible that financial flows are not contracted in money term at the time the loan is taken. Also, some expected future cash flows are initially non-contracted sales or purchases but, at the date of delivery, becomes contracted flows in the form of account receivables and account payables.

The table below gives a simple example to demonstrate how transaction exposure is measured:

Table 2.2: Measuring transaction exposure in a foreign currency (FC)

	Quarter			
	I	**II**	**III**	**IV**
Account receivables from exports	40	50	60	30
Account payable from imports	-20	-30	-30	-30
Foreign interest payments (net)	-10	-10	-10	-10
Amortization of foreign debt (net)	0	0	-50	0
Net exposure before covering	10	10	-30	-10
Sale or purchase of foreign currency in forward markets	-10	-10	20	0
Net exposure	FC 0	FC 0	FC-10	FC-10

Source: Oxelheim and Wihlborg (1987, p. 38)

Net exposure before covering is estimated in the given currency denominations of contracts. Thereafter, protective measures to protect against transaction exposure involve entering into foreign currency transactions whose cash flows exactly offset the cash flows of the transaction exposure. Forward contracts and currency options are among the most frequently used protective measures to hedge against transaction exposure. Alternatively, firms could try to invoice all transactions in domestic currency and therefore avoid transaction exposure entirely. In the case of transaction exposure for contracted flows, nearly exact covers can be obtained by entering the forward contracts when the exact day on which cash flow will occur in known. In the case of transaction exposure for non-contracted flows, the exact covers cannot be obtained but the cover decision must be based on expectations of cash flows.

2.3.2. Translation exposure approach

Translation exposure is the difference between assets and liabilities that are exposed to currency fluctuations. Oxelheim and Wihlborg (1987, p.39) refer to it as "the net balance sheet position in a foreign currency". In reality, translation exposure arises from the need, for purpose of reporting and consolidation, to convert the financial statements of foreign operation from the local currency involved to the home currency. If exchange rates have changed since the previous reporting period, this translation of those assets and liabilities, revenues, expenses, gains, and losses that are denominated in foreign currency will result in foreign exchange gains or losses. In theory, there are four principal translation methods that are used internationally as shown in the table below:

Table 2.3: Balance sheet translation rules

	Current/non-current	**All-current (Closing rate)**	**Monetary/ Non-monetary**	**Temporal**
Asset:				
Cash	C	C	C	C
Securities				
- historical cost	C	C	C	H
- market price	C	C	C	C
- Receivables				
- current	C	C	C	C
- Long-term	H	C	C	C
Inventory				
- historical cost	C	C	H	H
- market price	C	C	H	C
Fixed assets	H	C	H	H
Liabilities:				
Current payables	C	C	C	C
Long-term debt	H	C	C	C
Equity	Residual	Residual	Residual	Residual

C: translated at current exchange rate

H: translated at historical exchange rate

* Includes the translation gain or loss

Source: Oxelheim (1985)

Under the current/non-current method, all foreign subsidiaries' current assets and short-term debt are translated into home currency at the current exchange rate, i.e. the exchange rate on the closing date, while non-current assets and long term liabilities are translated at their historical exchange rates, i.e. the rate applying when an asset was acquired. The income statement is translated at the average exchange rate of the period except for those revenue and expense items associated with non-current assets and liabilities, which are translated at the same rates as the corresponding balance sheet items.

According to the monetary/non-monetary method, monetary balance sheet items such as cash, account receivables, account payables are translated at the current exchange rate. Non-monetary items such as fixed assets and inventory are translated at the historical exchange rates. On the income statement, revenue and expense items are translated at the average exchange rate of the period. However, revenue and expense items associated with non-current assets and liabilities such as depreciation and amortization charge and cost of goods sold are translated at the same rate as the corresponding balance sheet items.

The temporal method is a modified version of the monetary/non-monetary method. This method is widely used by U.S companies. The only difference is that under monetary/non-monetary method, inventory is always translated at the historical exchange rate while, under the temporal method, inventory is normally translated at the historical rate but it can be translated at the current rate if the inventory is shown on the balance sheet at market values. Despite the similarities, the theoretical bases of two methods are different. The choice of exchange rate for translation in the monetary/non-monetary method is based on type of asset or liability. Under the temporal method, it is based on the underlying approach to evaluating cost (i.e. historical versus market). Similar to

monetary/non-monetary method, the income statement is translated at the average exchange rate for the reporting period. Cost of goods sold, depreciation and amortization charges are translated at the same rate corresponding to the balance sheet items.

Under the all-current method, all balance sheet and income statement items are translated at the current rate. Therefore, this method is sometimes referred to as the closing-rate method. This method is widely employed by British companies. Under this method, if a firm's foreign currency-denominated assets exceed its foreign currency-denominated liabilities, currency devaluation will result in a loss and a revaluation will result in a gain (Shapiro 2002, p.255).

2.3.3. Economic exposure approach

If we define the value of a firm as the present value of expected future cash flows, economic exchange rate exposure measures the sensitivity of the firm's future expected cash flows and thus the firm's value to the movements of exchange rates during the period. The sensitivity in amount of the firm's future cash flows to exchange rate fluctuations can be broken down into the sensitivity of the firm's future financial cash flows and the sensitivity of the firm's future operating cash flows to exchange rate fluctuations. The first item refers to the transaction exposure. The latter item refers to the operating exposure, which measures the extent to which currency fluctuation can alter the firm's future operating cash flows. Therefore, economic exposure is the combined effect of transaction exposure and operating exposure. Hence economic exposure depends on the type of currency exposure firms want to deal with and particularly the operations of the firms such as locations of factories, competitive structure, pricing strategy etc. Nydahl (1999) claimed that the measurement of economic exposure is prospective in nature and it is based on future activities and in practice is very complicated to identify and hedge. Oxelheim and Wihlborg (1987, p. 46) identified four factors affecting the firms' economic value. They are the type of cash flows, the nature of exchange rate changes, the timing of cash flow remittances, and the expected degree of permanence of exchange rate changes.

2.3.4. Limitations of traditional approaches

Traditional approaches have obtained relative success in handling macroeconomic exposures according to some observers. Despite this, they are exposed to several weaknesses. Oxelheim and Wihlborg (1987, p. 82) identified three major limitations of traditional approaches.

The first major limitation of the traditional approaches is that they only deal with one type of risk independent from others. In other words, traditional approaches disregard the fact that exchange rate, interest rate, and inflation rate are often correlated and they adjust simultaneously to changes in macroeconomic conditions and policies. Moreover, traditional methods tend to be partial in the sense that they do not capture all influences of a particular disturbance on the firm. They mainly focus on the foreign exchange rate risk.

Another problem associated with the traditional risk measurement approaches is that some exposure measures may not stable over time. For example, the actual economic relevance of translation exposure depends on whether exchange rate changes correspond to inflation, and whether exchange rates are expected to be temporary or permanent. However, all exchange rate changes are not alike in these respects. Thus, fixed rules for dealing with translation exposure may be inappropriate.

The last major problem is the impact of exchange rate risk and other macroeconomic variables on firms does not distinguish between anticipated changes and unanticipated changes. Anticipated change is measured by the expected change, which is normally evaluating through forecasting while unanticipated change is often referred to as unforeseen change. And by exposure management, we emphasize the firm's handling of unanticipated changes in exchange rate, interest rate, and inflation rate.

2.4. Measuring macroeconomic exposures using regression coefficient approach

Previous section reviewed several traditional approaches to measure risks, in particular the foreign exchange rate risk, related to the macroeconomic environment of the firm. These traditional risk measurement methods are criticized for being partial in the sense that they do not recognize the interdependencies among exchange rates, interest rates, and inflation rates. In this section, we introduce two new and more comprehensive approaches to measure macroeconomic risks. They are so-called the capital market approach and the cash flow approach. These approaches employ regression analysis of historical data to measure macroeconomic exposures. Similar to traditional approaches, the capital market approach is originally designed to detect foreign exchange rate risk. The cash flow approach is more comprehensive in the sense that it simultaneously takes into consideration the impact of foreign exchange rates and other different macroeconomic variables as well as firm and industry specific variables.

2.4.1. Capital market approach

The capital market approach estimates capital market exposure as the sensitivity of stock returns to movement in a trade-weighted exchange rate index. The model is originally based on a study carried out by Adler and Dumas (1984). In this study, Adler and Dumas observed that economic exposure of a firm could be measured through a simple regression with changes in firm value as the dependent variables and the exchange rate changes as the regressor. Since the value of a firm is reflected in its stock prices, this regression can be performed using the firm's stock price and the exchange rate.

Equation (1) describes how capital market approach is used to estimate foreign exchange rate exposure (Martin & Mauer, 2005):

$$R_t = \beta_0 + \beta_m R_{mt} + \beta_x X_{t+} e_t \quad (1)$$

where:

R_t = return on the individual firm's stock measured as the percentage change in the stock prices;

X_t = percentage change in the exchange rate factor for time t;

R_{mt} = return on market portfolio;

B_0 = the intercept;

B_x = firm's exposure to exchange rates changes;

e_t = error term for time t.

Based on the way the equation is written, the coefficient β_x indicates about the change in a period's stock return when there is a one unit change in the exchange rate factor from one period to another, given that other variables in the equation remain constant.

Historically, identifying significant exchange rate exposure in this manner has had limited success. Jorion (1995) found 5% of 287 multinational firms exhibiting significant exposures while Choi and Prasad (1995), on another study, revealed 15% significance over a sample of 409 multinational firms. Over time many modifications and improvements have been added to the model with the purpose to increase the significant detection level of exchange rate exposure. Traditionally, the model estimates foreign exchange exposure as the sensitivity of stock returns to a trade-weighted exchange rate index. However, researchers now no longer use the trade-weighted exchange rate index. They claimed that "detecting exposure may be difficult using an index if firm have different relative linkages with the index, or if firms have offsetting exposures to different currencies included in the index, or firms may lack exposure to the currencies that comprise the index" (Martin & Mauer 2005). Martin et al (1999) focused on estimating exposure relative to an index of only European currencies for U.S. multinational firms with operations in Europe while Williamson (2001). Koutmos and Martin (2003) measured exposures with respect to movements in specific bilateral exchange rates.

2.4.2. Cash flow approach

2.4.2.1. Cash flows and macroeconomic exposures

In this sub-section, we will explain why firms' cash flows might be influenced by macroeconomic factors. The firm's value is equal to the net present value of its expected cash flows. A multinational firm has both domestic cash flows and foreign cash flows. The foreign cash flows in foreign currency are converted to the domestic currency upon consolidation.

$$CF_t^{Firm} = CF_t^{Domestic} + CF_t^{Foreign} \times S_t \quad (2)$$

CF_t^{Firm} is the firm's total nominal cash flows in domestic currency in period t. $CF_t^{Domestic}$ is the firm's nominal domestic cash flows. $CF_t^{Foreign}$ is the firm's nominal foreign cash flows. S_t is the exchange rate defined as domestic currency units per unit of foreign currency. The nominal cash flows are deflated by the domestic price level (P_t) to obtain the real cash flows:

$$CF_t^{Firm} / P_t^{Domestic} = CF_t^{Domestic} / P_t^{Domestic} + CF_t^{Foreign} \times S_t / P_t^{Domestic} \quad (3)$$

$$S_t = P_t^{Domestic} \times u_t / P_t^{Foreign} \quad (4)$$

u_t is the real exchange rate. Substituting equation (4) into equation (3), we have:

$$CF_t^{Firm} / P_t^{Domestic} = CF_t^{Domestic} / P_t^{Domestic} + CF_t^{Foreign} \times u_t / P_t^{Foreign} \quad (5)$$

The cash flows in equation (5) represent the consolidated real cash flow in domestic currency, which obviously depends on the real exchange rate (u_t). However, the firm's consolidated real cash flows also depend on real domestic cash flows ($CF_t^{Domestic} / P_t^{Domestic}$) and real foreign cash flows ($CF_t^{Foreign} / P_t^{Foreign}$). Real domestic cash flows and real foreign cash flows, in turn, depend on macroeconomic variables, which influence the demand and supply of the firm's products. Using the following expression,

we can further explore the sources of exposure of real commercial cash flow (Oxelheim & Wihlborg 1995):

$$CF_t^{Foreign} / P_t^{Foreign} = q_t[(OP_t^{Foreign} / P_t^{Foreign}) - (IP_t^{Foreign} / P_t^{Foreign}) - (W_t^{Foreign} / P_t^{Foreign}) \times (1 - T) + T \cdot Depr_t^{Foreign} / P_t^{Foreign} \ldots (6)$$

where:

q = quantity of sales

OP = unit output price

IP = unit input price

W = unit labor cost

T = tax rate

Depr = depreciation

Unanticipated changes in macroeconomic conditions (or macroeconomic uncertainties) can affect the quantity of sales (q) and relative prices (OP/P, IP/P, W/P). In reality, it is difficult to assess and observe changes in macroeconomic conditions. Firms therefore have to rely on observations of macroeconomic price variables such as exchange rates, interest rates, and goods prices as indicators of macroeconomic conditions (Oxelheim and Wihlborg 1995). Macroeconomic uncertainties influence macroeconomic price variables simultaneously and based on changes in macroeconomic price variables, firms adjust their production output and output prices. It is possible to estimate the magnitude of the influence of macroeconomic price variables on the firm's output and price but this estimation requires a lot of information. An effective way to measure this influence is using the historical data to estimate the relation between macroeconomic variables (i.e. exchange rates, interest rates, goods prices) and cash flows.

2.4.2.2. Cash flow method

Cash flow approach estimates cash flow exposure as "the sensitivity of cash flows to unanticipated changes in macroeconomic conditions as captured by exchange rates, interest rates, and inflation" (Oxelheim & Wihlborg 1995). Compared to other

approaches, the cash flow approach is more comprehensive in the sense that it simultaneously considers different macroeconomic variables as well as firm and industry specific variables. Therefore, if well implemented, this method can distinguish among different kinds of macroeconomic exposures and separate the effects of each type of exposures on firms. This separation is proved "useful not only for risk management but also for strategic management and for the evaluation of a corporation" (Oxelheim & Wihlborg 1995).

The impact of exchange rates, interest rates, inflation and other macroeconomic variables as well firm and industry specific variables on the firm's economic value can be estimated by running the following regression (Oxelheim & Wihlborg 1995):

$$CF^{LC}_t / P^{LC}_t = A_0 + A_1(LC/FC)_t + A_m V_t + A_x X_t + e_t \quad (7)$$

where:

CF^{LC}_t = nominal cash flow of commercial operation during period t in local currency
P^{LC}_t = price level in local currency country in period t
$(LC/FC)_t$ = vector of exchange rates in period t (period average)
V_t = vector of other macroeconomic variables representing macroeconomic disturbances in period t (period averages)
X_t = vector of firm and industry specific disturbances
A_1, A_m = vectors of coefficients as measures of exchange rate and other macroeconomic exposures
A_x = vector of coefficients for variables in x
e_t = error term for period t.

Based on the way the equation is written, the coefficient A_1 indicates about the change in a period's cash flow in real local currency when there is a one unit change (of local currency) in price of foreign currency from one period to another, given that other variables in the equation remain constant.

In Section 2.2 we mentioned that the changes in exchange rates, interest rates, and inflation rates generally depend on policy and non-policy disturbances in monetary conditions and fiscal policies as well as industrial policies. However, the exact choices of macroeconomic variables in equation (7) depend on "the econometric considerations, the firm's exposure management objectives, and the observability of macroeconomic disturbances at the time the management decision is made" (Oxelheim & Wihlborg 1995). If the objective is to explain as much variability as possible, firm should try any combination of relevant a priori determined variables (Oxelheim & Wihlborg 1995). The exchange rates, domestic and foreign interest rates, and domestic and foreign price levels are proved to be "the most important variables of this kind" (Oxelheim & Wihlborg 1995). If the objective is to identify regression coefficients for a set of variables that management can observe and use for various decisions, firms should use such macroeconomic variables that are familiar and easily observable. As noted above, the most easily observable and readily available macroeconomic variables are the exchange rates, interest rates, and other price variables or inflation. In addition, the firm and industry specific variables in equation (7) are usually the relative prices in the firm's commodity market.

2.4.3. Limitation of regression coefficient approaches

Compared to traditional approaches, the regression coefficient approaches are more comprehensive in the sense that they simultaneously take into consideration the impact of different macroeconomic variables as well as the firm and industry specific variables. Despite this, they contain certain weaknesses.

Firstly, the regression coefficient approaches are relatively difficult to implement. It requires practitioners to have an extensive knowledge about economics and particularly econometric.

Secondly, the cash flows approach only works well under the conditions of readily available information. Martin and Mauer (2005) claimed that readily available

information is necessary to accurately identify net exposure. However, this is not often a case in reality. In our thesis, we have to rely on data extracted from the firms' financial reports. Nonetheless, previous studies reveal that financial statement disclosure is inadequate (e.g., Roulstone, 1999; Wong, 2000; Marshall and Weetman, 2002).

3. METHODOLOGY AND DATA COLLECTION

This section aims at informing readers about our selected approach namely the cash flows approach to measure the macroeconomic risks. A brief discussion on the choices of industry and firms as well as choices of variables and the study time period is represented. Finally, the sources and the reliability of the data are discussed.

3.1. Our methodology – cash flow approach

One similarity among risk measurement approaches discussed in the previous section is that they all apply the quantitative method. Quantitative method is preferred over qualitative method because firms need to know the exact possible impact of exposures on the firm's value and cash flows. Without knowing precisely the potential impact, it will be difficult for the firm's management to manage these risks. If traditional approaches only limit to measure the foreign exchange exposure, the regression coefficient approaches overcome this limitation by incorporating other macroeconomic exposures into the models. As mentioned in the previous section, the cash flow approach appears to be relatively more advantageous than other approaches as it takes into account different macroeconomic exposures as well as the firm and industry specific elements. Besides, there have already been a number of studies that implemented the capital market approach. Thus, we would like to adopt the cash flow approach for our study.

We would like to implement the Oxelheim and Wihlborg's model which we have explained in section one, but expand the sample to several competing firms in a specific industry. Our study, therefore, will employ the cash flow approach to measure the macroeconomic exposures for a number of competing firms in a specific industry.

We assume that firms are ultimately concerned about uncertainty of cash flows caused by changes in macroeconomic conditions. Thus, the macroeconomic exposures we propose are referred to the sensitivity of cash flows to unanticipated changes in macroeconomic conditions. We have explained in section 2.4.2 how changes in firms' cash flows are

related to foreign exchange rate movements and other macroeconomic conditions. However, as few macroeconomic conditions are directly observable, we consider exchange rate, interest rate, and consumer goods price levels (inflation) as captured by the consumer price index as approximate indicators of macroeconomic conditions. We also include some firm and industry specific variables such as producer goods price level, oil prices, and raw material prices. Finally, the industry relative price is the ratio of producer price index for electrical machinery and consumer price index. Full discussion on our statistical model will be presented in section 5.3.

The cash flow approach will employ the multiple regression model to measure macroeconomic exposures. The regression sensitivity coefficients are interpreted as exposures.

3.2. Choices of firms

Since we want to include a firm in Sweden, we first scan through the multinational firms based in Sweden. These firms should at least possess the following characteristics:

- Be a public firm, preference given to firm that has share traded in NYSE;
- Have operations in global market, covering all five continents;
- Be the leading firm in its industry;
- Be in a competitive and dynamic industry, but not a financial industry due to its special type;
- No specific public study in the same area on this firm.

Sweden has a small population but it has numerous large and leading multinational firms, including ABB, Electrolux, Ericsson, SKF, Volvo, and H&M. There are more than one firm that could match our above criteria. Based on our criteria together with our personal preference, we finally select Ericsson. Ericsson's products are spreading all over the world. The company is not only competitive in the Europe but also in the United States

and Asia markets. Its industry, the communication equipment industry, is among the most competitive and innovative industries in the world.

With Ericsson being the starting point, we take a closer look at its industry namely the communication equipment. Other firms to be included in the study have to satisfy following criteria:

- Leading firms in the communication equipment industry (in term of market share which is often associated with revenues);
- Operating in multi-continents.

A brief discussion about the communication equipment industry and selected firms will be presented in section 4.

3.3. Choices of variables and time period

Dependent variables

Cash flows:

The choice of dependent variables depends on the firm's objective. The choices vary but in this study, we assume that the firms ultimately concern with the cash flow patterns that result from changes in macroeconomic variables.

Independent variables

Foreign exchange rate: As shown in equation (3) and (5), foreign exchange rate is the obvious source of macroeconomic exposure and directly affects the cash flows of the firm. In this study, we will test different bilateral foreign exchange rates to examine the significance of each foreign exchange rate to the firms.

Other independent variables are macroeconomic variables that influence the output volumes and output/input prices of the firms. The output volumes and output/input prices subsequently affect the firm's cash flows as shown in equation (6).

Interest rate: No matter what industry the firms are in, they are all affected by interest rates, either directly through coupon payment and loan interest expense, or indirectly through business environment. We include both short-term and long-term interests to see how the cash flows react to the changes in the interest rate over a short and long horizon. In addition, interest rate also has an interacting effect on the exchange rate.

Goods price (consumer price index): Higher inflation will lead to higher input and output prices of a firm. Inflation can also affect interest rates and the firm's competitive ability.

Producer price index: This is the firm and industry specific element. Most of firms have to buy raw materials and outsource some components from a foreign country for their manufacturing activities. A variation in the producer prices of the foreign country may affect the firms' input costs and thus their competitiveness.

Oil price: This is also the firm and industry specific element. Firms depend on oil for its manufacturing operations. Therefore, the fluctuation of oil prices may have an impact on the cash flow of the firms.

Others: We will also include the world non-energy commodities index in the model. This is the index for raw materials as we expect that the firms will purchase various materials for their manufacturing operations. Finally, the industry relative price is the ratio of producer price index for electrical machinery and consumer price index.

In section five, we will discuss in detail how we collect the above data.

Time period

The study aims for the 5 to 10 year period. Since we want to study the impact of euro, the best period would be from 1999 to 2005. In addition, in the financial reports, as the financial data in year 1998 are converted from domestic currency to euro (for firms use euro as functional currencies started 1999), we would also include year 1998's data to increase the number of observations. Data will be collected quarterly.

3.4. Data sources

Our data for this study are secondary data, which are data collected by others and re-used by us. We collected these data from different trustworthy sources. For our study, primary data are not appropriate as it would take enormous time to collect those data by ourselves, while those data are already collected by others and available for use. We obtain quarterly cash flows figures from the annual and interim reports published in the firms' official websites as well as from the Securities Exchange Commission in the United States. Other data such as exchange rates, consumer price index, producer price index, world oil price, and world non-energy commodity index are collected from the International Financial Statistics and the Central Banks of related countries.

3.5. Reliability and validity of our data and model

The data used in our regressions are collected directly from the International Financial Statistics, the central bank websites and the company's financial reports. Hence, they are highly reliable. In addition, since our model has been adopted by a numbers of researchers, we have a reason to believe its validity in practice.

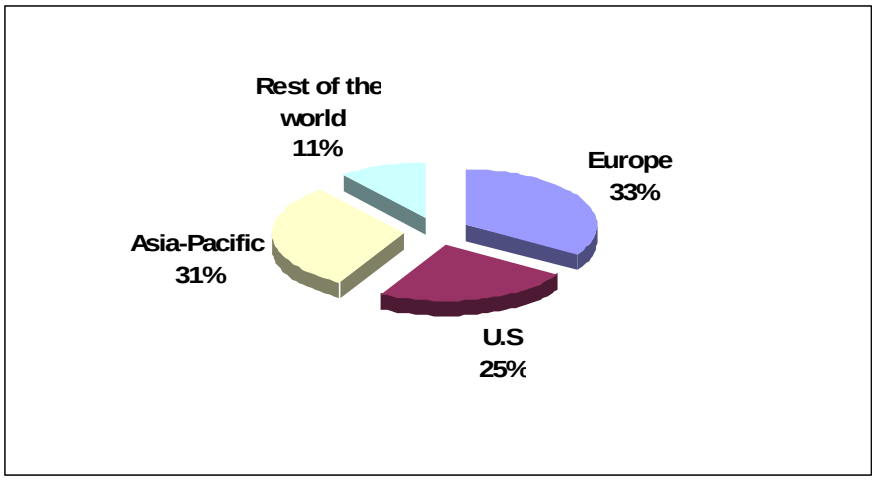
4. COMMUNICATION EQUIPMENT INDUSTRY AND SELECTED FIRMS

The main objective of this section is to give readers an overview about the selected industry and firms. For each selected firms, we present the largest sale markets, the main suppliers or primary manufacturers, and the main competitors. This information is the base to select the macroeconomic variables for the regression models.

4.1. Communication equipment industry

Global communication equipment industry includes manufacturers of communication equipment and products, including LANs, WANs, routers, telephones, switchboards and exchanges. In 2003, market value of the industry reached $290.7 billion, of which $234.64 billion comes from telecommunication equipment (Datamonitor, 2004). Europe leads the market share with 33% and the rest of the pie in 2003 was divided as follows:

Figure 4.1: Market share of communication equipment industry



Source: Datamonitor 2004

The leading companies within the global communications equipment market, in terms of revenue, are Nokia, Alcatel, Motorola, Siemens, Ericsson (Datamonitor, 2004). Revenues of these five leading firms accounts for approximately 40% of the total global industry (Datamonitor, 2004).

4.2. Nokia

Nokia is the world's largest manufacturer of mobile devices and a leader in mobile networks, equipment, solutions, and services (Nokia Form 20-F 2004, p. 46). The company also provides equipment, solution, and services for network operators and corporations. Nokia is headquartered in Helsinki, Finland and has about 55,505 employees. For fiscal year 2004, Nokia net sales totaled EUR29.3 billion and net profit was EUR3.2 billion (Nokia Form 20-F 2004, p. 23). The following table shows the distribution by geographical areas of net sales (in percentage) from 1998 to 2004:

	2004	**2003**	**2002**	**2001**	**2000**	**1999**	**1998**
Finland	1	1	1	1	2	2	3
United States	6	8	6	6	8	8	9
China	12	15	16	18	17	17	15
United Kingdom	9	7	9	11	10	12	13
Germany	8	9	10	9	9	9	9
Other markets	64	60	57	54	53	51	51

Sources: Calculated from Nokia's annual reports

As can be seen from the table, China has been the leading single market over the years.

On the input side, Nokia's manufacturing operations greatly depend on adequate supplies of fully functional components on a timely basis. All Nokia's functional components were supplied by a limited number of suppliers and manufactured at production facilities in nine countries around the world. The main manufacturing facilities are located in China.

The market for Nokia's products is intensely competitive. Industry participants compete with each other mainly on the basis of the breath and depth of their product portfolios, price, operational and manufacturing efficiency, technical performance, product features, quality, and customer support. Nonetheless, the competition varies depending on the products and services. Nokia's major competitors are large and established companies

including Motorola, Ericsson, Siemens, and Samsung. These companies combined will take away the company's market share. Competition could be particularly strong in the most price sensitive markets such as Asia. In addition, as a result of the industry developments, Nokia also expects to face new competition from companies in related industries, such as consumer electronics manufacturer and business device, including Dell, H.P, Microsoft, and Sony.

4.3. Ericsson

LM Ericsson Telephone Company (Ericsson) is a global leader in the development and supply of advanced systems and services for mobile and fixed line communications. The company provides solutions, systems, and services that enable mobile and fixed line networks to transmit voice, data and multimedia communication. Ericsson is headquartered in Stockholm, Sweden and has about 51,500 employees. For fiscal year 2004, the company had net sales of SEK132 billion and the net profit was SEK19 billion (Ericsson's 2004 Annual report p.27). The following table shows the distribution by geographical areas of net sales (in percentage) from 1999 to 2004:

	2004	**2003**	**2002**	**2001**	**2000**	**1999**
United States	11	14	15	11	12	11
China	9	9	9	13	7	9
Italy	7	7	7	6	6	6
Sweden	5	5	6	3	3	4
United Kingdom	3	5	4	5	8	7
Other markets	65	60	59	62	64	63

Sources: Ericsson's Annual reports

Overall, U.S market represents the largest single market of Ericsson's products. China has been following up the U.S to become the second dominated market.

On the input side, Ericsson manufactured and assembled a large part of its products in house. However, more than half of its total products are outsourced to a group of

electronic manufacturing services companies such as Flextronics, Solectron, Sanmina-SCI (Ericsson Form 20-F 2004, p. 86). These suppliers design and manufacture specialized and customized components for Ericsson's networks. Sony Ericsson Mobile Communication, a subsidiary of Ericsson, outsources a significant part of its production of mobile handsets to Flextronics.

The markets for Ericsson's products are highly competitive in terms of pricing, functionality and service quality, the timing of development and introduction of new products, customer service and terms of financing. Ericsson competition varies depending on the products and services offered. Ericsson's most significant competitors include Alcatel, Lucent, Motorola, Nokia, Nortel, Cisco and Siemens. In addition, as a result of the industry development, Ericsson can expect to see additional competitors, possibly some network operators attempting to expand into new segments.

4.4. Motorola

Motorola is a global leader in providing integrated communications solutions and embedded electronic solutions. It is the number-two provider of cell phones globally. The company provides a wide range of telecommunication services and products. Its areas of expertise encompass integrated communication solutions and embedded electronic solutions. These include software-enhanced wireless telephone, two-way radio, messaging, as well as networking and Internet access products. Motorola has a workforce of about 68,000 employees and is headquartered in Schaumburg, Illinois. For fiscal year 2004, Motorola's net sales totaled USD31 billion and the net profit was USD1.5 billion (Motorola form 10-K 2004 p.31).

Regarding the market share, U.S represents the largest single market for Motorola's products. Many of Motorola's customers are, however, located outside the U.S. The largest single international markets are China and the United Kingdom (Motorola Form 10-K 2004 p.13). Since 2000, China has dominated to become the second individual

largest market after the U.S. The following table shows the distribution by geographical areas of net sales (in percentage) from 2001 to 2004:

	2004	2003	2002	2001
United States	47	54	51	44
Europe	19	13	12	14
China	9	9	14	13
Latin America	9	8	6	8
Asia excluding China and Japan	7	7	9	9
Japan	3	2	2	5
Other markets	6	7	6	7

Sources: Motorola's Annual reports

On the input side, most of Motorola's products and parts are manufactured in-house at its manufacturing facilities worldwide. In particular, over half of the company's products are produced at manufacturing facilities in Asia, in which China represents the primary and largest manufacturing operation.

Motorola faces a strong competition in worldwide market from various global competitors, including some of the world largest companies. The competition however varies depending on the products and services offered. The primary competitors are European and Asian manufacturers including Nokia, Ericsson, Siemens, Alcatel, NEC, and Samsung.

4.5. Siemens

Siemens is a leading global company in electrical engineering and electronics. The company is active in areas of information and communication, automation and control, power, transportation, medical and lighting. Siemens is headquartered in Munich, Germany and has about 434,000 employees. For fiscal year 2004, Siemens had net sales of EUR75 billion and the net profit was EUR3.4 billion (Siemens Form 20-F 2004 p.1). Regarding the market share, Germany represents the largest single market with about 22% of total sales. The most significant international market is the U.S market. The

following table shows the distribution by geographical areas of net sales from 1999 to 2004:

	2004	2003	2002	2001	2000	1999
Germany	23	23	22	22	24	27
Europe excluding Germany	33	34	32	30	31	31
United States	18	21	24	24	22	18
Other markets	26	22	23	24	23	24

Sources: Calculated from Siemens's Annual reports

On the input side, about 75% of Siemens's products and components are manufactured in-house at various manufacturing facilities in Germany and worldwide; the rest is outsourced to third party vendors (Datamonitor 2004). The major manufacturing facilities are located in Germany and China.

Siemens competition varies depending on the products and services offered. Some of the most significant traditional competitors include Nokia, Motorola, Nortel, Cisco, Lucent, Ericsson, LG and Samsung. In addition, the company is confronting with new competitors with a strong regional focus, for example China, who build on their low cost structures.

4.6. Alcatel

Alcatel is a leading global supplier of hi-tech equipment and communication solutions. The primary products are network switching and transmission system for wireline and wireless networks for telecommunication carriers, internet service providers, and enterprises for delivery of voice, data, and video applications. The company also manufactures cell phones, communication cable, and satellite equipment and provides such services as consulting, integration, design, planning, operation, and maintenance. Alcatel is headquartered in Paris, France and has about 56,000 employees. For fiscal year 2004, the company had net sales of EUR12 billion and net profit of EUR281

million. The following table shows the distribution by geographical areas of net sales from 1999 to 2004:

	2004	2003	2002	2001	2000	1999
United States	15	16	17	23	22	18
Asia-Pacific	15	18	17	13	7	8
France	14	13	14	15	14	16
Germany	6	7	7	8	8	9
Other western Europe	22	23	21	21	31	36
Other markets	28	23	24	20	18	13

Sources: Calculated from Alcatel annual reports 1999-2004

U.S represents the largest single market for Alcatel. However, sales in France and in Asia-Pacific are also approximate sales in the U.S. With the contribution of the China market, the sales in Asia have been increasing over the years.

On the input side, Alcatel develops and manufactures most of its products and components at its manufacturing facilities worldwide. A substantial portion of manufacturing operations however is conducted in France and China (Alcatel Form 20-F 2004, p.20).

Alcatel has one of the broadest product and services offerings in the telecommunications service provider market. The company's addressable market segment therefore is very broad. The company's competitors are large and well-known companies including Avaya, Cisco, Ericsson, Fujitsu, Huawei, Lucent, Motorola, Nokia, Nortel and Siemens.

5. EMPIRICAL DATA AND STATISTICAL MODEL

This section aims at presenting the statistical model for the study. This is an expansion of the methodology section. In this section, we specify the independent and dependent variables and how to collect them. We also represent the sequential steps in testing. Understanding this section is extremely important to understand and interpret the empirical results in the next section.

5.1. Dependent variables

Most of the firms are concerned about their market values, which are measured either directly through stock prices or indirectly through the present value of cash flows. The cash flow approach that we selected will measure the sensitivity of the cash flows to changes in macroeconomic variables. As such, cash flows are collected from the firms' financial reports. Then it comes to the question whether we should collect annual, quarterly, or monthly cash flows. Which frequency would be appropriate? As suggested by Oxelheim and Wihlborg (1987), the frequency that cash flows effects are estimated would depend on the length of time over which the firm forms its expectations of cash flows and its ability to manage the exposures (hedging). Certainly annual data could satisfy the above requirements, but quarterly date would be more appropriate since it can detect more fluctuation with higher frequency. Monthly period would be too short for the firm to adjust or form its expectations. All quarterly cash flows are collected from the firms' quarterly and annual reports. The data for current year (e.g. 2000) will be collected from the following year's financial reports (e.g. 2001) to ascertain that all adjustments have been reflected.

Operational vs. financial cash flow

Commercial cash flow is defined as gross profit before depreciation and after tax. Financial flow is defined as net interest payments including exchange rate gains or losses (Oxelheim and Wihlborg 1987, p 133). To the extent of this study, we only focus on the

operational cash flows (or commercial cash flows) since it would be more difficult to estimate the fluctuation in commercial cash flow than in financial cash flows as firms can certainly control how much they borrow and lend.

Quarterly commercial cash flows are collected from year 1998 to year 2005. The last quarter commercial cash flow of year 1997 is also collected to calculate the percentage change. We select this time period because we want to examine the significance of the euro currency on firms. Euro currency was only introduced since 1999 but for comparison purpose, the financial data in 1998, which originated in other currencies than euro, have been converted into euro in the 1999 financial reports (Alcatel, Nokia). Therefore, we would like to include the 1998 financial data to improve the number of observations in order to have a better accuracy when running the regressions. For firms that have fiscal years ended on December 31, the data are only available up to the 3rd quarter 2005 (Alcatel, Ericsson, Nokia, Motorola). Firms that have fiscal years ended September 30 or July 31 will have the full four-quarter data in 2005 (Cisco, Siemens). In exceptional case of Siemens, the data in year 1998 is only available in Deutsche mark and in year 1999 and year 2000, not all quarter data are available.

Cash flows will be converted to percentage of change between quarters. As such, for the period from 1998 to 2005, there will be 31 observations for Alcatel, Ericsson, Nokia, Motorola, and 32 observations for Cisco and 24 observations for Siemens. Nominal cash flows are deflated by consumer price index to obtain the real cash flows.

5.2. Independent variables (explanatory variables)

We have explained in section three which macroeconomic exposures could potentially impact on the firms' cash flows. In this section, we will explain further how we collect these macroeconomic exposures.

Foreign exchange rate

Foreign exchange rates we collect are the bilateral foreign exchange rates. For each firm, we collect three bilateral foreign exchange rates representing three countries (or markets) that dominate as the highest sales (outside the home country), the main supplier and the main competitor. From the financial reports, we can quantify the firms' highest sale markets and specify their main suppliers (see section 4). However, it would be more difficult to identify the main competitors since firms often have several different lines of business and each line has its own competitors. Therefore, we have to select a firm's main competitor based on the main business of the firm as well as the sales revenues from the main business of the firm and of the competitor. Nevertheless, it would not be too difficult because the leading companies in the telecommunication equipment industry either rest in the European market (Alcatel, Nokia, Siemens), Sweden (Ericsson) or in the U.S (Cisco, Motorola).

Quarterly average foreign exchange rates are obtained from the Ecowin Financial database. For foreign exchange rates that do not have quarterly average data available, we obtain daily foreign exchange rates and calculate the quarterly averages. Nominal foreign exchange rates are deflated by consumer price index to obtain the real foreign exchange rates.

Interest rate

As interest rate could affect the competitive environment, it may have an impact on the firm's commercial cash flows. The nominal interest rates of each country are collected from the Ecowin Economics database. Those data unavailable from the Ecowin Economics database can be obtained from the central bank official website of the respective country.

Both short-term and long-term interest rates are collected. Short-term interest rate represents the average yield for 3-month treasury bills. Long-term interest rate represents

the average yield for 5-year government bond. Nominal interest rates are deflated by consumer price index to obtain the real interest rates.

Consumer price index (CPI)

Consumer price index measures the average price movement of goods and services purchased by companies throughout the country. It reflects changes in the cost of purchasing goods and services in a fixed "market basket." Changes in consumer price index reflect the inflation of a country. To some extent, inflation can impact interest rates and foreign exchange rates. Particularly, given that the Purchase Power Theory holds, inflation can influence the "competitiveness" of domestic companies.

We collect monthly CPI data from the Ecowin Economics database. Based on the monthly data, we calculate the quarterly average CPI.

Similar to foreign exchange rate, besides CPI of the home country, we collect CPIs of three other countries that dominate as the largest market, the main supplier and the main competitor.

Producer price index (PPI)

Producer price index measures the average change in wholesales selling prices received by domestic producers of goods and services over time. In other words, producer price index measures price changes from the perspective of the seller. Similar to consumer price index, changes in producer price index also indicate inflation of a country. Therefore, changes in producer price index can impact the "competitiveness" of domestic companies as well as foreign companies that buys material from domestic suppliers.

We collect the monthly PPI from the Ecowin Economics database. Based on the monthly data, we calculate the quarterly average PPI.

Similar to CPI, besides PPI of the home country, we collect PPIs of three other countries that dominate as the largest sales market, the main supplier and the main competitor.

World oil price

Companies usually rely on oil for their manufacturing operations. Variation in oil market price may affect the companies.

The world oil price index measures the changes in average USD price of Brent quality oil in the world market. We collect monthly oil prices from the Ecowin Financial database. Based on the monthly data, we calculate the quarterly average oil prices. The nominal oil prices are deflated by the U.S consumer price index to obtain the real oil prices.

World non-energy commodity price

This index represents the raw materials prices. Companies must purchase raw materials and outsource some components for their manufacturing operation. Variation in market prices of raw materials may affect the companies.

World non-energy commodity price measures the changes in average USD price of all commodities excluding energy in the world market. We collect monthly prices from the Ecowin Financial database. Based on the monthly data, we calculate the quarterly average prices. The nominal prices are deflated by the U.S consumer price index to obtain the real prices.

Industry relative price

Industry relative price is the ratio between the industry's producer price and the consumer price index.

5.3. Statistical model

Simple vs. Multiple linear regression model

To examine the relationships between economic variables, we can use regression models. Simple regression model is suitable for cases with one explanatory variable (Hill, Griffiths & Judge, 2001, p.44). Multiple regression model involves two or more explanatory variables that influence the dependent variable (Hill et al, 2001, p.145). Since we expect there are several macroeconomic exposures (independent variables) that could influence the cash flow (dependent variables), the multiple regression model would be an appropriate choice.

Our model

As explained above, we hypothesize that there is an economic relationship between firms' cash flows, and macroeconomic exposures. Turning this economic relationship to an econometric model, we have the following equation:

$$CCF_t = a_1 + a_2 FX_t + a_3 SI_t + a_4 LI_t + a_5 CPI_t + a_6 PPI_t + a_7 OIL_t + a_8 NEI_t + a_9 IR_t + e_t$$

$$CCF_t = a_1 + a_2 FX_t + a_3 SI_t + a_4 LI_t + a_5 CPI_t + a_6 PPI_t + a_7 OIL_t + a_8 NEI_t + a_9 IR_t + e_t \quad (8)$$

where:

all variables are presented as percentage changes between quarter t and t-1

CCF_t = Commercial Cash flow of the firm

S_t = net sales of the firm

FX_t = Average bilateral exchange rate

SI_t = Average short-term interest rate

LI_t = Average long-term interest rate

CPI_t = Average consumer price index

PPI_t = Average producer price index

OIL_t = Average world oil price

NEI_t = Average non-energy world index

IR_t = Industry relative price

a_1 = intercept

$e_{t:}$ = error term at period t.

Coefficients (a_1, a_2 … a_9) are unknown parameters and indicate the percentage change in real or nominal cash flows from a one percent change in each variable, holding other variables constant. Our purpose is to study the relationships between macroeconomic variables and the firm's cash flows by estimating these unknown parameters. To estimate the parameters of the multiple regression model, the least square method is used (Hill et al, 2001, p.151). Basically, the least square method asserts that "to fit a line to the data values we should fit the line so that the sum of the squares of the vertical distances from each point to the line is as small as possible and the distances are squared to prevent large positive distances from being canceled by large negative distances" (Hill et al, 2001, p.51). According to the Gauss-Markov Theorem, the least squares estimators are the Best Linear Unbiased Estimators of the parameters in a multiple regression model (Hill et al, 2001, p.154). Using the least square principle, Excel is programmed to have a function to run the regression. We choose the Excel to run regression for the above model.

Steps in testing

i. **Collinearity test:** Many economic variables may move in the same direction systematically. Those variables are called collinear (Hill et al, 2001, p.189). This may also the case in our model. For instance, increase in inflation potentially raises interest rate. If our explanatory variables move together, there is not much information that we can infer from several macroeconomic exposures. In addition, if collinearity exists, we cannot obtain estimate of coefficients using least square principle (Hill et al, 2001, p.190). One effective way to detect the collinearity is to construct the "auxiliary regressions" (Hill et al, 2001, p.190). This is the regression with one explanatory variable in the left-hand side and the remaining explanatory

variables in the right-hand side. If the R^2 value from this model is high (>90%), it means most of the fluctuation in the left-hand side explanatory variable is explained by the remaining explanatory variables in the right-hand side, or in the other words, collinearity exists between that variable and other remaining variables (Hill et al, 2001, p.191). If that is the case, we may consider drop the explanatory variable on the left hand side from the model to have a better estimate of the model. The auxiliary regression will be run for each explanatory variable in the model to obtain R^2. We then rank all obtained R^2 and the variable associated with highest R^2, if above 0.9, will be first dropped from the model. After eliminating the first variable, we run the auxiliary regression for remaining variables again and continue to drop one variable with highest R^2 and above 0.9. We repeat this process until each of the remaining variables has R^2 less than 0.9.

ii. **Autocorrelation test (Durbin-Watson test):** "When the economic data generation process is such that the errors in a linear regression model are correlated, we say that autocorrelation exists" (Hill et al, 1997, p.255). As suggested by Hill (1997, p.256), a check for the presence of autocorrelated errors should be done in all economic models that use time-series data. We will use Durbin-Watson test for the aurocorrelation test. In our study, we only consider the first-order autoregressive model. This is also the most common autoregressive model:

$$e_t = \rho e_{t-1} + v_t \quad (9)$$

Note that if $\rho = 0$, the errors in equation (8) will not be autocorrelated. Thus, for a null hypothesis of no autocorrelation, we have:

H0: $\rho = 0$

H1: $\rho \neq 0$

Durbin-Watson statistic will be calculated as follows:

$$d = \frac{\sum_{t=2}^{T}(e_t - e_{t-1})^2}{\sum_{t=1}^{T} e_t^2} \cong 2(1 - \rho) \quad (10)$$

If $\rho = 0$, $d = 2$, meaning there is no autocorrelation. If d is significant different from 2, the model error are correlated. In such case, using the least square estimator will result in estimator with larger variance and least squares estimator is no longer the best. The more usual tool is to employ a better estimation procedure, namely, generalized least squares (Hill et all, 1997, p. 244). We will then need to transform our model in equation (8) to a new model, using the first autoregressive model . The transformed dependent variable is:

$CCF^*_t = CCF_t - \rho CCF_{t-1}$ with ρ is estimator from equation (9)

The transformed explanatory variable is:

$FX^*_t = FX_t - \rho FX_{t-1}$

And the new constant term is:

$a^*_1 = 1 - \rho$

Equation (8) is transformed to:

$CCF^*_t = a^*_{t\,1} + a_2 FX^*_t + a_3 SI^*_t + a_4 LI^*_t + a_5 CPI^*_t + a_6 PPI^*_t + a_7 OIL^*_t + a_8 NEI^*_t + a_9 IR^*_t + v_t$ (11)

The first observation is defined by

$$CCF_1^* = \sqrt{1-\rho^2}\,CCF_1 \qquad a_1^* = \sqrt{1-\rho^2} \qquad FX_1 = \sqrt{1-\rho^2}\,FX_1$$

We are then able to use the least square method to apply for the transformed model.

iii. **Regressions:** After running the collinear test, we may have a new model. The final regression will be run based on this model in order to estimate the coefficients.

iv. **t-test**: We run the test statistic to see which coefficient is statistically significant. Our hypothesis is :

H_0: $a_i = 0$

H_1: $a_i > 0$ or $a_i < 0$ $\alpha = 0.05$

$$t - stat = \frac{estimated\_coefficient}{se(estimated\_coefficient)}$$ se: standard error

As our null hypothesis is coefficient is equal to zero, the t-statistic will be calculated based on above formula. The summary output from Excel will show the t-stat result. If

t-stat > t-critical or < -t-critical, we reject the null hypothesis and conclude that the estimated coefficients are significant different from zero. Otherwise, we do not reject the null hypothesis.

6. EMPIRICAL RESULTS

This section reports our results after we finished the testing as discussed in the previous section. In addition, explanations on the relevance of the finding are also discussed.

6.1. Basic findings

We carried the collinearity test for each of the five firms as explained in the previous section. For Alcatel, Nokia, and Siemens, due to their high correlation with other variables, some explanatory variables are dropped out from the original model, which are detailed in table 6.1. Mostly the exchange rate EUR/USD correlates with exchange rate EUR/CNY[1], and short-term interest rate with long-term interest rate. For Ericsson and Motorola, the model with original variables still holds.

Table 6.1: Results of collinear test

Firms	Removed variables
Nokia	- Real exchange EUR/USD - Long-term real interest rate in Finland - PPI in Finland
Siemens	- Real exchange EUR/CNY - PPI in U.S.A
Alcatel	- Real exchange rate EUR/USD - PPI in France

The Durbin-Watson (DW) test also shows that for Nokia, Ericsson and Siemens, the model errors are not autocorrelated as DW statistic is approximate 2. In contrast, DW statistics of Motorola and Alcatel indicate that the model errors are autocorrelated. As such, we need to transform all the variables as discussed in section 5.3.

[1] EUR/CNY = EUR/USD x USD/CNY. Exchange rate USD/CNY is still pegged.

In tables 6.2 to 6.6, we present the regression results for the commercial cash flows data with coefficient and t-statistics.

Table 6.2: Sensitivity coefficients for Nokia

	Real commercial cash flow	t-statistic *
Intercept	8.88	1.28
Real exchange EUR/SEK	**6.69**	**2.60**
Real exchange rate EUR/CNY	**-3.36**	**-2.03**
Short-term real interest rate in Finland	-0.07	-0.44
CPI in Finland – Domestic	5.80	0.45
CPI in China – Supplier	5.73	0.99
CPI in Sweden – Competitor	-7.36	-0.68
PPI in China	-4.80	-1.21
PPI in Sweden	12.10	1.56
Real world oil price	-0.26	-0.65
Real price of world non-energy commodities	**-2.15**	**-1.96**
Industry relative prices	0.56	0.41
R^2	0.37	
Durbin-Watson statistic	2.43	
Number of observations	30	

* t-critical value at significant level $\alpha = 0.05$ is +/- 1.796 (one-sided test)

Table 6.3: Sensitivity coefficients for Ericsson

	Real commercial cash flow	t-statistic *
Intercept	5.75	0.64
Real exchange rate SEK/USD	**-3.32**	**-1.82**
Real exchange rate SEK/EUR	-0.55	-0.26
ST real interest rate in Sweden	**-0.59**	**-2.02**
LT real interest rate in Sweden	0.20	0.52
CPI in Sweden – Domestic	-17.79	-1.65
CPI in U.S.A – Highest sales & competitor	1.80	0.10
PPI in Sweden	**15.82**	**1.91**
PPI in U.S .A	-8.98	-1.67
Real world oil price	0.38	0.81
Real prices of world non-energy commodities	-0.26	-0.24
Industry relative prices	**-1.47**	**-1.91**
R^2	0.52	
Durbin-Watson test	2.24	
Number of observations	31	

* t-critical value at significant level α = 0.05 is +/- 1.796 (one-sided test)

Table 6.4: Sensitivity coefficients for Motorola

	Real commercial cash flow	t-statistic *
Intercept	7.43	0.70
Real exchange rate USD/EUR	0.02	0.01
Real exchange rate USD/CNY	13.17	0.92
ST real interest rate in USA	0.00	-0.23
LT real interest rate in USA	0.26	0.70
CPI in U.S A (Domestic)	3.46	0.14
CPI in China (Highest sales)	-2.68	-0.47
CPI in Finland (Competitor)	-15.29	-1.11
PPI in U.S.A	**-10.05**	**-1.99**
PPI in China	5.07	1.27
PPI in Finland	6.14	0.95
Real world oil price	-0.30	-0.59
Real prices of world non-energy commodities	0.29	0.25
Industry relative prices	-6.13	-0.45
R^2	0.52	
Number of observations	31	

* t-critical value at significant level α = 0.05 is +/- 1.771 (one-sided test)

Table 6.5: Sensitivity coefficients for Siemens

	Real commercial cash flow	t-statistic *
Intercept	9.61	1.04
Real exchange EUR/USD	-0.65	-0.40
Real exchange rate EUR/SEK	-4.14	-1.53
Short-term real interest rate in Germany	0.06	0.17
Long-term real interest rate in Germany	0.13	0.26
CPI in Germany (Domestic)	-8.87	-0.41
CPI in U.S.A (Highest sales)	-4.39	-0.29
CPI in Sweden (Competitor)	-7.03	-0.77
PPI in Germany	3.19	0.34
PPI in Sweden	-5.88	-0.68
Real world oil price	**0.86**	**1.91**
Real price of world non-energy commodities	-0.81	-0.64
Industry relative prices	1.73	0.16
R^2	0.50	
Durbin-Watson statistic	2.28	
Number of observations	23	

* t-critical value at significant level $\alpha = 0.05$ is +/- 1.782 (one-sided test)

Table 6.6: Sensitivity coefficients for Alcatel

	Real commercial cash flow	t-statistic *
Intercept	13.08	1.40
Real exchange rate EUR/CNY	0.27	0.18
Short-term real interest rate in France	0.07	0.19
Long-term real interest rate in France	-0.57	-1.02
CPI in France (Domestic)	-31.14	-1.69
CPI in China (Supplier)	**11.25**	**1.83**
CPI in USA (Competitor & highest sales)	-0.51	-0.02
PPI in China	-1.33	-0.33
PPI in U.S.A	1.34	0.22
Real world oil price	0.70	1.24
Real prices of world non-energy commodities	-1.06	-0.95
Industry relative prices	1.69	0.18
R^2	0.48	
Number of observations	29	

* t-critical value at significant level $\alpha = 0.05$ is +/- 1.796 (one-sided test)

One common characteristic among all regressions is the R^2 value is not high. Highest R^2 value is about 0.52. This means that approximately 52% or less of the changes in real commercial cash flows is explained by the foreign exchange rates and macroeconomic variables. The sensitivity coefficients vary among the firms and we choose to interpret only coefficients that are statistically significant, which is indicated by t-statistic.

Consistent with earlier studies on foreign exchange rates, our regressions do not detect significant exposures of foreign exchange rates. Only Nokia and Ericsson show significant exposures to foreign exchange rates. Compared to the other three firms, home markets of Nokia and Ericsson are relative small. Sales in their home market constitute only 1% and 5%, respectively, of total sales. For Motorola, Siemens and Alcatel, sales in home market account for approximately 50%, 23% and 14%, respectively. As most of the sales come from abroad, exposure to foreign exchange rate is understandable for Nokia and Ericsson. Nokia has sensitivity coefficients for real exchange rates EUR/SEK and real exchange rate EUR/CNY of 6.69 and –3.36 respectively. This means that a 1% depreciation of euro relative to Swedish Krona will cause a 6.69% increase in commercial cash flows. This is intuitively true. Ericsson dominates as the Nokia's main competitor. The depreciation of euro makes Nokia's products less expensive and more competitive (relatively to Ericsson's), resulting in higher sales and higher commercial cash flows. In contrast, a 1% appreciation of Chinese Yuan relative to euro will lead to a 3.36% decrease of the cash flows. As China is the primary manufacturer and main supplier of Nokia's components, the appreciation of Chinese Yuan relative to euro will create higher cost for Nokia, which evidently reduce its commercial cash flow. In the same analysis, a 1% appreciation of U.S dollar relative to Swedish Krona will cause a 3.32% decrease in the Ericsson's commercial cash flows. This result is also reasonable as Ericsson's main supplier comes from the U.S and higher input costs mean lower commercial cash flow.

Similar to foreign exchange rates, the fluctuations of short-term or long-term interest rates unlikely affect the commercial cash flows. Among five sampled firms, only Ericsson's are sensitive to changes in interest rates. The firm has sensitivity coefficient

for short-term real interest rate of –0.59, which is not very different from zero. This indicates that if interest rate increases by 1%, for example from 10% to 10.1%, commercial cash flows will be reduced by 0.59%. Because we do not include financial cash flows in the model, this decrease in commercial cash flows cannot dedicate to the higher cash outflow of financial expense. The case study carried out by Oxelheim and Wihlborg (1995) also showed that when interest rate increases, the sales revenues fall. This indicates that firms also should consider the effect of interest rate on commercial operations besides the financial operations.

For all sampled firms, only Alcatel's commercial cash flow is significantly exposed to changes in the consumer price index. Although the sensitivity coefficient is high in value for some other firms[2] but it is not statistically significant. A 1% increase in China CPI results in 11.25% increase in Alcatel's commercial cash flows. China is the main supplier but also stands as a large sales market of Alcatel. As a role of supplier, increase in China CPI should result in higher cost for Alcatel and lower cash flows. But as a large sales market of Alcatel, increase in China CPI will oppositely bring more cash flows to Alcatel. A positive coefficient indicates the sales factor outweighs the cost factor. This is reasonable as the China is a booming market for recent years. Although representing as the main supplier of Alcatel, Alcatel does have numerous factories around the world and also has a substantial production portion in France (Alcatel Form 20-F 2004, p.20).
With regard to PPI, we find significant exposure of PPI Sweden in the case of Ericsson and PPI U.S.A in case of Motorola. The sensitivity coefficient is equal to 15.82 implying that a 1% increase in Swedish PPI increases Ericsson's commercial cash flows by 15.82%. For Motorola, it is opposite. A 1% increase in U.S PPI reduces commercial cash flows by 10.05%. PPI, in fact, could have both positive and negative effects on the commercial cash flows. Increase in PPI of home country would increase input cost, thus reduce cash inflows. On the other hand, it could also be argued that as PPI increases, the wholesale price level in the home country increases, and sales price of firm's products might increase as well, resulting in higher cash inflows. For Ericsson, the second effect seems to outweigh the first one as Sweden is a small market compared to other market.

[2] A coefficient of -25.12 for CPI in U.S.A in Motorola model

Increase in price level would not affect much. It should be worth to note that more than half of Ericsson's products are outsourced to companies abroad and thus an increase in Sweden PPI will less likely lower Ericsson's competitiveness. However, U.S market accounts for Motorola's 50% sales and this market is a fierce competition. An increase in the sales price in the U.S market seems difficult to achieve as it would hurt Motorola position in the U.S market. As such, for Motorola, the first effect seems to outweigh the second effect.

Surprisingly, we find Siemens's commercial cash flows and Nokia's commercial cash flows are significantly affected by the changes in world oil prices and prices of world non-energy commodities, respectively. Theoretically, there should be an inverse relationship between real commercial cash flows and oil prices and non-energy commodities prices. However, the coefficient for world oil price of 0.86 indicates a positive relationship (a 1% increase in real oil price increases commercial cash flows by 0.86%). In the case of Nokia, the coefficient for world non-energy commodities prices is equal to –2.15, indicating a negative correlation between commercial cash flows and prices of world non-energy commodities. This finding is reasonable as the increase in prices of world non-energy commodities implies higher cost and thus a lower commercial cash flow.

The results show that although in the same industry, each firm exposed to different sources of macroeconomic exposures. Nokia's commercial cash flows are impacted by the movements of Swedish Krona and Chinese Yuan relatively to euro and prices of world non-energy commodities while Ericsson's commercial cash flows are influenced by the fluctuations of U.S dollar relative to Swedish Krona and PPI in Sweden. Motorola's commercial cash flow moves inversely with U.S PPI and Siemens's commercial cash flows are sensitive to the world oil prices. Alcatel, on the other hand, is affected by China CPI. The underlying economic explanations may be that firms have different sales market, main suppliers, competitor and different operating strategies. The size of home market also plays an important role in the case of foreign exchange rate risk. In addition, euro currency seems not to play a significant role in firms' commercial cash

flows. The following section will present limitations affecting our regression results and possible improvements.

6.2. Limitations and possible improvements

Our regression results reveal that five sampled firms show significant exposures to the selected macroeconomic variables but not consistent among the firms. R^2 values in all regressions are not high but at acceptable level. However, it is not the R^2 that matters but the t-statistic. We also look back to examine the possible elements that might affect our regression results. Two possible explanations are the research design and the existence of potential mispricing.

Research design

One limitation of our regression models concerns potential drawbacks in the research design, particularly in the use of accounting cash flows data and information in the financial reports to measure exposures and select macroeconomic variables.

Exposure analysis would be better if it is performed based on the actual cash flow data. Since firms are unwilling to have their basis cash flow figures presented publicly, we have to use the accounting cash flows from the firms' financial reports as the best alternative. According to Oxelheim and Wihlborg (1995), measuring foreign exchange rate and macroeconomic exposures based on accounting information are seriously flaws from an economic point of view in the sense that they disregard the fact that foreign exchange and macroeconomic variables influence the firm's cash flows in variety of way that are not immediately observable in accounting data. The second issue relates to the accounting cash flow data is that they are aggregated cash flows. Ideally, we wish to measure exposure coefficients of commercial cash flows by separate lines of business operation. Oxelheim and Wihlborg (1987, p.119) claimed that there are substantial information advantages to be gained from decomposing cash flows for purposes of exposure analysis. However, it is a challenging task to decompose cash flows based on

the firms' financial reports without firms' internal assistance. The third issue of the accounting cash flows data is that they are not seasonally adjusted. Many industries cash flows have strong seasonal patterns, which for the firm is predictable. Academic studies revealed that the explanatory value of regressions increases significantly when the cash flows data are seasonally adjusted.

As already mentioned in section five, for certain explanatory independent variables such as foreign exchange rate, CPI, and PPI in the regression models, besides the home country, we collect three different variables representing three countries (or markets) that dominate as the highest sales, the main supplier and the main competitor respectively. Without the firm's internal assistance, we have to rely entirely on the financial reports for information on the highest sale market, main supplier and main competitor. Nevertheless, except for information on highest sale market and the main supplier, it is difficult to single out a representative competitor as firms have several different business lines and each line has it own competitors. This limitation affects our ability to select the macroeconomic variables that mostly reflect the firms.

Existence of potential mispricing

The second possible explanation for the result of our regression models is the existence of potential mispricing arising from systematic errors by analysts in the estimation of the relation between fluctuations in foreign exchange rate and other macroeconomic variables and the firm's value as measured by the net resent value of cash flows. The mispricing implies that the impact of changes in foreign exchange and macroeconomic variables on the firm's cash flows often takes time. It is opposed to the conventional point of view that the firm's cash flows adjust fully and instantaneously to changes in market variables. This theory corresponds to intuition. Changes in market conditions force firms to specify pricing strategies. However, these strategies and marketing and sales efforts are often relatively long term, which are costly and difficult to adjust. Bartov and Bodnar (1994) already mentioned the effect of mispricing on the relation between changes in dollars and contemporaneous stock returns and suggested the

inclusion of lagged changes in the dollar when analyzing the relation between changes in firm performance and the foreign currency value of the U.S dollar.

7. CONCLUSION

7.1. Summary

Understanding the impact of foreign exchange risk and macroeconomic risk is critical element for the purpose of firm valuation and risk management. For decades, firms have employed a number of different methods to measure and manage foreign exchange risk. The most widely used methods are the transaction exposure approach, the translation exposure approach, and the economic exposure approach. In spite of some successes, these traditional risk measurement approaches are criticized for being partial in the sense that they do not recognize the interdependencies among foreign exchange and other macroeconomic variables such as interest rates, and inflation rates. The recent approaches in measuring foreign exchange and macroeconomic exposures are the capital market approach and the cash flows approach. These approaches employ regression analysis of historical data to measure foreign exchange and macroeconomic exposures. Similar to traditional approach, the capital market approach and cash flow approach are originally designed to detect foreign exchange risk, but are still able to incorporate other variables in the model as well. However, the cash flow approach is more comprehensive in the sense that it simultaneously considers the impact of foreign exchange rates and other different macroeconomic variables as well as firm and industry specific variables.

We use the cash flow approach to estimate the foreign exchange and macroeconomic exposures for five multinational firms in the communication equipment industry namely Nokia, Ericsson, Motorola, Alcatel, and Siemens using the quarterly cash flows data for the period from 1998 to 2005. The macroeconomic variables we selected are the foreign exchange rates, the domestic interest rates, and the domestic and foreign price levels as captured by domestic and foreign PPIs and CPIs. In addition, we include the industry relative price variable, which is the ratio between domestic PPI for electrical machinery and domestic CPI.

Low R^2 values from regressions indicate that changes in commercial cash flows are not much explained by changes in macroeconomic variables. However, a R^2 of approximate 50% is acceptable and it is not the R^2 value that matters but the t-statistic. Two out of five sampled firms (Nokia and Ericsson) have significant exposures to foreign exchange rates. One out of five sampled firms (Ericsson) shows significant exposures to interest rate. Two firms (Ericsson and Motorola) are exposed to changes in PPI. Alcatel is influenced by China CPI. Surprisingly, we find significant relation between Siemens's and Nokia's commercial cash flows and the movement of world oil prices and world non-energy commodities prices respectively.

One possible limitation of our model concerns potential drawbacks in the research design, particularly in the use of accounting cash flows data and accounting information to measure the foreign exchange and macroeconomic exposures. Another possible explanation relates to the existence of potential mispricing. The mispricing implies that the impact of changes in foreign exchange and macroeconomic variables on the firm's cash flows often takes time as opposed to occurring instantaneously.

7.2. Suggestions for future studies

As the study by Bartov and Bodnar (1994) suggested that changes in stock prices correspond to lagged changes in the dollar rather than the instantaneous changes. It could be the case for the commercial cash flows as well. The commercial cash flows may vary in accordance with the previous period's changes in macroeconomic variables. As such, a lagged model may be applied in study.

In addition, a study to examine the changes of stock prices with respect to the changes in macroeconomic variables could be done parallel to our study. In that case, we can crosscheck if the firm's stock prices and commercial cash flows are exposed to the same source of macroeconomic factors.

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APPENDIX: INPUT DATA FOR REGRESSIONS

NOKIA

Unit: In percentage change

Quarter	Real CCF	Real EUR/SEK	Real EUR/USD	Real EUR/CNY	Real ST interest rate	Real LT interest rate	Finland CPI all items	China CPI all items	Sweden CPI all items	Finland PPI all items	China PPI all items	Sweden PPI all items	Real world oil price	Real world non-energy commodities prices	Industry relative price
1998-2	33.95	2.37	1.17	(1.61)	(5.57)	(6.27)	0.63	(0.87)	0.38	(0.38)	(2.00)	(0.78)	(6.38)	(3.98)	(2.45)
1998-3	11.07	(4.24)	2.06	(0.70)	15.60	7.38	0.03	(0.57)	(0.50)	(0.73)	(0.57)	(0.08)	(6.56)	(5.44)	(1.48)
1998-4	20.73	(3.97)	5.56	(4.42)	(2.63)	(10.51)	0.03	0.34	0.09	(1.90)	(0.61)	(0.56)	(9.54)	(3.41)	(3.40)
1999-1	(4.08)	4.35	(5.00)	4.71	(11.73)	(7.45)	(0.03)	(0.34)	(0.05)	(1.22)	0.71	(1.08)	0.52	(4.12)	(1.40)
1999-2	9.20	0.35	(6.31)	4.57	(53.04)	(33.63)	1.15	(0.64)	0.66	1.05	1.24	0.54	36.15	(1.97)	(1.18)
1999-3	11.19	2.69	(0.01)	3.44	96.48	86.29	0.00	0.78	(0.04)	1.62	1.37	0.88	33.73	2.30	(0.05)
1999-4	28.27	0.64	(1.67)	0.20	(0.34)	(4.41)	0.58	0.47	0.48	1.49	1.47	1.10	16.68	3.61	(2.63)
2000-1	1.98	0.59	(4.92)	5.20	(7.08)	(2.89)	0.99	0.94	(0.28)	2.93	1.86	1.23	11.19	2.87	(1.10)
2000-2	10.23	3.64	(5.49)	4.50	18.92	0.82	1.18	0.00	0.82	1.56	1.69	0.33	(0.54)	(2.27)	(2.69)
2000-3	(2.68)	(1.72)	(2.59)	3.95	37.55	18.88	0.50	0.17	(0.04)	0.50	1.32	1.10	14.83	(1.30)	(8.31)
2000-4	24.99	(1.79)	(4.43)	4.11	(0.35)	(9.04)	0.70	0.30	0.72	0.60	(0.71)	1.63	(3.26)	(1.16)	(4.00)
2001-1	(10.33)	(4.71)	6.90	(6.28)	(1.01)	(4.87)	0.43	(0.46)	0.14	(1.81)	(2.38)	(0.37)	(12.92)	(0.86)	(4.79)
2001-2	(8.67)	(0.63)	(6.28)	6.20	(27.02)	(21.86)	1.44	1.00	1.90	(0.54)	(1.13)	0.32	5.71	(5.77)	(3.53)
2001-3	(7.34)	(3.39)	2.54	(1.69)	35.32	40.10	(0.06)	(0.30)	0.06	(1.22)	(1.77)	0.00	(6.52)	(4.04)	(1.11)
2001-4	29.75	(0.39)	0.07	(1.36)	(20.74)	(11.77)	0.06	(0.93)	0.42	(1.81)	(1.57)	(0.35)	(23.30)	(2.97)	(3.11)
2002-1	(15.13)	2.82	(1.92)	1.82	(14.05)	2.38	0.52	(0.80)	0.27	(0.35)	(0.55)	(0.40)	8.91	2.71	(3.73)
2002-2	3.66	0.61	5.15	(4.26)	(11.16)	(5.39)	0.87	(0.13)	1.20	(0.24)	1.46	0.22	17.49	2.74	(5.71)
2002-3	(5.29)	(1.10)	7.45	(5.31)	35.98	8.89	(0.10)	0.30	(0.06)	(0.84)	0.96	(0.08)	8.27	6.58	(4.00)
2002-4	24.47	1.95	1.22	(2.25)	(20.04)	(18.93)	0.29	0.13	0.73	(0.35)	1.49	(0.54)	(0.65)	2.46	(5.47)
2003-1	(22.57)	(0.87)	7.70	(6.05)	(25.77)	(24.60)	0.54	1.14	1.09	0.25	4.01	0.73	16.65	4.43	(2.46)
2003-2	13.55	(0.15)	5.68	(6.05)	6.41	10.25	0.13	0.17	0.10	(2.05)	(1.32)	(1.15)	(16.38)	1.14	(14.59)
2003-3	(6.63)	(0.13)	(0.26)	1.42	17.06	29.15	(0.41)	0.17	(0.34)	(0.22)	(0.88)	(0.57)	8.76	0.04	(0.82)
2003-4	36.61	1.89	4.68	(4.50)	(23.88)	(10.35)	0.19	1.82	0.43	0.36	0.62	(0.82)	4.04	10.46	(3.54)
2004-1	(32.58)	(2.25)	6.11	(6.10)	4.74	(1.60)	0.00	0.10	(0.13)	0.18	1.57	0.61	7.49	12.39	(3.55)
2004-2	(1.08)	0.92	(3.19)	5.26	(0.40)	4.46	0.06	1.59	0.44	0.54	1.99	1.64	10.45	(0.01)	(5.76)
2004-3	1.13	(0.88)	0.22	(2.36)	(5.44)	(8.04)	0.19	0.83	(0.18)	0.18	1.26	0.57	17.78	(2.86)	(6.30)
2004-4	35.92	2.01	6.32	(8.51)	(4.13)	(15.44)	0.32	(1.99)	0.35	0.07	0.78	(0.21)	6.59	1.92	(3.04)
2005-1	(19.26)	(0.91)	1.48	1.10	23.72	17.78	(0.13)	(0.32)	(0.35)	0.43	(2.10)	0.59	7.46	10.14	(0.58)
2005-2	4.38	(1.41)	(4.06)	2.50	(35.57)	(30.96)	0.63	(1.07)	0.48	0.82	0.03	1.79	6.65	(1.41)	(3.72)
2005-3	(1.39)	(1.68)	(2.77)	6.37	32.82	12.22	0.19	(0.18)	0.04	0.71	(0.60)	1.81	20.84	(0.14)	(2.19)

ERICSSON													
Unit: In percentage change													
Quarter	Real CCF	Real SEK/USD	Real SEK/EUR	Real ST interest rate	Real LT interest rate	Sweden CPI all items	U.S CPI all items	Finland CPI all items	Sweden PPI all items	U.S PPI all items	Real world oil price	Real world non-energy commodities prices	Industry relative price
1998-1	(7.51)	6.33	2.81	40.07	16.13	(0.95)	0.27	0.21	0.17	(1.85)	(24.20)	(5.95)	(0.47)
1998-2	20.28	(3.69)	(2.31)	(26.05)	(27.99)	0.38	0.54	0.63	(0.78)	(0.08)	(6.38)	(3.98)	(0.93)
1998-3	(2.10)	3.42	4.43	17.28	13.59	(0.50)	0.39	0.03	(0.08)	(0.53)	(6.56)	(5.44)	0.16
1998-4	30.91	(1.24)	4.13	(20.70)	(20.61)	0.09	0.35	0.03	(0.56)	(0.70)	(9.54)	(3.41)	(17.79)
1999-1	(27.74)	0.54	(4.17)	(13.69)	(7.90)	(0.05)	0.39	(0.03)	(1.08)	(0.65)	0.52	(4.12)	21.10
1999-2	13.92	5.26	(0.34)	(30.54)	(13.86)	0.66	0.97	1.15	0.54	2.01	36.15	(1.97)	(3.02)
1999-3	(2.65)	(0.98)	(2.62)	36.32	59.75	(0.04)	0.62	0.00	0.88	2.15	33.73	2.30	0.61
1999-4	56.32	(0.39)	(0.64)	(6.83)	(5.60)	0.48	0.62	0.58	1.10	0.99	16.68	3.61	0.58
2000-1	(21.18)	4.61	(0.59)	45.66	22.79	(0.28)	0.99	0.99	1.23	1.52	11.19	2.87	2.44
2000-2	3.99	1.78	(3.52)	(25.04)	(25.18)	0.82	1.06	1.18	0.33	1.78	(0.54)	(2.27)	(8.96)
2000-3	(5.68)	5.55	1.75	29.56	18.81	(0.04)	0.80	0.50	1.10	1.82	14.83	(1.30)	(3.31)
2000-4	14.10	5.52	1.82	(18.72)	(21.97)	0.72	0.54	0.70	1.63	1.27	(3.26)	(1.16)	(5.89)
2001-1	(24.75)	(0.65)	4.94	19.10	5.26	0.14	0.96	0.43	(0.37)	1.62	(12.92)	(0.86)	(3.37)
2001-2	(4.74)	5.35	0.63	(46.21)	(34.39)	1.90	1.04	1.44	0.32	(1.52)	5.71	(5.77)	(3.27)
2001-3	(15.66)	2.32	3.51	97.37	69.40	0.06	0.13	(0.06)	0.00	(2.61)	(6.52)	(4.04)	0.93
2001-4	(2.71)	(0.85)	0.40	(21.45)	(12.32)	0.42	(0.28)	0.06	(0.35)	(2.98)	(23.30)	(2.97)	(1.59)
2002-1	(26.61)	(0.37)	(2.74)	11.05	16.77	0.27	0.36	0.52	(0.40)	(0.54)	8.91	2.71	(0.59)
2002-2	3.82	(4.64)	(0.60)	(15.91)	(15.62)	1.20	1.09	0.87	0.22	2.08	17.49	2.74	(1.69)
2002-3	(23.11)	(5.40)	1.12	40.61	18.37	(0.06)	0.43	(0.10)	(0.08)	0.50	8.27	6.58	(0.78)
2002-4	(5.36)	(3.54)	(1.92)	(26.45)	(23.29)	0.73	0.31	0.29	(0.54)	1.20	(0.65)	2.46	(1.98)
2003-1	(18.23)	(6.03)	0.88	(22.52)	(21.28)	1.09	1.01	0.54	0.73	3.89	16.65	4.43	(1.58)
2003-2	26.90	(5.51)	0.15	25.88	25.13	0.10	0.36	0.13	(1.15)	(1.05)	(16.38)	1.14	(1.59)
2003-3	1.03	1.77	0.13	(0.58)	19.24	(0.34)	0.49	(0.41)	(0.57)	0.51	8.76	0.04	(1.11)
2003-4	54.87	(8.18)	(1.85)	(25.37)	(11.75)	0.43	0.02	0.19	(0.82)	0.05	4.04	10.46	(1.81)
2004-1	(11.57)	(1.70)	2.31	12.79	0.61	(0.13)	0.90	0.00	0.61	2.59	7.49	12.39	(1.53)
2004-2	21.92	3.35	(0.91)	(39.55)	(12.04)	0.44	1.43	0.06	1.64	2.40	10.45	(0.01)	(2.19)
2004-3	(3.80)	(1.75)	0.89	40.95	16.21	(0.18)	0.35	0.19	0.57	1.82	17.78	(2.86)	(1.47)
2004-4	18.39	(7.38)	(1.97)	(24.91)	(20.19)	0.35	0.60	0.32	(0.21)	2.40	6.59	1.92	(3.33)
2005-1	(13.57)	0.15	0.91	42.19	9.55	(0.35)	0.63	(0.13)	0.59	1.01	7.46	10.14	(0.51)
2005-2	13.98	5.59	1.43	(41.54)	(36.58)	0.48	1.34	0.63	1.79	1.73	6.65	(1.41)	(2.63)
2005-3	(6.34)	5.26	1.71	5.71	10.33	0.04	1.22	0.19	1.81	3.15	20.84	(0.14)	(0.90)

MOTOROLA														
Unit: In percentage change														
Quarter	Real CCF	Real USD/EUR	Real USD/CNY	Real ST interest rate	Real LT interest rate	U.S CPI all items	China CPI all items	Finland CPI all items	U.S PPI all items	China PPI all items	Finland PPI all items	Real world oil price	Real world non-energy commodities prices	Industry relative price
1998-1	(4.43)	3.35	0.27	2.03	(3.56)	0.27	(0.99)	0.21	(1.85)	(1.59)	(1.00)	(24.20)	(5.95)	(0.12)
1998-2	4.43	(1.15)	(0.00)	(7.42)	(3.83)	0.54	(0.87)	0.63	(0.08)	(2.00)	(0.38)	(6.38)	(3.98)	(0.99)
1998-3	1.03	(2.02)	(0.00)	(0.00)	(6.29)	0.39	(0.57)	0.03	(0.53)	(0.57)	(0.73)	(6.56)	(5.44)	(0.88)
1998-4	22.77	(5.27)	0.02	(11.88)	(14.42)	0.35	0.34	0.03	(0.70)	(0.61)	(1.90)	(9.54)	(3.41)	(0.35)
1999-1	(6.95)	5.27	(0.01)	2.86	11.24	0.39	(0.34)	(0.03)	(0.65)	0.71	(1.22)	0.52	(4.12)	0.11
1999-2	4.42	6.73	0.00	(13.93)	(1.30)	0.97	(0.64)	1.15	2.01	1.24	1.05	36.15	(1.97)	(1.77)
1999-3	(10.23)	0.01	0.01	16.14	15.73	0.62	0.78	0.00	2.15	1.37	1.62	33.73	2.30	(1.76)
1999-4	6.44	1.70	(0.01)	9.87	5.71	0.62	0.47	0.58	0.99	1.47	1.49	16.68	3.61	(1.18)
2000-1	12.73	5.18	(0.00)	1.97	2.39	0.99	0.94	0.99	1.52	1.86	2.93	11.19	2.87	(1.25)
2000-2	4.63	5.81	0.01	2.68	(4.33)	1.06	0.00	1.18	1.78	1.69	1.56	(0.54)	(2.27)	(1.43)
2000-3	(8.74)	2.66	(0.02)	12.47	(1.55)	0.80	0.17	0.50	1.82	1.32	0.50	14.83	(1.30)	(0.88)
2000-4	(1.60)	4.63	0.02	5.18	(4.51)	0.54	0.30	0.70	1.27	(0.71)	0.60	(3.26)	(1.16)	(0.81)
2001-1	(47.27)	(6.46)	0.00	(29.84)	(23.70)	0.96	(0.46)	0.43	1.62	(2.38)	(1.81)	(12.92)	(0.86)	(0.86)
2001-2	3.91	6.70	0.00	(32.25)	(1.36)	1.04	1.00	1.44	(1.52)	(1.13)	(0.54)	5.71	(5.77)	(1.69)
2001-3	12.46	(2.48)	0.00	17.19	15.88	0.13	(0.30)	(0.06)	(2.61)	(1.77)	(1.22)	(6.52)	(4.04)	(0.47)
2001-4	69.38	(0.07)	0.00	(27.70)	0.86	(0.28)	(0.93)	0.06	(2.98)	(1.57)	(1.81)	(23.30)	(2.97)	0.16
2002-1	(43.22)	1.96	0.00	(37.96)	(6.74)	0.36	(0.80)	0.52	(0.54)	(0.55)	(0.35)	8.91	2.71	(0.48)
2002-2	16.78	(4.90)	(0.00)	(54.22)	(18.78)	1.09	(0.13)	0.87	2.08	1.46	(0.24)	17.49	2.74	(2.07)
2002-3	2.96	(6.93)	0.00	94.47	(12.42)	0.43	0.30	(0.10)	0.50	0.96	(0.84)	8.27	6.58	(1.07)
2002-4	9.43	(1.21)	(0.00)	(16.13)	(7.57)	0.31	0.13	0.29	1.20	1.49	(0.35)	(0.65)	2.46	(0.84)
2003-1	(22.52)	(7.15)	0.00	(85.91)	(30.09)	1.01	1.14	0.54	3.89	4.01	0.25	16.65	4.43	(1.47)
2003-2	1.39	(5.37)	0.00	369.96	17.14	0.36	0.17	0.13	(1.05)	(1.32)	(2.05)	(16.38)	1.14	(0.43)
2003-3	13.87	0.27	(0.00)	(34.97)	19.81	0.49	0.17	(0.41)	0.51	(0.88)	(0.22)	8.76	0.04	(1.46)
2003-4	14.14	(4.47)	0.00	105.20	22.54	0.02	1.82	0.19	0.05	0.62	0.36	4.04	10.46	0.11
2004-1	(12.20)	(5.76)	(0.00)	(98.48)	(35.89)	0.90	0.10	0.00	2.59	1.57	0.18	7.49	12.39	(1.99)
2004-2	8.65	3.29	0.00	(2,656.33)	9.05	1.43	1.59	0.06	2.40	1.99	0.54	10.45	(0.01)	(2.04)
2004-3	20.06	(0.22)	0.00	(422.84)	39.10	0.35	0.83	0.19	1.82	1.26	0.18	17.78	(2.86)	(0.51)
2004-4	(33.83)	(5.95)	0.00	23.96	(8.41)	0.60	(1.99)	0.32	2.40	0.78	0.07	6.59	1.92	(0.79)
2005-1	25.18	(1.46)	0.00	35.35	12.35	0.63	(0.32)	(0.13)	1.01	(2.10)	0.43	7.46	10.14	(0.85)
2005-2	6.73	4.24	0.00	(18.99)	(23.12)	1.34	(1.07)	0.63	1.73	0.03	0.82	6.65	(1.41)	(1.48)
2005-3	5.25	2.85	1.66	37.90	12.06	1.22	(0.18)	0.19	3.15	(0.60)	0.71	20.84	(0.14)	(1.49)

Motorola															
Transformed variables															
Unit: In percentage change															
Quarter	Real CCF	a*(1)	USD/EUR	USD/CNY	Real ST interest rate	Real LT interest rate	U.S CPI all items	China CPI all items	Finland CPI all items	U.S PPI all items	China PPI all items	Finland PPI all items	Real world oil price	Real world non-energy commodities prices	Industry relative price
1998-1	(4.08)	0.92	3.09	0.25	1.87	(3.28)	0.25	(0.91)	0.19	(1.71)	(1.46)	(0.92)	(22.31)	(5.48)	(0.11)
1998-2	2.71	1.39	0.15	0.10	(6.63)	(5.21)	0.64	(1.25)	0.71	(0.80)	(2.62)	(0.77)	(15.78)	(6.29)	(1.04)
1998-3	2.74	1.39	(2.47)	(0.00)	(2.88)	(7.77)	0.60	(0.91)	0.28	(0.56)	(1.35)	(0.88)	(9.04)	(6.98)	(1.27)
1998-4	23.17	1.39	(6.05)	0.02	(11.88)	(16.86)	0.50	0.12	0.05	(0.90)	(0.84)	(2.19)	(12.08)	(5.52)	(0.69)
1999-1	1.88	1.39	3.22	(0.00)	(1.74)	5.64	0.52	(0.21)	(0.02)	(0.92)	0.47	(1.96)	(3.18)	(5.44)	(0.02)
1999-2	1.73	1.39	8.78	(0.00)	(12.82)	3.06	1.12	(0.77)	1.13	1.76	1.52	0.58	36.35	(3.56)	(1.73)
1999-3	(8.51)	1.39	2.62	0.01	10.74	15.23	1.00	0.53	0.44	2.93	1.86	2.03	47.76	1.54	(2.45)
1999-4	2.47	1.39	1.70	(0.01)	16.14	11.81	0.86	0.78	0.58	1.82	2.00	2.11	29.76	4.50	(1.86)
2000-1	15.22	1.39	5.83	(0.01)	5.80	4.60	1.23	1.12	1.22	1.90	2.43	3.50	17.66	4.27	(1.70)
2000-2	9.56	1.39	7.82	0.00	3.45	(3.40)	1.44	0.37	1.57	2.37	2.41	2.69	3.80	(1.16)	(1.92)
2000-3	(6.94)	1.39	4.92	(0.01)	13.51	(3.23)	1.21	0.17	0.96	2.51	1.98	1.10	14.62	(2.18)	(1.44)
2000-4	(4.99)	1.39	5.66	0.02	10.02	(5.11)	0.85	0.36	0.89	1.98	(0.20)	0.79	2.49	(1.67)	(1.15)
2001-1	(47.89)	1.39	(4.66)	0.01	(27.83)	(25.45)	1.17	(0.35)	0.70	2.11	(2.65)	(1.58)	(14.19)	(1.31)	(1.17)
2001-2	(14.43)	1.39	4.19	0.00	(43.83)	(10.56)	1.41	0.82	1.61	(0.89)	(2.06)	(1.24)	0.70	(6.11)	(2.02)
2001-3	13.98	1.39	0.12	0.00	4.67	15.35	0.54	0.09	0.50	(3.20)	(2.21)	(1.42)	(4.30)	(6.29)	(1.12)
2001-4	74.21	1.39	(1.03)	0.00	(21.03)	7.02	(0.23)	(1.04)	0.04	(3.99)	(2.25)	(2.28)	(25.82)	(4.54)	(0.02)
2002-1	(16.31)	1.39	1.94	0.00	(48.71)	(6.41)	0.25	(1.16)	0.54	(1.69)	(1.16)	(1.05)	(0.13)	1.56	(0.42)
2002-2	0.01	1.39	(4.14)	(0.00)	(68.95)	(21.39)	1.23	(0.45)	1.07	1.87	1.25	(0.38)	20.95	3.79	(2.26)
2002-3	9.47	1.39	(8.83)	0.00	73.44	(19.71)	0.85	0.25	0.24	1.31	1.53	(0.94)	15.05	7.64	(1.88)
2002-4	10.58	1.39	(3.90)	(0.00)	20.52	(12.39)	0.48	0.25	0.25	1.40	1.87	(0.68)	2.56	5.01	(1.26)
2003-1	(18.86)	1.39	(7.62)	(0.00)	(92.16)	(33.03)	1.13	1.19	0.65	4.35	4.59	0.11	16.40	5.38	(1.79)
2003-2	(7.34)	1.39	(8.15)	0.00	336.63	5.46	0.76	0.61	0.34	0.46	0.24	(1.95)	(9.92)	2.85	(0.99)
2003-3	14.41	1.39	(1.82)	(0.00)	108.56	26.46	0.63	0.23	(0.36)	0.10	(1.39)	(1.01)	2.41	0.48	(1.62)
2003-4	19.52	1.39	(4.37)	0.00	91.64	30.22	0.21	1.88	0.03	0.24	0.28	0.28	7.44	10.47	(0.46)
2004-1	(6.71)	1.39	(7.50)	(0.00)	(57.66)	(27.14)	0.91	0.80	0.07	2.61	1.81	0.32	9.06	16.45	(1.95)
2004-2	3.92	1.39	1.06	0.00	(2,694.53)	(4.87)	1.78	1.63	0.06	3.41	2.60	0.61	13.35	4.80	(2.82)
2004-3	23.41	1.39	1.06	0.00	(1,453.37)	42.61	0.91	1.45	0.21	2.76	2.04	0.39	21.83	(2.86)	(1.31)
2004-4	(26.05)	1.39	(6.03)	0.00	(140.08)	6.76	0.73	(1.67)	0.39	3.10	1.27	0.14	13.48	0.81	(0.99)
2005-1	12.06	1.39	(3.77)	0.00	44.64	9.09	0.86	(1.10)	(0.00)	1.94	(1.80)	0.46	10.01	10.89	(1.16)
2005-2	16.50	1.39	3.67	0.00	(5.28)	(18.33)	1.58	(1.20)	0.58	2.12	(0.78)	0.98	9.54	2.53	(1.81)
2005-3	7.86	1.39	4.49	1.66	30.53	3.09	1.74	(0.60)	0.43	3.82	(0.59)	1.02	23.41	(0.69)	(2.07)

SIEMENS																			
Unit: In percentage change																			
Quarter	Real CCF	Real EUR/USD	Real EUR/CNY	Real EUR/SEK	Real ST interest rate	Real LT interest rate	German CPI all items	U.S CPI all items	China CPI all items	Sweden CPI all items	Finland CPI all items	German PPI all items	U.S PPI all items	China PPI all items	Sweden PPI all items	Finland PPI all items	Real world oil price	Real world non-energy commodities prices	Industry relative price
1999-4	21.67	(6.57)	7.87	2.76	(22.94)	15.99	0.34	0.62	0.78	(0.04)	0.00	0.48	2.15	1.37	0.88	1.62	33.73	2.30	(0.43)
2000-2	(9.83)	(5.93)	6.06	1.86	19.86	10.36	0.71	0.99	0.94	(0.28)	0.99	0.61	1.52	1.86	1.23	2.93	11.19	2.87	0.18
2000-3	0.01	(4.77)	5.30	4.44	46.52	14.44	0.13	1.06	0.00	0.82	1.18	0.92	1.78	1.69	0.33	1.56	(0.54)	(2.27)	(1.28)
2000-4	61.04	(3.67)	2.80	(2.80)	0.34	(6.86)	0.57	0.80	0.17	(0.04)	0.50	1.44	1.82	1.32	1.10	0.50	14.83	(1.30)	(0.56)
2001-1	(19.17)	(4.01)	4.56	(1.37)	12.88	0.42	0.33	0.54	0.30	0.72	0.70	1.13	1.27	(0.71)	1.63	0.60	(3.26)	(1.16)	(0.91)
2001-2	0.31	6.30	(6.81)	(5.25)	(12.60)	(16.37)	0.63	0.96	(0.46)	0.14	0.43	0.95	1.62	(2.38)	(0.37)	(1.81)	(12.92)	(0.86)	(0.50)
2001-3	(15.38)	(5.60)	6.97	0.09	(11.09)	(5.02)	0.92	1.04	1.00	1.90	1.44	0.97	(1.52)	(1.13)	0.32	(0.54)	5.71	(5.77)	(1.03)
2001-4	33.46	1.71	(2.48)	(4.17)	11.08	13.03	0.23	0.13	(0.30)	0.06	(0.06)	(0.48)	(2.61)	(1.77)	0.00	(1.22)	(6.52)	(4.04)	(0.56)
2002-1	(5.41)	0.59	(0.85)	0.13	(10.33)	1.91	(0.16)	(0.28)	(0.93)	0.42	0.06	(1.16)	(2.98)	(1.57)	(0.35)	(1.81)	(23.30)	(2.97)	0.37
2002-2	2.73	(2.56)	1.16	2.15	(33.97)	(14.75)	0.95	0.36	(0.80)	0.27	0.52	0.36	(0.54)	(0.55)	(0.40)	(0.35)	8.91	2.71	(0.83)
2002-3	(1.97)	6.31	(3.20)	1.72	35.71	27.04	0.19	1.09	(0.13)	1.20	0.87	0.07	2.08	1.46	0.22	(0.24)	17.49	2.74	(0.48)
2002-4	5.27	6.45	(6.18)	(2.02)	(1.65)	(13.39)	0.16	0.43	0.30	(0.06)	(0.10)	(0.33)	0.50	0.96	(0.08)	(0.84)	8.27	6.58	(0.60)
2003-1	(15.43)	1.87	(1.62)	2.61	0.73	(2.34)	(0.10)	0.31	0.13	0.73	0.29	0.20	1.20	1.49	(0.54)	(0.35)	(0.65)	2.46	(0.20)
2003-2	(3.19)	6.91	(6.74)	(1.61)	(44.97)	(39.73)	0.90	1.01	1.14	1.09	0.54	1.73	3.89	4.01	0.73	0.25	16.65	4.43	(1.61)
2003-3	0.42	6.29	(5.50)	0.43	38.84	36.16	(0.10)	0.36	0.17	0.10	0.13	(0.13)	(1.05)	(1.32)	(1.15)	(2.05)	(16.38)	1.14	(0.30)
2003-4	5.60	(1.18)	0.49	(1.04)	(24.87)	(4.53)	0.29	0.49	0.17	(0.34)	(0.41)	0.13	0.51	(0.88)	(0.57)	(0.22)	8.76	0.04	(0.65)
2004-1	1.87	5.55	(3.71)	2.73	12.93	17.00	0.06	0.02	1.82	0.43	0.19	0.06	0.05	0.62	(0.82)	0.36	4.04	10.46	(0.23)
2004-2	(2.12)	5.18	(6.94)	(3.12)	(38.20)	(29.57)	0.76	0.90	0.10	(0.13)	0.00	0.06	2.59	1.57	0.61	0.18	7.49	12.39	(1.26)
2004-3	(2.46)	(3.03)	5.43	1.09	9.39	13.81	0.66	1.43	1.59	0.44	0.06	1.09	2.40	1.99	1.64	0.54	10.45	(0.01)	(0.72)
2004-4	6.80	0.63	(1.95)	(0.47)	22.96	6.65	0.38	0.35	0.83	(0.18)	0.19	0.92	1.82	1.26	0.57	0.18	17.78	(2.86)	(1.09)
2005-1	0.05	6.69	(8.20)	2.36	15.66	(2.37)	0.16	0.60	(1.99)	0.35	0.32	0.88	2.40	0.78	(0.21)	0.07	6.59	1.92	(0.72)
2005-2	(4.08)	0.66	0.28	(1.71)	(20.13)	(16.59)	0.53	0.63	(0.32)	(0.35)	(0.13)	1.18	1.01	(2.10)	0.59	0.43	7.46	10.14	(1.24)
2005-3	1.33	(3.42)	3.19	(0.75)	(6.69)	(14.35)	0.62	1.34	(1.07)	0.48	0.63	1.38	1.73	0.03	1.79	0.82	6.65	(1.41)	(1.55)
2005-4	13.51	(3.37)	5.71	(2.29)	(11.83)	(14.21)	0.80	1.22	(0.18)	0.04	0.19	1.18	3.15	(0.60)	1.81	0.71	20.84	(0.14)	(1.20)

ALCATEL														
Unit: In percentage change														
Quarter	Real CCF	Real EUR/USD	Real EUR/CNY	Real ST interest rate	Real LT interest rate	France CPI all items	China CPI all items	U.S CPI all items	France PPI all items	China PPI all items	U.S PPI all items	Real world oil price	Real world non-energy commodities prices	Industry relative price
1998-3	(8.28)	2.17	(0.59)	22.89	7.84	(0.23)	(0.57)	0.39	(0.62)	(0.57)	(0.53)	(6.56)	(5.44)	(1.33)
1998-4	78.22	5.35	(4.61)	(9.44)	(15.01)	(0.03)	0.34	0.35	(0.70)	(0.61)	(0.70)	(9.54)	(3.41)	(1.35)
1999-1	(43.94)	(5.16)	4.53	(14.01)	(13.43)	0.07	(0.34)	0.39	(0.25)	0.71	(0.65)	0.52	(4.12)	(0.21)
1999-2	58.94	(5.68)	5.28	(32.56)	(13.80)	0.57	(0.64)	0.97	0.39	1.24	2.01	36.15	(1.97)	(0.80)
1999-3	(10.45)	(0.52)	2.91	31.51	52.39	(0.07)	0.78	0.62	0.59	1.37	2.15	33.73	2.30	(0.42)
1999-4	46.78	(1.58)	0.28	(5.17)	(3.18)	0.43	0.47	0.62	1.11	1.47	0.99	16.68	3.61	(0.45)
2000-1	(28.41)	(4.66)	5.49	13.90	6.56	0.56	0.94	0.99	1.41	1.86	1.52	11.19	2.87	(0.68)
2000-2	36.88	(5.31)	4.70	26.27	0.96	0.56	0.00	1.06	1.19	1.69	1.78	(0.54)	(2.27)	0.14
2000-3	2.99	(3.02)	3.48	20.52	7.75	0.33	0.17	0.80	1.17	1.32	1.82	14.83	(1.30)	0.55
2000-4	18.13	(4.33)	4.22	3.86	(6.89)	0.42	0.30	0.54	0.70	(0.71)	1.27	(3.26)	(1.16)	(0.73)
2001-1	(29.16)	7.11	(6.11)	6.40	0.72	(0.03)	(0.46)	0.96	(0.16)	(2.38)	1.62	(12.92)	(0.86)	(0.45)
2001-2	27.72	(6.57)	5.87	(32.79)	(27.46)	1.30	1.00	1.04	0.63	(1.13)	(1.52)	5.71	(5.77)	(1.73)
2001-3	(43.23)	2.23	(1.99)	29.68	30.50	0.10	(0.30)	0.13	(0.59)	(1.77)	(2.61)	(6.52)	(4.04)	(1.40)
2001-4	(5.39)	0.23	(1.20)	(19.92)	(7.53)	0.06	(0.93)	(0.28)	(0.82)	(1.57)	(2.98)	(23.30)	(2.97)	(0.54)
2002-1	(19.98)	(2.07)	1.67	(20.27)	(3.34)	0.67	(0.80)	0.36	(0.07)	(0.55)	(0.54)	8.91	2.71	(1.65)
2002-2	0.38	5.39	(4.04)	(1.76)	2.04	0.79	(0.13)	1.09	0.50	1.46	2.08	17.49	2.74	(1.65)
2002-3	(13.23)	7.03	(5.68)	19.94	(0.95)	0.22	0.30	0.43	0.50	0.96	0.50	8.27	6.58	(0.56)
2002-4	28.71	1.39	(2.09)	(16.74)	(15.80)	0.44	0.13	0.31	0.03	1.49	1.20	(0.65)	2.46	(0.72)
2003-1	(27.65)	7.48	(6.24)	(34.25)	(28.89)	0.91	1.14	1.01	0.95	4.01	3.89	16.65	4.43	(1.20)
2003-2	11.10	5.83	(5.91)	15.12	15.40	0.34	0.17	0.36	(0.62)	(1.32)	(1.05)	(16.38)	1.14	(0.68)
2003-3	9.51	(0.71)	0.97	(5.28)	2.76	0.25	0.17	0.49	0.03	(0.88)	0.51	8.76	0.04	(0.07)
2003-4	13.13	4.86	(4.33)	(24.71)	3.60	0.68	1.82	0.02	0.10	0.62	0.05	4.04	10.46	(1.21)
2004-1	(23.45)	6.08	(6.14)	7.63	(5.54)	0.52	0.10	0.90	0.69	1.57	2.59	7.49	12.39	(1.57)
2004-2	28.47	(3.50)	4.92	(25.78)	(6.93)	0.91	1.59	1.43	1.04	1.99	2.40	10.45	(0.01)	(1.20)
2004-3	(1.70)	1.11	(1.49)	73.81	29.58	0.15	0.83	0.35	0.96	1.26	1.82	17.78	(2.86)	0.24
2004-4	12.72	6.11	(8.70)	(16.41)	(20.52)	0.48	(1.99)	0.60	0.54	0.78	2.40	6.59	1.92	(1.32)
2005-1	(25.95)	1.37	0.98	20.53	10.50	0.15	(0.32)	0.63	0.51	(2.10)	1.01	7.46	10.14	(0.33)
2005-2	16.62	(4.05)	2.52	(40.84)	(36.97)	0.90	(1.07)	1.34	0.85	0.03	1.73	6.65	(1.41)	(0.80)
2005-3	2.09	(2.68)	6.47	48.85	25.71	0.36	(0.18)	1.22	1.13	(0.60)	3.15	20.84	(0.14)	(0.94)

ALCATEL													
Transformed variables													
Unit: ln percentage change													
Quarter	Real CCF	a*(1)	EUR/CNY	Real ST interest rate	Real LT interest rate	France CPI all items	China CPI all items	U.S CPI all items	China PPI all items	U.S PPI all items	Real world oil price	Real world non-energy commodities prices	Industry relative price
1998-3	-6.97	0.84	-0.50	19.28	6.61	-0.20	-0.48	0.33	-0.48	-0.45	-5.52	-4.58	-1.12
1998-4	73.76	1.54	-4.93	2.90	-10.78	-0.16	0.03	0.56	-0.92	-0.98	-13.07	-6.35	-2.07
1999-1	-1.78	1.54	2.05	-19.10	-21.52	0.05	-0.15	0.57	0.38	-1.02	-4.63	-5.96	-0.94
1999-2	35.25	1.54	7.72	-40.11	-21.04	0.60	-0.82	1.18	1.63	1.66	36.43	-4.19	-0.91
1999-3	21.32	1.54	5.76	13.96	44.95	0.24	0.44	1.15	2.04	3.23	53.22	1.24	-0.85
1999-4	41.15	1.54	1.85	11.81	25.05	0.40	0.89	0.95	2.21	2.15	34.86	4.85	-0.67
2000-1	-3.20	1.54	5.64	11.11	4.84	0.79	1.20	1.32	2.65	2.05	20.18	4.81	-0.92
2000-2	21.57	1.54	7.66	33.76	4.49	0.86	0.51	1.59	2.70	2.60	5.49	-0.73	-0.23
2000-3	22.87	1.54	6.02	34.67	8.26	0.63	0.17	1.37	2.23	2.78	14.54	-2.52	0.63
2000-4	19.74	1.54	6.10	14.92	-2.72	0.60	0.39	0.97	0.00	2.25	4.73	-1.86	-0.43
2001-1	-19.39	1.54	-3.83	8.49	-2.99	0.20	-0.30	1.25	-2.76	2.31	-14.68	-1.48	-0.84
2001-2	12.01	1.54	2.58	-29.33	-27.07	1.28	0.75	1.56	-2.42	-0.65	-1.25	-6.24	-1.97
2001-3	-28.29	1.54	1.17	12.01	15.70	0.79	0.24	0.69	-2.38	-3.43	-3.44	-7.16	-2.33
2001-4	-28.69	1.54	-2.28	-3.92	8.91	0.12	-1.09	-0.21	-2.52	-4.38	-26.81	-5.15	-1.29
2002-1	-22.88	1.54	1.02	-31.01	-7.40	0.71	-1.30	0.21	-1.40	-2.14	-3.65	1.11	-1.94
2002-2	-10.39	1.54	-3.14	-12.69	0.24	1.16	-0.57	1.28	1.16	1.79	22.29	4.20	-2.53
2002-3	-13.02	1.54	-7.85	18.98	0.15	0.65	0.23	1.01	1.75	1.63	17.69	8.06	-1.45
2002-4	21.58	1.54	-5.15	-5.99	-16.32	0.56	0.30	0.54	2.01	1.47	3.81	6.00	-1.02
2003-1	-12.18	1.54	-7.37	-43.27	-37.41	1.14	1.21	1.18	4.82	4.54	16.31	5.75	-1.58
2003-2	-3.80	1.54	-9.27	-3.34	-0.17	0.83	0.78	0.91	0.84	1.05	-7.41	3.52	-1.32
2003-3	15.49	1.54	-2.22	2.87	11.06	0.43	0.25	0.69	-1.59	-0.06	-0.07	0.65	-0.43
2003-4	18.25	1.54	-3.81	-27.56	5.09	0.81	1.91	0.28	0.15	0.32	8.76	10.48	-1.25
2004-1	-16.37	1.54	-8.47	-5.69	-3.60	0.89	1.08	0.91	1.90	2.61	9.67	18.03	-2.22
2004-2	15.83	1.54	1.61	-21.67	-9.91	1.19	1.64	1.92	2.84	3.80	14.48	6.67	-2.04
2004-3	13.64	1.54	1.16	59.92	25.84	0.64	1.69	1.12	2.34	3.12	23.41	-2.86	-0.41
2004-4	11.81	1.54	-9.50	23.37	-4.58	0.56	-1.55	0.79	1.46	3.38	16.17	0.38	-1.20
2005-1	-19.09	1.54	-3.70	11.68	-0.57	0.41	-1.40	0.95	-1.68	2.30	11.01	11.18	-1.05
2005-2	2.63	1.54	3.05	-29.78	-31.31	0.98	-1.24	1.68	-1.10	2.27	10.67	4.06	-0.98
2005-3	11.05	1.54	7.83	26.84	5.78	0.84	-0.76	1.94	-0.58	4.08	24.42	-0.90	-1.37