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Exchange-rate uncertainty and microeconomic benefits from the EMU

Richard Friberg* and Anders Vredin**

Summary

■ This paper reviews the argument that the EMU leads to benefits from lower exchange-rate uncertainty; it addresses two questions:

- The microeconomic question of how exchange-rate uncertainty affects firms
- The macroeconomic question of how the EMU affects uncertainty

This paper deals mostly with the first question; for example, it looks at correlations between exchange rates and stock prices and exchange rates and output prices. These facts speak against the idea that the EMU will be beneficial for Swedish firms:

- Firms can adjust to exchange-rate uncertainty, for example, by pricing-to-market
- Exchange-rate changes may work as automatic stabilizers
- No strong empirical evidence shows that exchange-rate uncertainty hampers trade, investment, or growth
- Important Swedish trading partners, such as the U.S., the UK, and Denmark might not participate in the monetary union in the near future

These facts speak for the EMU:

- Exchange-rate uncertainty stems from policy uncertainty, which may be lower inside the EMU.
- The EMU may lower protectionist pressures.
- It is very hard for firms to hedge against total economic exchange-rate risk (as opposed to mere transaction risk). ■

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Usually, evaluations of the potential economic costs and benefits of a European monetary union are primarily concerned with the impact on macroeconomic stability and microeconomic efficiency (compared with present monetary policies or some alternative arrangements). Regarding macroeconomic stability, the main benefit is typically expected to come from lower and less volatile inflation. The loss of monetary autonomy might lead to a cost for higher output and employment instability. It also involves a potential micro-economic efficiency cost, because the optimal inflation tax and seigniorage cannot be determined on a national basis. But other microeconomic efficiency arguments point at benefits. Lower transaction costs and lower exchange-rate uncertainty are believed to foster trade, investment, and growth, and to lead to higher efficiency and welfare.

This paper attempts to shed some light on the argument that the EMU leads to benefits from lower exchange-rate uncertainty. Two questions must be addressed:

- How are firms affected by exchange-rate uncertainty?
- How does the EMU affect uncertainty?

We pay most attention to the first—microeconomic—question. Other reports to the Swedish Government Commission on the EMU discuss the second—macroeconomic—question in more detail.

Note that from the outset, the division between the macro-economic and microeconomic arguments is not clear-cut. If the

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EMU leads to lower overall exchange-rate uncertainty, this may have macroeconomic implications through lower interest rates (because of lower risk *premia*). But if the loss of monetary autonomy is associated with higher output volatility, the overall uncertainty may increase and interest rates (and risk *premia*) go up. The nature of shocks and the sources of uncertainty are usually regarded as macroeconomic issues. But these issues have strong implications for exchange-rate uncertainty and are therefore also connected to the microeconomic arguments.

For example, one of the important questions is whether closer monetary integration among EU countries leads to lower or higher exchange-rate uncertainty *vis-à-vis* countries outside the EU[1].

The interdependence of microeconomic and macroeconomic issues points to the desirability of a general equilibrium framework. Unfortunately we lack a suitable micro-based general equilibrium model of international monetary economics in which to evaluate different nominal exchange-rate regimes[2]. So this study applies a partial equilibrium view.

At this point, we stress that it is impossible to equate national—Swedish—welfare effects of the EMU with how firms would be affected. The performance of Swedish entities and the Swedish economy may differ from the performance of Swedish firms. To take an extreme example, a Swedish-owned multinational company may be essentially unaffected by an appreciation of the crown by switching production to other locations. Perhaps this would have adverse consequences (for example, unemployment) on the local economy as a result, even though the multinational company, as a whole, may be hurt little. It is also true that the degree of foreign ownership is increasing in many companies, providing another reason for not equating Swedish welfare effects of the EMU with how Swedish firms would be affected. With these words of caution we proceed.

[1] While the volatility (monthly standard deviation) of intra-European exchange rates was lower in 1984-1989 than in 1974-1983, the volatility versus the U.S. dollar was higher (but not versus the yen). Cf. European Economy (1990), Chapter 3.

[2] It is important to realize that in a frictionless world, all nominal exchange-rate regimes are equally efficient. To evaluate the effects of the EMU in a general equilibrium framework, we need a model (with three countries) that incorporates real-world imperfections, which we believe to be central to the choice of nominal exchange-rate regime. Extending the work by Obstfeld and Rogoff (1995) to include three countries and pricing-to-market issues (see Betts and Devereux, 1996) is one avenue that would seem promising at this point.

This paper is organized as follows: Section 1 provides some information on Swedish industries' exposure to exchange-rate changes, as indicated by correlations between stock prices and exchange rates. Section 2 takes a closer look at the relations between exchange rates and profits. Section 2.1 investigates correlations between exchange rates and prices of Swedish exports and imports. Because nominal price rigidities apparently are important, Section 2.2 presents some information about whether trade prices are set in domestic or foreign currencies. We then look at how the relations between exchange rates and profits may be affected by market competition (Section 2.3), factor prices and other variables, which affect profits (Section 2.4), and inter-temporal aspects, such as adjustment costs (Section 2.5). Section 2 concludes with a discussion about why exchange-rate fluctuations matter for firms (Section 2.6).

After discussing how exchange-rate uncertainty affects firms' profits, we address the question of how the EMU might affect uncertainty. So Section 3 follows a macroeconomic track and discusses the relation between monetary policy and exchange-rate uncertainty. Section 4 discusses some microeconomic aspects that are often put forward in discussions about the EMU, but which are overlooked in the framework used in Section 2. Section 5 presents conclusions.

1. Measures of exchange-rate exposure

The exchange-rate exposure of a firm may generally be defined as "the sensitivity of the value of the firm to movements in exchange rates" (Adler and Jorion, 1992). In the literature on this subject, one often sees a distinction between:

- Economic exposure, which refers to the total impact of exchange rates on the economic value of the firm, and
- Accounting exposure, which merely measures the extent to which exchange-rate changes cause accounting gains and losses

Accounting exposure is often divided into *translation* exposure and *transaction* exposure. Translation exposure is concerned with the impact of exchange rates on the home currency value (in accounting statements) of foreign assets and liabilities. Generally transaction ex-

posure denotes the balance of known payments and receivables denoted in foreign currency[3].

The exact definition of accounting exposure will vary among countries, because of differences in accounting standards. But it also has other deficiencies as a measure of exchange-rate exposure. It ignores all effects from exchange rates that are not recorded on the books. Exchange-rate changes may affect expected profits and hence the firm's value through planned (certain but not recorded) contracts, through expected demand for the firm's products, through changes in the firm's actions because of exchange-rate changes, and so on. Such effects may be large even for firms without foreign currency assets, liabilities, or transactions, that is, even for firms whose accounting-based measures of exchange-rate exposure are zero.

In the financial literature, economic exposure is commonly estimated simply by regressing changes in stock prices on changes in exchange rates (see, for example, Adler and Dumas, 1984 and Jorion, 1990). Such estimates provide a natural starting point for our discussion of how exchange-rate changes affect firms. Table 1 shows some different estimates of exchange-rate exposure for the Swedish stock market. We also study STORA, a large corporation in the forest products industry[4]. The total economic exposure to exchange-rate fluctuations is the point estimate of β from this regression:

$$\ln(P_{t+1}/P_t)=\alpha+\beta\ln(S_{t+1}/S_t)+\varepsilon_{t+1} \qquad (1)$$

where P is the stock-price index and S is the effective nominal exchange rate, the weighted average of crown prices of foreign currencies. Two measures of the effective exchange rate have been used, based on IMF's *MERM* or *TCW* weights, respectively[5].

[3] See Tornianen (1992) for a thorough discussion.

[4] STORA was selected because we have received permission to look at unofficial internal material from this company, which has helped us organize our thinking about exchange-rate uncertainty. Section 2.1, for example, contains some of this information (on prices).

[5] The MERM weights are based on IMF's Multilateral Exchange-Rate Model. This is an econometric model that tries to estimate the effects on trade flows from exchange-rate changes. The model includes estimated and calibrated behavioral (supply and demand) equations. IMF recently abandoned the MERM weights in favor of the Total Competitiveness Weights (TCW), which are easier to calculate. They are similar to simple bilateral trade weights, although adjustments are made to account for competition in third markets.

Table 1. Estimated exchange-rate exposure

1a. Exposure using effective exchange rates:

Dependent variable	Period	Coefficients β TCW	R^2	β MERM	R^2
Swedish stock market index (AFGX)	80:02-96:02	0.41	0.01	**0.80***	0.07
		[1.61]		[3.71]	
	92:12-96:02	0.42	0.06	**0.61**	0.13
		[1.53]		[2.37]	
STORA	80:02-96:02	0.65	0.01	**1.24***	0.07
		[1.62]		[3.59]	
	92:12-96:02	**1.24**	0.14	**1.38**	0.19
		[2.48]		[2.95]	

1b. Exposure to selected exchange rates:

Dependent variable	Period	Coefficients β DEM	β FIM	β GBP	β USD	R^2
Swedish stock market index (AFGX)	80:02-96:02	-0.45	**0.65**	-0.04	**0.63**	0.12
		[-1.93]	[2.12]	[-0.16]	[4.19]	
	92:12-96:02	-0.46	0.07	0.26	0.67	0.19
		[-1.08]	[0.14]	[0.44]	[1.56]	
STORA	80:02-96:02	**-1.09**	**1.58**	0.07	**0.97**	0.16
		[-3.00]	[3.32]	[0.22]	[4.12]	
	92:12-96:02	-0.86	1.32	0.20	1.18	0.26
		[-1.13]	[1.44]	[0.19]	[1.53]	

Notes: Coefficients on constants not reported. Coefficients in **bold** are significant at the 5-percent level (t-values reported within brackets). All exchange rates and exchange rate indexes are expressed as the price of foreign currency in terms of Swedish currency. The TCW index is the nominal effective exchange rate taken from IMF's Financial Statistics. The MERM exchange rate was computed by weighting nominal exchange rates using IMF's MERM weights. Australian dollars, Spanish pesetas and Irish punt were not included.

Source: IMF. Findata.

*) These regressions were computed on the period 82:02-96:02.

The regression was estimated on monthly data from a period during which the crown exchange rate was flexible (December 1992 to February 1996) and the longer period covering 1980 and onward, which includes the pegged exchange-rate regime(s).

The upper panel of Table 1 shows that a depreciation of the crown, defined using the TCW weights, with 1 percent, is associated with an increase in the total value of the stock market by 0.4 percent[6]. This estimate is not affected by the choice of sample period. The corresponding estimate for STORA is 1.24, based on the flexible exchange-rate period and 0.65, for the longer period. So this company is more exposed to exchange rates than the stock market as a whole. (From regressions we chose not to report, we can see that this also holds for the forest-products industry on average.) When the effective exchange rate is defined using the MERM weights, which give a larger role to the U.S. dollar, all estimates of exposure are somewhat higher. For hedging purposes, one might want to estimate the economic exposure to different foreign currencies (see Adler and Dumas, 1984, and Adler and Jorion, 1992). This can be done simply by running the multiple regression:

$$\ln(P_{t+1}/P_t)=\alpha+\Sigma_i\beta_i\ln(S_{i,t+1}/S_{i,t})+\eta_{t+1} \qquad (2)$$

where S_i is the price of currency i in terms of the domestic currency (crown). Table 2 shows some indications of which foreign currencies that are likely to be most important. Columns 1 and 2 show the shares of Swedish exports to and imports from the most important trading partners. Columns 3 and 4 display IMF's TCW and MERM weights. These are constructed to take account of the degree and composition of competition in export and import markets. The most important trading partners are Germany, the UK, the U.S., Norway, Denmark, and Finland. According to the MERM weights in column 4 (but not the TCW), Japan, Italy, and France are more important than the UK and the Nordic countries. For STORA, Germany, Sweden, the UK, and France are the most important markets. Almost 90 percent of total sales (external and internal) are on European markets.

[6] We have also run regressions with the change of the nominal interest rate as an additional explanatory variable. This increases the explanatory power of the regression, but does not affect the point estimate of β very much.

Table 2. Swedish exports and imports of goods and exchange-rate index weights

	Imports	Exports	TCW	MERM
Country	% of total	%of total		
Germany	18.4	13.3	22.28	12.68
France	5.6	5.1	7.15	6.96
Netherlands	4.1	5.3	4.24	3.03
Austria	1.2	1.4	1.71	1.48
Belgium-Luxembourg	3.5	4.9	3.55	2.74
Sum of the above	**32.8**	**30.0**	**38.93**	**26.89**
UK	9.6	10.2	11.56	5.18
Denmark	6.8	6.9	5.60	4.19
Finland	6.3	4.8	6.69	5.75
Italy	3.8	3.8	6.05	7.27
Spain	1.4	1.9	2.48	1.90
Ireland	0.8	0.7	0.77	0.68
Portugal	1.0	0.5	0.93	0.00
Greece	0.2	0.6	0.27	0.00
Total EU countries	**62.7**	**59.4**	**73.28**	**51.86**
Norway	6.1	8.1	5.58	6.69
Switzerland	1.9	1.9	2.74	1.40
Canada	0.6	1.1	1.16	4.25
U.S.	8.6	8.0	11.63	25.56
Japan	4.7	2.7	5.20	8.46
Australia	0.2	1.3	0.27	1.78
New Zealand	0.0	0.2	0.14	0.00
Total	**84.8**	**82.7**	**100**	**100**

Source: Imports and exports 1994; Foreign trade statistics of Statistics Sweden. Exchange rate weights; *Sveriges Riksbank.*

In Table 3, columns 1 and 2 on STORA show the percentage of sales and costs denominated in different currencies. The table shows that much more of the costs are denominated in Swedish crowns (43 percent) than sales (19 percent). Column 3 in Table 3 gives the composition of the known but not yet received net flows in different currencies for STORA's Swedish entities as of June 1995. The table shows that the German mark, the U.S. dollar, and the British pound are about equally important for transaction exposure, and that these currencies are far more important than any other currency. There is a net outflow of currency only in Finnish marks and ecu. So a depreciation of the crown would, if flows were not hedged, lead to aggregate net flows becoming worth more in crowns. But the economic

exposure might be quite different from the transaction exposure, not least because half of STORA's equity is located outside Sweden.

Table 3. STORA, variables affecting exchange-rate exposure

	CD, %, 1995		TE, June 1995	ES, % of total external sales
Country	**Sales**	**Costs**		
Germany	19	17	23.67	22
France	9	8	7.08	9
Netherlands	3	1	4.28	5
Austria	0	0	2.36	NA
Belgium-Luxembourg	5	4	2.00	4
Sum of the above	**36**	**30**	**39.39**	**40**
UK	10	2	20.77	11
Denmark	5	5	4.36	5
Finland	0	0	-1.40	NA
Italy	3	0	5.03	4
Spain	2	0	3.10	NA
Ireland	0	0	1.62	NA
Portugal	0	2	0.08	NA
Greece	0	0	0.00	NA
Total EU countries	**56**	**39**	**72.95**	**60**
Norway	3	2	3.82	3
Switzerland	0	0	1.33	NA
Canada	0	3	0.00	NA
U.S.	15	7	22.82	5*
Japan	0	0	0.05	NA
Australia	0	0	0.35	NA
New Zealand	0	0	0.04	NA
Sweden	19	43	NA	17
Ecu	7	6	-1.38	NA
Total	**100**	**100**	**100**	**80**

Notes: CD = Currency denomination of sales and costs, TE = Transaction exposure, Swedish entities, ES = External sales to various markets, 1994

Source: STORA. Transaction exposure defined as the percentage of total net currency flows to Swedish entities of STORA. A negative sign indicates larger outflows than inflows in that currency. External sales are defined as sales to a market of goods produced in another country.

*) includes Canada

We chose to estimate (2) using the crown prices on the currencies from Germany, Finland, the UK, and the U.S. This set appears to capture exchange rates, which have developed somewhat independently in the past and can be expected to do so in the future. The results in the lower panel of Table 1 show that a depreciation of the crown against the U.S. dollar or the Finnish mark raises stock prices significantly for STORA and for the stock market as a whole. A depreciation against the German mark seems to lower stock prices. The regression coefficients for the individual currencies (the β_i's) do not add up to the measure of total economic exposure (β). The important reason is not that we have only included a subset of all relevant currencies, but that the different crown exchange rates are not entirely independent. So an unambiguous decomposition of total economic exposure to different currencies cannot be made.

Nevertheless, the results provide important information about exchange-rate exposure among Swedish firms. First, there are reasons to expect overall exchange-rate risk (*economic exposure*) to be quite different from narrow accounting-based measures of exchange-rate risk, such as transaction exposure. Second, Swedish firms' exchange-rate exposure is not only determined by the fluctuations in the value of the crown versus the German mark and other potential EMU currencies. Fluctuations in the crown/U.S. dollar rate may be equally (or even more) important[7].

2. Exchange-rate fluctuations and firm profits

The previously reported estimates of exchange-rate exposure do not provide information about the mechanisms whereby exchange-rate fluctuations affect firm profits. And the estimated βs are probably not invariant to a change in the monetary policy regime. Even though casual observations and more careful interviews studies (see,

[7] Wihlborg (1994) reports that a depreciation of the Swedish crown on average *lowers* the stock-market value of Swedish industries. For STORA, he finds significant negative effects form a depreciation versus the German mark and the yen. But his results are based on a study of monthly data from January 1987 - February 1992. That the crown's value was fixed (within a target zone) versus a currency basket between September 1982 and May 1991 means that during this period a depreciation should have been expected to be followed by an appreciation (if the target zone was credible). And the construction of the currency basket implied that a depreciation against the German mark was typically associated with an appreciation against the U.S. dollar.

for example, Torniainen, 1992, and *European Economy*, 1990) suggest that firm managers worry about exchange-rate fluctuations, it is unclear why exchange-rate uncertainty should matter for the firms' owners. In a frictionless world with complete markets, investors should be able to hedge against exchange-rate uncertainty by choosing a proper portfolio of firm shares (according to a version of the *Modigliani-Miller* theorem). There is obviously a need to go beyond the statistical measures of exchange-rate exposure to try to understand the relations between exchange-rate fluctuations and firm profits and to discuss whether or not exchange-rate uncertainty is harmful.

Exchange-rate changes affect firm profits through prices, unit costs, and produced quantities and through market values of physical assets and financial assets and liabilities. Only the effects through short-term assets and liabilities are captured in measures of accounting exposure. This also seems to be the only channel of exchange-rate uncertainty that is considered when it is argued, as is frequently done, that firms now have access to forward foreign-exchange markets, which allow them to hedge against changes in exchange rates. But to understand the full importance of exchange-rate uncertainty one needs to know a lot about "the nature of the good and the industry structure" (Dumas, 1994, p 18).

In the following, we review analyses of the links between exchange rates and firm profits. The analyses show how the links depend on the nature of the good and the industry structure. Sections 2.1-2.3 present analyses of the relations between exchange rates and prices, which are based on the assumption that firms solve a static profit-maximization problem, where the exchange rate is the only source of uncertainty. Here, firms are assumed to be risk-neutral, that is, they want to maximize expected profits but do not care about the degree of uncertainty (variance). Within this framework, one cannot answer questions about optimal hedging strategies. But the analyses are useful for our understanding of the effects of exchange-rate fluctuations. Section 2.4 discusses correlations between exchange rates and variables (other than prices), which affect firm profits. Section 2.5 considers inter-temporal aspects. And we return to the hedging question in Section 2.6.

One thing that must be emphasized at an early stage is the distinction between nominal and real exchange rates. Empirically, it is well known that relative prices among different countries are more volatile when nominal exchange rates are more flexible (see, for ex-

ample, Obstfeld, 1995). Consumer price indices are more stable in the short run than nominal exchange rates. So short-run fluctuations in real exchange rates (relative consumer prices expressed in the same currency) largely reflect fluctuations in nominal exchange rates. Price stickiness is probably an important explanation for why nominal exchange rates are correlated with relative prices, real profits, and other real variables. Most of the following theoretical models are also based on assumptions of some kinds of nominal rigidities. In these models, changes in nominal and real exchange rates are often equivalent. Nevertheless, the EMU issue that we want to focus on in this paper primarily concerns fluctuations in nominal exchange rates. Monetary policy cannot directly control real exchange rates (or other relative prices of goods or services). And nominal exchange-rate uncertainty is a problem for firms that differs from uncertainty about relative prices[8].

2.1. Prices and exchange rates

If Swedish import and export firms face prices that are exogenously determined in foreign currency on the world market, that is, if the small, open economy hypothesis is valid, then they cannot deliberately change their prices when exchange rates fluctuate. If costs are fixed in domestic currency, which may be a realistic assumption in the short run, exchange-rate changes may have strong effects on firms' profitability.

It is well known that exporters in large economies, such as the U.S., Germany, and Japan can pursue policies of price discrimination. The empirical evidence suggests that they price-to-market and that relative export prices among different markets are affected by nominal exchange rates; see, for example, Giovannini (1988) and Knetter (1989).

Froot and Klemperer (1989) and Kasa (1992) show why a firm with some market power may want to adjust relative export prices in response to changes in real exchange rates. For example, if the real exchange rate between the U.S. and Germany appreciates, say because aggregate demand in the U.S. goes up relative to Germany, exporters may want to raise their export prices to the U.S. in relation to the German market. But the relation between relative export prices and nominal exchange rates cannot be explained in terms of price

[8] See Adler and Dumas (1983) for a further discussion of this point.

discrimination only. Some kind of nominal rigidity must also be present. If exporters keep prices (temporarily) fixed in the importing countries' currencies—*local-currency price stability*—relative export prices will be perfectly correlated with nominal exchange rates. If the U.S. dollar appreciates against the German mark ($S_{US,D}$ goes down), the price of exports to the U.S. in the exporters' currency (P^{US}) will go up relative to the price of exports to Germany (P^{D}). Here, the nominal exchange rate $S_{US,D}$ will be positively correlated with the relative price P^{D}/P^{US}. According to Giovannini (1988), empirical evidence on pricing-to-market suggests that changes in relative export prices reflect both staggered nominal price setting and deliberate price discrimination (which could be present even in the absence of nominal rigidities).

Pricing-to-market may be a way for firms to manage their exchange-rate exposure. Is this also an option for Swedish import and export firms? Or is Sweden a small, open economy? The investigation of pricing-to-market in Swedish exports by Alexius and Vredin (1996) suggests that pricing-to-market is a common phenomenon and that the degree of pricing-to-market depends not only on real exchange rates (because of price discrimination) but that nominal rigidities also play an important role.

For a selection of industries and export markets, Table 4 a-b shows correlations between relative export prices and nominal and real exchange rates. The table shows that the correlations are often significantly positive, which is consistent with pricing-to-market. That relative export prices are correlated with real exchange rates suggests that there is price discrimination. Whether the correlations between relative export prices and nominal exchange rates are due to local currency pricing at the industry level, or because nominal and real exchange rates are correlated at the macro level, is an open question. Prices are not completely rigid in local currencies, because the correlations between relative export prices and nominal exchange rates are not perfectly positive. It is encouraging that the (admittedly relatively few) observations on genuine prices on an individual product (newspaper paper from STORA) are roughly consistent with the data on aggregated unit values (export values divided by export volumes).

Table 4a. Correlations between relative export prices and nominal exchange rates

Industry	D/UK	D/U.S.	D/F	U.S./UK	U.S./F	UK/F
Radio, TV, communications equipment & apparatus manufacturing (ISIC3832)	-.80	.54	-.13	-.10	.64	.36
Motor vehicle & chassis manufacturing (ISIC 38432)	.12	.74	-.28	.81	.90	.26
Newspaper paper (SITC 641)	.54	.59	.35	.50	.41	.29
Craft liner board paper (SITC6414)	.79	.31	-.02	0	.03	.67
Newspaper paper from a STORA subsidiary	.92	NA	.84	NA	NA	-.37

Notes: D = Germany, F = France. The relative export price is defined as the ratio between the export prices (in SEK) to markets i and j (for example, P^{us}/P^{uk}) and the corresponding nominal exchange rate; currency j in terms of currency i (for example, Suk,us). All correlations except those for STORA are computed on quarterly unit value data, 1980-1994. *Source:* Alexius and Vredin (1996). Correlations for STORA computed on quarterly price data, 92:1-95:2 for D/UK, 93:01-95:02 for the other two. *Source:* STORA.

Table 4b. Correlations between relative export prices and real exchange rates

Industry	D/UK	D/U.S.	D/F	U.S./UK	U.S./F	UK/F
Radio, TV, communications equipment & apparatus manufacturing	-.06	.55	-.32	-.09	.61	-.10
Motor vehicle & chassis manufacturing	.40	.82	-.34	.89	.88	.59
Newspaper paper	.74	.59	.53	.55	.44	.58
Craft liner board paper	.69	.21	-.24	.04	.23	.58
Newspaper paper from a STORA subsidiary	.92	NA	.44	NA	NA	-.40

Notes: D = Germany, F = France. The relative export price is defined as the ratio between the export prices (in SEK) to markets i and j (for example, P^{us}/P^{uk}) and the corresponding real exchange rate as the ratio between the consumer price indexes in countries j and i in common currency (for example, Suk,usCPIus/CPIuk). All correlations except those for STORA are computed on quarterly unit value data, 1980-1994. *Source:* Alexius and Vredin (1996). Correlations for STORA computed on quarterly price data, 92:1-95:2 for D/UK, 93:01-95:02 for the other two. *Source:* STORA.

The literature on pricing-to-market is related to the literature on *exchange-rate pass-through* (see, for example, Knetter, 1993). The latter concept usually refers to the effect on import prices from changes in exchange rates. If, for example, exporters price-to-market and stabilize prices in the local (importer's) currency, the degree of pass-through will be low.

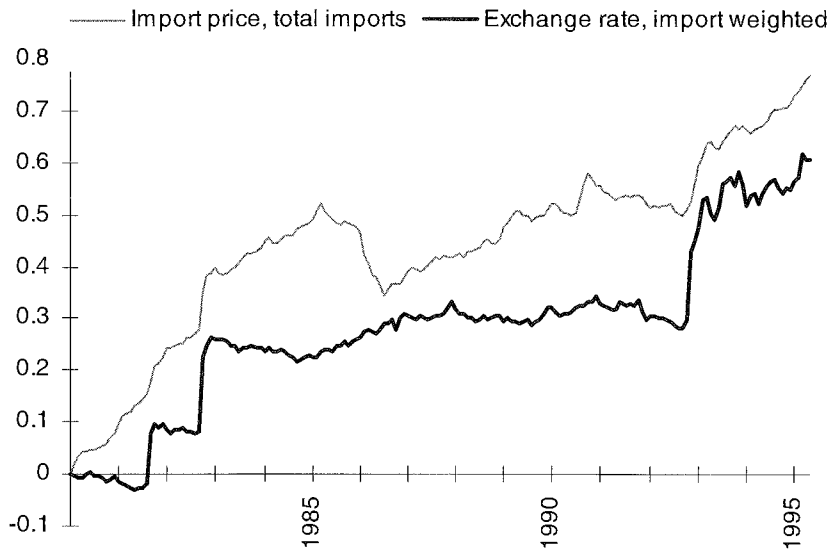
Local-currency price stability tends to stabilize the demanded quantity for the exported product. Exchange-rate fluctuations will then predominantly affect the markup, that is, the ratio between the export price and domestic marginal costs (which for the sake of the argument may be assumed to be constant). The larger the degree of pass-through to export prices in foreign currency, the more demanded quantities will fluctuate, which leads to more volatile production. This may lead to more or less volatility in profits. The exporting firms' profits will be affected no matter what the degree of pass-through.

Unfortunately, the literature on exchange-rate pass-through (see the survey by Menon, 1995) is often concerned with the effects of changes in real, rather than nominal, exchange rates. Nevertheless, the degree of pass-through into Swedish import prices is important for how exchange-rate changes affect Swedish firms and consumers.

Focusing on firms, we note that the degree of pass-through to imported inputs and to the prices of foreign competitors' exports to Sweden is important for how much profits will be affected by exchange-rate changes.

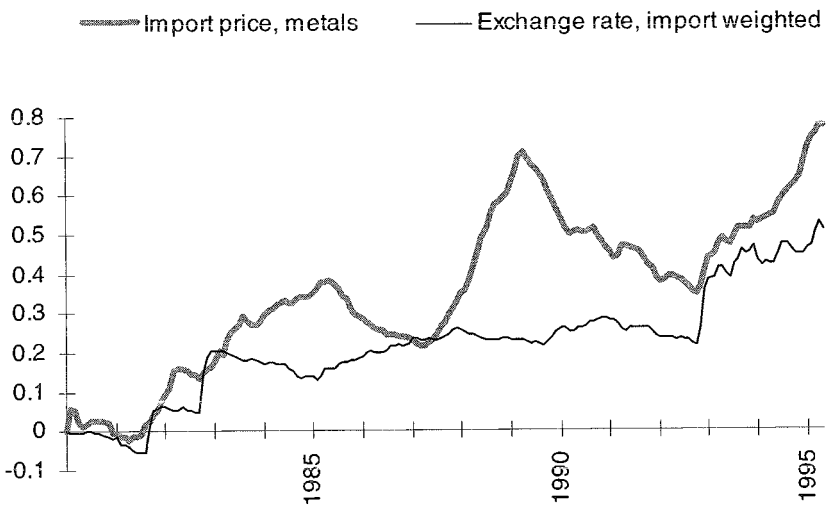
Casual inspection of Swedish import prices suggests that pass-through is incomplete but also that it differs among industries. On average, the immediate pass-through is greater than zero but far from complete; cf. Figure 1 a. Adolfson (1996) reports an estimate of the contemporaneous pass-through for aggregate imports of 21 percent. Figure 1 b-c displays the pass-through for the basic metals (ISIC 37) and transport equipment (ISIC 384) industries. The contemporaneous pass-through coefficients are 26 percent and 33 percent, respectively. Adolfson's econometric analysis, which also takes world-market prices into account, suggests that there is a 100 percent long-run pass-through in the transport equipment industry, but not in imports of basic metals.

Figure 1a. Import price of total imports and import-weighted exchange rate, Sweden 1980-1995



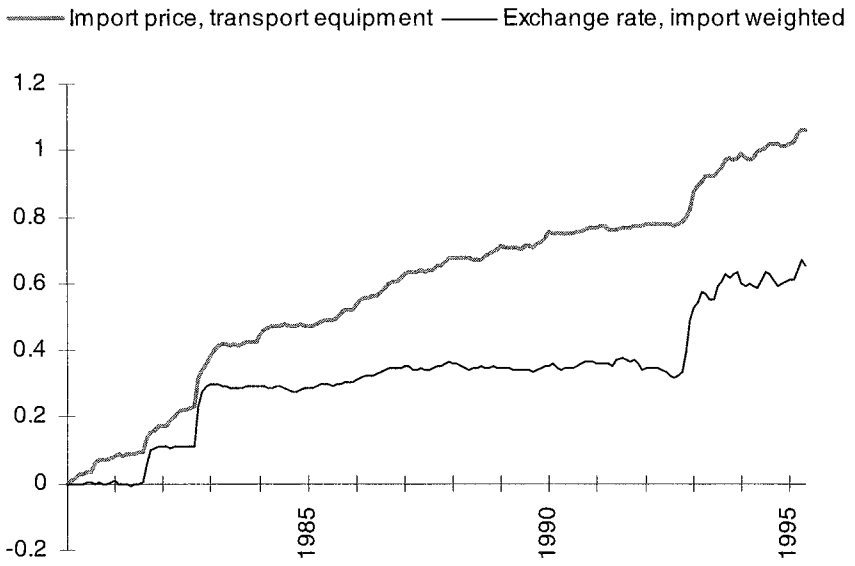
Source: Adolfsson (1996). Variables expressed as logs of index. Import price from Statistics Sweden. The nominal exchange rate is constructed using weights based on 1993 import shares for OECD 14, except Canada.

Figure 1b. Import price of metals (ISIC 37) and import-weighted exchange rate, Sweden 1980-1995



Source: Adolfsson (1996). Variables expressed as logs of index. Import price index from Statistics Sweden. The nominal exchange-rate index is constructed using weights based on source countries (OECD 14, except Canada) for Swedish metal imports in 1993.

Figure 1c. Import price of transport equipment (ISIC 384) and imported-weighted exchange rate, Sweden 1980-1995



Source: Adolfsson (1996). Variables expressed as log of index. Import price from Statistics Sweden. The nominal exchange-rate index is constructed using weights based on source countries (OECD 14, except Canada) for Swedish transport equipment imports in 1993.

The conclusion from data on prices and exchange rates is that nominal exchange-rate changes are associated with changes in relative prices of exports and imports.[9] The apparent ability of Swedish firms to price-to-market and the apparently less-than-full, immediate exchange-rate pass-through into Swedish import prices suggests that economic exposure to exchange-rate fluctuations is more limited than the small, open economy hypothesis implies. But note that the economic mechanisms behind the pricing-to-market behavior among domestic and foreign exporters are not fully understood. For example, as one goes beyond the partial analysis of firm behavior and applies a general equilibrium approach, exchange-rate volatility cannot

[9] Gottfries (1994) studies the aggregate of Swedish manufacturing exports and reaches the same conclusion.

be treated as an exogenous variable that is independent of the factors that determine the degree of pricing-to-market[10].

2.2 The role of invoicing currency

Because correlations between exchange rates on the one hand, and export and import prices on the other, partly depend on nominal price rigidities, the currency of denomination of prices—the invoicing currency—is important (see Giovannini, 1988, for a formal analysis)[11]. According to *European Economy* (1990, p 72), most trade among the major industrialized countries is invoiced in the exporters' currencies, which is supposed to be explained by the exporters' wish to eliminate exchange-rate risk.

Using data from 1968, Grassman (1973) reported that the Swedish crown was indeed the most important invoicing currency for Swedish exports, its share being 66 percent. The corresponding figure for imports was 26 percent. Other studies (Page, 1977, Van Nieuwkerk, 1979) confirmed that exports are predominantly invoiced in the exporters' currencies, which is sometimes called *Grassman's law*. The law seems to hold stronger for large export countries than for small. For example, exports to the U.S. are often priced in the U.S. dollar.

Table 5 suggests that there has been a drastic change in the invoicing practices of Swedish exporters since Grassman's study. The share of the crown is now down to 37 percent. Judging from the figures for different manufacturing sectors, the crown is still the most important invoicing currency in most cases, followed by the U.S. dollar and the German mark. One exception is the wood products industry (ISIC 33), for which the British pound is much more important than the dollar. In this industry, the crown is about as important as in the aggregate of Swedish exports in Grassman's study. Another exception is the basic metals (iron and steel) industry (ISIC 37), where the share of the dollar is almost twice as large as that of the crown or the German mark.

Comparing Table 5 with Table 1, we see that the dollar share of export revenue is much higher than the share of the U.S. market in Swedish exports. While 8 percent of Swedish exports are directed to

[10] See, for example, Betts and Devereux (1996). In their analysis, the degree of pricing-to-market is exogenous, while exchange-rate volatility is endogenous.

[11] In principle, a firm may quote price in one currency (the price-setting currency) and a buyer may agree to pay that price in another currency (the invoicing currency). In practice, the two usually seem the same.

the U.S., 37 percent of the non-crown export revenues are quoted in dollars. The German mark and the French franc are also somewhat more important as invoicing currencies than the German and French markets are in Swedish exports. In the wood products industry, where the crown seems unusually important in invoicing, the export shares of the U.S. and German markets are unusually small. The share of the German mark is still much higher than the German market share (14.5 percent versus 2.1 percent). Similarly, the role of the U.S. dollar is much more important in invoicing in the iron-steel industry than the share of the U.S. market (27.3 percent versus 8.7 percent).

If pricing exports in domestic currency is a way to hedge against exchange-rate risk, as argued in *European Economy* (1990), why do Swedish producers invoice their exports in foreign currencies? And why do they invoice exports to a certain country in a third country's currency (usually the U.S. dollar or the German mark)? Part of the answer is probably that the price-setting and invoicing currencies are often the same and that pricing exports in domestic currency does not mean that risk is eliminated. Suppose that nominal exchange rates are the only source of uncertainty. If export prices are set before exchange rates are realized, which is a common and reasonable assumption, domestic currency pricing means that there is no uncertainty about the export price—but also that the exported quantity is uncertain. But if the export price is fixed in the importer's currency (local-currency pricing), the exported quantity is certain while the value in domestic currency is not[12]. The resulting exposure is then the *transaction* exposure.

Investigations by the Confederation of Swedish Industries show that invoicing practices also differ very much within industries. The investigations give the (hardly surprising) impression that the U.S. dollar is somewhat more important for the Swedish industry than the simple trade weights suggest. This is also reflected in the MERM (but not the TCW) weights in Table 2 and to some extent in the regression results in Table 1.

[12] This is discussed in Giovannini (1988), Donnenfeld and Zilcha (1991) and Friberg (1996).

Table 5. Invoicing currency used in Swedish trade, 1993 (in percent)

Invoicing currency and shares of national markets in Swedish exports

			Food ISIC 31		
Currency	Imports	Exports	Currency	Market	**Country**
USD	25.5	23.4	25.5	13.9	U.S.
SEK	27.0	37.1	48.2	NA	Sweden
DM	16.7	10.7	11.7	11.1	Germany
GBP	5.7	6.0	2.8	3.8	UK
JPY	2.7	2.3	0	1.0	Japan
FRF	3.4	5.4	2.1	2.4	France
DKK	4.2	2.3	1.6	9.2	Denmark
NLG	2.7	1.3	.5	1.8	Netherlands
NKK	2.3	2.7	2.4	13.8	Norway
CHF	1.5	1.0	.7	2.2	Switzerland
ITL	NA	NA	.5	3.3	Italy
FIM	NA	NA	2.1	11.0	Finland
Other	8.3	7.8	1.9	26.6	Other
Total	**100**	**100**	**100**	**100**	**Total**

	Textiles ISIC 32		**Wood products** ISIC 33		
Currency	Currency	Market	Currency	Market	**Country**
USD	18.0	6.7	3.3	1.4	U.S.
SEK	28.5	NA	60.6	NA	Sweden
DM	13.4	10.5	14.5	2.1	Germany
GBP	6.3	4.5	11.1	19.2	UK
JPY	10.9	.6	.1	1.6	Japan
FRF	3.1	1.8	2.9	3.7	France
DKK	1.8	12.2	.9	10.5	Denmark
NLG	4.6	2.1	.5	6.9	Netherlands
NKK	4.9	29.3	3.7	10.8	Norway
CHF	.7	1.7	.2	2.0	Switzerland
ITL	1.1	1.6	.1	9.0	Italy
FIM	1.6	12.4	.4	1.3	Finland
Other	5.1	16.6	1.7	31.7	Other
Total	**100**	**100**	**100**	**100**	**Total**

Table 5. Continued ...

Invoicing currency and shares of national markets in Swedish exports

	Pulp and paper ISIC 34		**Chemical** ISIC 35		
Currency	Currency	Market	Currency	Market	**Country**
USD	9.9	2.0	14.4	5.9	U.S.
SEK	40.0	NA	27.4	NA	Sweden
DM	13.4	22.1	14.7	14.8	Germany
GBP	5.4	15.9	7.6	11.2	UK
JPY	.1	.6	6.1	2.6	Japan
FRF	5.3	7.4	6.8	6.6	France
DKK	4.4	6.4	4.0	8.0	Denmark
NLG	1.9	5.7	2.9	5.6	Netherlands
NKK	2.4	6.1	4.6	8.3	Norway
CHF	2.5	2.1	1.3	1.7	Switzerland
ITL	6.5	5.7	.9	3.3	Italy
FIM	1.1	2.2	2.4	6.4	Finland
Other	7.1	23.8	6.9	25.6	Other
Total	**100**	**100**	**100**	**100**	**Total**

	Earth and stone ISIC 36		**Iron and steel** ISIC 37		
Currency	Currency	Market	Currency	Market	**Country**
USD	12.1	5.4	27.3	8.7	U.S.
SEK	39.2	NA	15.9	NA	Sweden
DM	16.0	16.4	15.3	18.0	Germany
GBP	5.7	8.0	12.6	11.4	UK
JPY	0	3.4	2.8	2.5	Japan
FRF	2.4	2.6	3.2	5.2	France
DKK	7.5	9.9	2.7	8.4	Denmark
NLG	.8	2.4	1.5	3.5	Netherlands
NKK	11.4	16.5	2.0	6.6	Norway
CHF	.2	1.8	.8	2.3	Switzerland
ITL	1.5	2.0	6.7	6.2	Italy
FIM	1.4	6.0	3.2	6.0	Finland
Other	1.8	25.5	6.0	21.3	Other
Total	**100**	**100**	**100**	**100**	**Total**

Table 5. Continued ...

Invoicing currency and shares of national markets in Swedish exports

	Engineering ISIC 38		
Currency	Currency	Market	**Country**
USD	24.4	12.2	U.S.
SEK	38.4	NA	Sweden
DM	10.4	10.8	Germany
GBP	7.2	8.1	UK
JPY	2.5	2.5	Japan
FRF	3.2	4.9	France
DKK	1.4	4.5	Denmark
NLG	1.2	5.0	Netherlands
NKK	1.5	6.7	Norway
CHF	1.2	1.8	Switzerland
ITL	1.0	3.2	Italy
FIM	.8	4.2	Finland
Other	6.8	36.0	Other
Total	**100**	**100**	**Total**

Source: Invoicing currency, *Riksbank*, export shares, NUTEK. The names on the various industries were shortened to save space.

The investigations also verify that market and currency composition are not all that matters, but that the origin of competitors also plays a role. For example, Swedish exporters of paper pulp to the European countries compete with North American producers for market shares when it comes to softwood pulp, which is invoiced in dollars. But for hardwood pulp, the main competitors come from Spain and Portugal, and the products are invoiced in ecu[13].

2.3 The role of competition

As previously discussed, the degree of pricing-to-market and exchange-rate pass-through depends on the degree of competition (price discrimination) and the degree and type of nominal price rigidity (see Giovannini, 1988, for a more detailed discussion). There are also reasons to expect that there is a link between the degree of competition and price rigidity. Consider the case discussed in the previous section, where an exporter is to decide whether to peg his price in his own or the importer's currency. If we add competition from a third country to this set-up, assuming that the competitor's price is set in his own currency, demand for the exporter's product as a function of exchange rates is uncertain no matter what price setting currency that is chosen. The choice of invoicing and price-setting currency, and hence the correlation between nominal exchange rates and relative export prices, can be expected to be affected by the degree of competition. Friberg (1996) discusses this in more detail.

Kim (1992) summarizes the effects of market conditions on the pass-through coefficient. The analyses surveyed by Kim generally assume prices to be set under certainty, which implies that the pricing currency is irrelevant. But he notes that pricing in the importer's currency tends to lead to a lower pass-through coefficient. The degree of pass-through to the local (importer's) currency price decreases with the degree of market concentration, and increases with the extent of substitutability between goods and with the market share of foreign firms relative to local competitors. The standard reference for the last

[13] Adolfson (1996) investigates whether industry differences regarding invoicing practices matter for the degree of exchange-rate pass-through in Swedish imports. For each industry, she calculates indexes of world-market prices and effective exchange rates using both weights based on each country's share in Swedish imports and each currency's share in import payments. In most industries, similar estimates of pass-through coefficients are obtained when the two different sets of weights are used.

effect is Dornbusch (1987), who studies various modes of competition. Feenstra et al. (1996) also show (in a model of Bertrand competition in differentiated goods) that pass-through should be high for imports from a source country with a large market share.[14] The predictions of their model seem to be borne out by the empirical analysis of the automobile industry.

The links between market share and pass-through imply that one should be interested in where the competitors to Swedish firms are based. The EMU will not necessarily lead to low profit fluctuations as a function of exchange-rate fluctuations, even on intra-EMU sales. Competition from non-EMU countries is important within many industries, and profits in these industries will (probably) fluctuate as long as the exchange rate fluctuates between the euro and the rest of the world's currencies. This effect will become less important, the more countries that join the EMU and the more widespread the use of the euro becomes in international transactions.

The columns on exchange-rate index weights in Table 2 give some indications of the role of different countries as competitors to Swedish exports of goods. While the EU countries' total shares in exports and imports are around 60 percent, the competitiveness (TCW) weights constructed by IMF suggest that the EU countries' total weight is around 70 percent. But according to the MERM weights, the EU weights sum to just above 50 percent[15]. The total weight of the core countries within EU—Austria, Benelux, France, and Germany, the most likely members of a monetary union in 1999—is clearly below 50 percent. This suggests that the exact definition of the EMU area will be very important. Whether or not the UK, Denmark, and Finland join the monetary union determines whether the majority of competition comes from EMU or non-EMU members. Even the former Swedish currency basket regime (1977-1991), which stabilized a weighted average of crown exchange rates, perhaps involved less exchange-rate uncertainty than a small EMU.

Another aspect of the EMU is that it may make it harder for Swedish firms to price-to-market on the EMU markets. Empirical evidence shows that there is larger price dispersion between identical goods sold in different countries than between differentiated goods,

[14] Their model predicts that pass-through may be a non-linear function of market share (first decrease and then increase).

[15] Note that the IMF weights do not include all Swedish trading partners and competitors. To some extent the weights overestimate the role of EU countries.

which are sold in the same country (see, for example, Engel, 1993). This suggests that having a common currency might facilitate arbitrage between national markets that are in the EMU. This would tend to hurt firms but generally benefit consumers. To judge the welfare consequences of less exchange-rate uncertainty and less price discrimination, one needs to know more about the explanations for nominal rigidities. If there are some imperfections that do not disappear when nominal exchange rates are fixed, it is hard to know whether or not reduced exchange-rate volatility raises welfare.

One final argument that links competition and exchange-rate uncertainty should be mentioned. It is frequently argued that a common currency is necessary to reap the full benefits of the internal European market, that is, that the EMU is a necessary part of the *1992 program*. This is partly based on the previously discussed argument that there may be less price discrimination if exchange-rate uncertainty is reduced. But it is also the case that protectionist movements often point at exchange-rate changes as a form of *beggar-thy-neighbor* policy. While the economic logic behind this line of reasoning remains to be shown, it seems reasonable that increased exchange-rate stability could be welfare-improving if it reduces the protectionist pressures. But these pressures will probably take other expressions once exchange rates have been stabilized within the EMU. The EMU countries' stronger international position may lead to more protectionism *vis-à-vis* countries outside the EMU.

2.4 Correlations between exchange rates and other variables that affect firm profits

In most of the literature on pricing-to-market and in our discussion so far, the nominal exchange rate is assumed to be the only source of uncertainty for the firm when it solves its maximization problem. But there are good theoretical and empirical reasons to believe that unexpected changes in exchange rates are also associated with unexpected changes in the cost for labor, capital, and intermediate inputs, and in income or wealth of consumers that demand the firm's products. Imported inputs make up a large fraction of the value of production in many industries. Table 6 provides a few examples, based on input-output data from 1985. In the paper and board industry (ISIC 34112), imported inputs account for 11.8 percent of the production value, while the corresponding figure for the electronics and telecommunications industry (ISIC 3832) is 33.6 percent. So the ex-

change-rate exposure of a firm, which uses imported inputs, depends on:

- The share of imported inputs
- How much exchange-rate changes affect the prices of these inputs
- How much the firm, in its turn, passes through these cost changes

So the overall economic exposure to exchange-rate fluctuations depends on the share (and currency denomination) of imported inputs in addition to the factors discussed in Sections 2.1-2.3.

Table 6. The share of inputs in the value of production, various sectors, 1985

Electronics and telecommunications, motor vehicle, paper & board, manufacturing and repair of aircraft

	Industry			
ISIC classification	**3832**	**3843**	**34112**	**3845**
Domestic inputs, goods	22.8	33.4	52.8	24.9
Wages	32.1	22.3	14.7	35.5
Gross operating profit	9.3	14.2	14.5	7.0
Imports	33.6	28.6	11.8	30.1
Production value	**100**	**100**	**100**	**100**

Source: Statistics Sweden, Input-output tables for Sweden, 1985

Labor is an important factor of production in all industries. Because nominal wages are quite rigid, changes in product real wages will be strongly correlated with changes in exchange rates through prices of firms' products.

In Sweden, the largest changes in competitiveness and real wages during the last decades occurred in conjunction with the devaluations of the crown in 1981 and 1982 and the depreciation after the move to a flexible exchange rate in November 1992. Figure 2 shows how Swedish industries' relative unit-labor cost *vis-à-vis* foreign competitors (relative wages, in common currency, adjusted for changes in productivity) dropped about 25 percent in 1981-83 and even more in 1991-1993. That real wages are correlated with nominal exchange rates affects exchange-rate exposure.

Interest rates are also correlated with changes in exchange rates, because capital is internationally mobile. The difference between nominal interest rates on assets in domestic and foreign currency is

equal to the expected rate of depreciation of the domestic currency plus a risk premium. But nominal interest-rate differentials are not very useful for predicting exchange-rate changes. This suggests that exchange-rate forecasts are systematically wrong or that risk *premia* are very volatile. Empirical research cannot provide a definite answer regarding the relative importance of forecast errors and fluctuations in risk *premia*, because these variables are not directly observable.[16] For our purposes, it is sufficient to note that the stochastic processes for nominal exchange rates will affect exchange-rate expectations and risk *premia* and hence interest rates (see Adler and Dumas, 1983).

The strength of the correlation between exchange rates and other fundamental variables has been the subject of much empirical work; see Taylor (1995), Frankel and Rose (1995), and Obstfeld (1995) for surveys. Among other things, the findings suggest that a large part of exchange-rate fluctuations seem unrelated to fundamentals and that estimated relations are not stable out of sample. Nevertheless, exchange rates are related to fundamentals. In the very short run (within a day) exchange-rate changes are correlated with news about macroeconomic conditions. The relations are weak in monthly and quarterly data, where exchange-rate fluctuations seem to be dominated by noise but become stronger again at longer horizons. It has been easier to establish links among exchange-rate changes and fundamentals for very unstable regimes (hyperinflations) and relatively stable regimes (target zones) than for regimes with more normal exchange-rate flexibility.

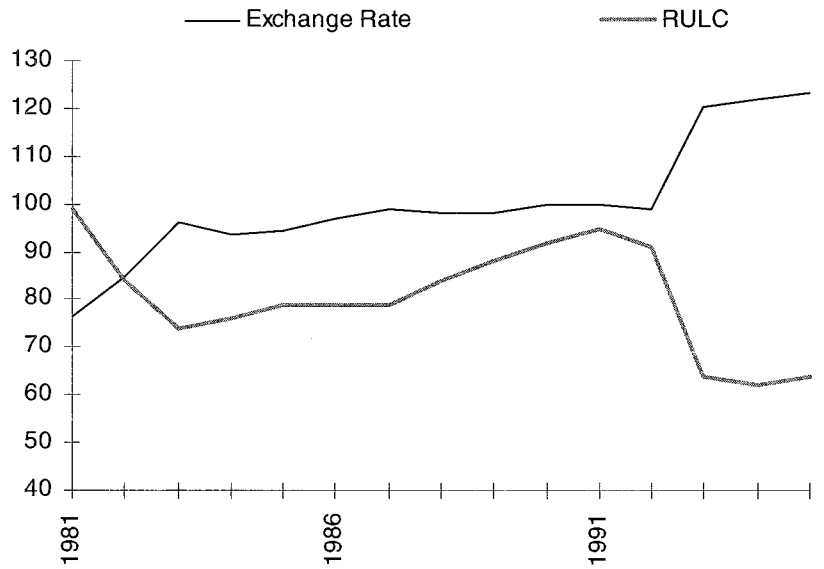
All this information about correlations between exchange rates and other variables, which affect firm profits, implies that exchange-rate fluctuations are not the only, probably not the most important, and certainly not an independent source of uncertainty for the firm.

Yet, analyses of pricing-to-market and exchange-rate pass-through are typically based on the assumption that exchange rates are the only source of uncertainty. This is not an unreasonable assumption within a static framework and if one is concerned with the volatility of profit, say, within a year. At such frequencies, nominal exchange rates are very volatile and weakly related to fundamentals. But if one is concerned with exchange-rate exposure over longer horizons, which

[16] Nessén's (1996) study on data from the Nordic countries suggests that fluctuations in risk *premia* are more important than expectational errors. Froot and Frankel (1989), who find the opposite result in U.S. data, inspired her analysis.

the next section suggests that one should be, the assumption of independent exchange-rate uncertainty is not tenable.

Figure 2. Nominal effective exchange rate and relative unit labor cost for Swedish manufacturing, 1981-1995.



Source: IMF and the Swedish Trade Union Confederation. RULC is the relative unit labor cost in manufacturing relative 14 OECD countries, measured in common currency. The effective exchange rate is IMF's TCW index.

2.5. Intertemporal aspects

Very often, a firm's behavior today affects its profits tomorrow. Inter-temporal links may arise from the demand side or the supply side. Froot and Klemperer (1989), who focus on consumers' search costs, studied the demand-side links. Baldwin and Krugman (1989) and Dixit (1989), who look at the decision to be present on an export market as an irreversible investment (in, for example, marketing and distribution networks) studied inter-temporal links on the supply side. The implications of such theories is that the pricing decision takes on an element of investment, because it affects future cash flows. This has further implications. In particular, responses to exchange-rate changes may depend on if the changes are perceived as permanent or

temporary. Furthermore, there may be *hysteresis* effects on trade—large swings in real exchange rates will have persistent effects on industry structure through entry and exit of firms on different national markets[17].

Kasa's (1992) model, where the firm has increasing adjustment costs for sales to the foreign market, has similar implications for pricing behavior. Using data on American and Canadian imports of seven commodities, he provides some empirical support for his theory of pricing-to-market. That his model does not seem to explain the pricing-to-market behavior in Swedish exports—see Alexius and Vredin (1996)—does not imply that the correlations between exchange rates and Swedish export and import prices are unaffected by inter-temporal relations. Gottfries (1991) suggests that the inter-temporal pricing approach can explain the behavior of Swedish exporters after the 1981 and 1982 devaluations. Exporters mainly raised their profit margins in Swedish crowns instead of investing in market shares. This would be the behavior predicted by the models of the Froot and Klemperer type if the real depreciation was perceived to be of short duration (that is, if exporters expected a real appreciation; see also Gottfries, 1994).

An interesting topic for further research is if export and import prices have reacted differently to the changes in the flexible crown after November 1992 than to the earlier devaluations. Changes in a floating exchange rate can be expected to be (even) less permanent than changes in a pegged rate. More generally, there is little reason to expect pricing behavior, and therefore exchange-rate exposure, to be invariant to changes in the monetary policy regime. This makes it hard to determine how the EMU will affect Swedish firms' exposure to exchange-rate uncertainty.

2.6. Why do exchange-rate fluctuations matter?

As previously noted, most theoretical and empirical analyses of how firms respond to exchange-rate fluctuations have focused on how profits are affected by exogenous (real or nominal) exchange-rate changes. Exchange-rate variability leads to profits that are sometimes higher and sometimes lower. This could be a problem if agents dis-

[17] The phenomenon of *hysterisis in trade* was given particular attention after the strong fluctuations in the U.S. dollar in the 1980's. See, for example, Baldwin and Krugman (1989).

like fluctuations in wealth (and cannot hedge against it without costs) or if exchange-rate fluctuations affect mean profits negatively. Exchange-rate fluctuations decrease mean profits if profits increase at a decreasing rate as the exchange rate becomes more favorable for the firm. If profits increase at an increasing rate as the exchange rate becomes more favorable, exchange-rate fluctuations lead to an increase in mean profits[18].

It is quite possible that exchange-rate fluctuations increase mean profits. A flexible firm can change its exports to and imports from different foreign markets in response to exchange-rate fluctuations. Total production, sales, and profits may increase when the exchange rate is favorable, while the adverse effects of an unfavorable exchange rate can be limited through cut backs. In this sense, exchange-rate variability can provide an opportunity to achieve higher mean profits than would be the case under stable exchange rates. This is also the intuition behind a well-known result from microeconomics, which states that mean profits of a price taker are higher the more the market price fluctuates (Oi, 1961). Although this is not directly applicable to our problem, because the representative firm is not a price taker, it is important to know whether profits are typically increasing or decreasing in exchange-rate fluctuations.

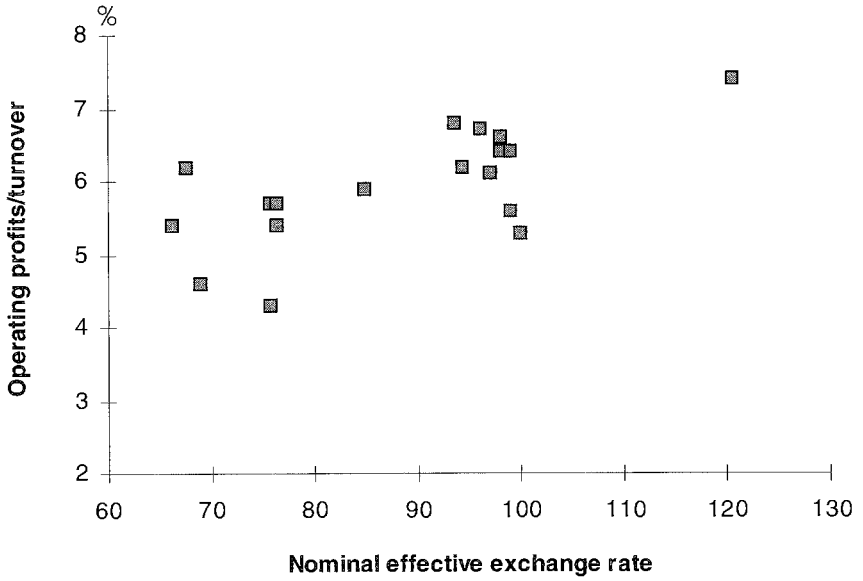
We know of no direct studies of this, although empirical studies of pricing-to-market, exchange-rate pass-through, and invoicing could provide part of the answer.

Figures 3a and 3b present the relation between operating profits, as a share of turnover, in the Swedish manufacturing industry and the real and the nominal effective exchange rates in the period 1975-1993. We note that for the Swedish manufacturing industry, as a whole, no clear pattern emerges. If anything, the relationship seems rather linear, that is, profits increase with the exchange rate in a fairly constant way.

The figures only represent aggregate relations in which even very strong patterns for individual firms may cancel. Some firms may benefit more from a depreciation than others. We must recognize that exchange rates are just one among many factors that influence profits. We can only say that no convincing theoretical or empirical evidence exists that exchange-rate instability harms risk-neutral firms.

[18] In technical terms, the question is if profits are concave or convex in the exchange rate.

Figure 3a. Operating profits/turnover in Swedish manufacturing and nominal exchange rate, 1975-1993

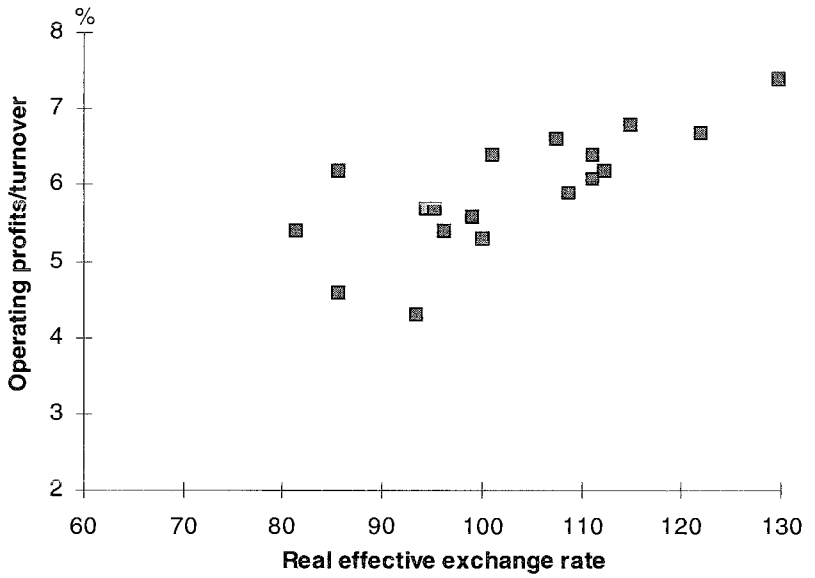


Source: IMF and Statistics Sweden. The figure shows operating profits/turnover at nominal effective exchange rates (TCW) 1975-1993.

International evidence on how firms manage exchange-rate exposure suggests that firms act as if they are risk averse; see Belk and Glaum (1990) for a study of 17 British companies and Torniainen (1992) for a survey[19]. Forward contracts seem to be the most common way of hedging exchange-rate risk. The focus is put on hedging of transaction exposure, that is, hedging of known net flows in different currencies, while there is limited concern with hedging of economic exposure. But different macroeconomic indicators are often given attention when strategic decisions are discussed, according to Torniainen (1992). These findings raise the questions, first, why firms hedge at all, and, second, why hedging is limited to transaction exposure.

[19] We know of no comprehensive study on how Swedish firms deal with exchange-rate uncertainty, although some studies of individual firms were done, for example, Hegbart and Jutterström's (1995) study of *Cloetta Choklad och Konfektyr*. Their results, and our own discussions with STORA, seem to be in line with the international evidence cited by Torniainen (1992).

Figure 3b. Operating profits/turnover in Swedish manufacturing and real exchange rate, 1975-1993



Source: IMF and Statistics Sweden. The figure shows operating profits/turnover at real effective exchange rates (TCW) 1975-1993.

In a frictionless world with complete markets, hedging cannot add value to the firm, because shareholders can equally well choose their own preferred risk profile given the exposure of different firms. In such a frictionless world, the choice of exchange-rate regime would hardly be interesting either. Dufey and Srinivasalu (1983) and Smith and Stulz (1985) point at some real-world imperfections, which may explain why firms try to limit their exposure to exchange-rate uncertainty. Reasons could be tax schedules (taxes are generally not negative when profits are negative) and credit constraints, which imply that exchange-rate fluctuations can lead to financial distress and bankruptcy. Another reason why hedging could add value to the firm is if the company has better information about its exposure to exchange-rate risk than individual investors do, or can create hedges at lower transaction costs[20]. An argument presented in financial text-

[20] There seem to be informational asymmetries between firms and investors. The Association of Swedish Financial Analysts (*Sveriges Finansanalytikers Förening 1994*) note in their recommendations that the information given by firms about ex-

books (for example, Brealey and Myers, 1991, or Sercu and Uppal, 1995) is that hedging may make it easier to evaluate the performance of various exchange-rate exposed divisions within a firm and help managers focus on the production activities of their business.

The instruments on the financial markets that can help firms to hedge their positions are mostly relevant for hedging of known positions (see Torniainen, 1992, ch.2). If a firm knows that it has a certain revenue accruing in German marks in six months, there is little problem in hedging this on the financial markets. The cost of doing this cannot be considered unreasonably large (that is, the market seems efficient) and procedures are straightforward. This involves hedging of transaction exposure or what Dumas (1994) calls *short-term hedging*. Because there are reasons to expect exchange rates to be affected by fundamentals with a lag (see Section 2.4), and because the firm has good reasons to look at its profit maximization problem in an inter-temporal perspective (see Section 2.5), a short-term—let alone static—perspective on exchange-rate exposure seems inappropriate. But as Dumas (1994) emphasizes, it is only within a static framework that the argument that firms can easily hedge against exchange-rate uncertainty is correct.

While *long-term hedging* may be warranted, it may also be terribly complicated, because the hedging plan must be continuously revised as the expectations about long-term conditions are modified, and because one needs rather detailed information about such economic mechanisms behind exchange-rate exposure that we previously discussed. Given transaction and information costs, it may thus be optimal for a firm only to consider short-term hedging. Dumas (1994) notes that managers are reluctant to have forward contracts that will not be matched by any real flows: "Managers—perhaps reacting to a no-regret condition—are loath to initiate a hedge, which might have to be reversed later".

It seems reasonable to assume that a larger firm will generally be able to handle exchange-rate uncertainty in a better way than small firms. The existence of specialized finance departments at large firms should mean that they have a better capacity to handle adverse effects of exchange-rate fluctuations. Large firms are also less likely to suffer from credit constraints and other real-world deviations from the frictionless (Modigliani-Miller) economy. So it is interesting to

change-rate exposure is often incomplete and that methods of reporting vary greatly between firms.

note the company composition of Swedish exports and imports in Table 7. A very large share of Swedish exports and imports seem to be accounted for by companies that can be expected to be able to handle complicated matters of international finance well. But the argument cuts both ways—the limited number of small firms trading internationally may reflect that there are significant barriers for smaller firms that want to engage in international trade. Variable exchange rates may be one of these.

Table 7. The largest corporations' shares of Swedish exports and imports of manufactured goods, 1994

	Share of exports	Share of imports
5 largest	26.3	17.1
10 largest	37.5	23.0
20 largest	50.9	31.2
100 largest	71.3	49.9

Source: Statistics Sweden

In conclusion, unexpected changes in exchange rates affect firms in many different ways: through the prices of their products, in relation to competing products and costs of inputs, and through consumers' demand. But the relations are complicated functions of market structures, nominal rigidities, and invoicing (and price-setting) practices. Theoretically, if capital markets worked perfectly, firms should not have to care about their exchange-rate exposure. A higher degree of exchange-rate uncertainty may just as well be beneficial as damaging for a firm, and investors could diversify through their ownership of shares in firms with different exchange-rate exposures. But in practice, firms generally act as if they would want to lower their exposure to exchange-rate uncertainty. Various imperfections (information and transaction costs) seem to give firms reasons to hedge their operations against exchange-rate uncertainty.

According to *European Economy* (1990, p 73), "only a fraction of total trade is hedged through forward operations and the available data on international portfolio diversification suggests that exchange-rate risk is not diversified by shareholders". But the discussion in Sections 2.1-2.5 shows that measuring and identifying the sources of economic exposure to exchange-rate uncertainty is by no means a simple exercise. The exposure to be hedged depends in a complicated way on the competitive situation of the firm—its competitors' price-

setting behavior and exchange-rate pass-through on its outputs and inputs—and other sources of uncertainty are not independent of exchange-rate uncertainty. So the actual degree of hedging and diversification is hard to measure for an outside observer. For the same reasons, exchange-rate hedging is also difficult for the firm. This seems to be an argument to reduce exchange-rate uncertainty through macroeconomic policy, if possible.

3. Exchange-rate uncertainty and monetary policy[21]

Section 2.4 argued that exchange-rate fluctuations are not an independent source of uncertainty for the firm. This argument, in itself, should hardly be surprising or controversial. Nominal exchange rates are relative prices of different national monies. As such, they should be affected by monetary policy and correlated with other variables that are affected by monetary policy. Monetary policy has immediate effects on exchange rates and short-run nominal interest rates, partly through expectations about future policy. Monetary policy affects inflation with a lag. Nominal rigidities imply that these effects on nominal variables, in turn, are transmitted to real interest rates and real wages, at least temporarily. That monetary policy can affect aggregate output and employment in the short run is not very controversial either.

Nevertheless, these observations have strong implications for the issue of whether the EMU will lead to microeconomic benefits from lower exchange-rate uncertainty. As Adler and Dumas (1983, p. 962) noted:

> ... the question of the relevance of exchange-rate risk becomes ill-formulated because exchange rates and price levels are endogenous. The issue then becomes that of the welfare impact or non-neutrality of monetary policies in a multi-currency world. It is a very complex one, for which few statements remain valid outside a particular context or model formulation.

[21] In this section, our discussion has a macroeconomic perspective. The issues involved are essential for the question of whether the EMU leads to lower exchange-rate uncertainty. But the discussion is brief because the topic is covered in other reports to the Swedish Government Commission on the EMU.

The answer one gives to the ill-formulated question of whether or not the EMU will beneficially lower exchange-rate uncertainty seems determined by which of two extreme views on exchange-rate fluctuations one most easily accepts. Friedman (1953) expressed the view that flexible exchange rates constitute no additional source of risk, and that increased exchange-rate flexibility "may not change the extent of uncertainty at all and, indeed, may even decrease uncertainty". But there is the idea that exogenous, possibly self-fulfilling and therefore destabilizing, expectations govern exchange-rate fluctuations. Friedman dismissed this idea. But it has recently become very popular, especially after the European currency crises in 1992 and 1993.

On a theoretical level, a flexible exchange rate clearly has potential to act as an automatic stabilizer when the economy is subject to real shocks. But a fixed exchange rate might be stabilizing when there are financial disturbances, for example, to money demand. These arguments can be found in standard textbooks in international economics, for example, Krugman and Obstfeld (1994). When nominal prices are sticky, the nominal exchange rate provides a link between the economy's real and financial sectors. A flexible exchange rate may beneficially transmit real shocks to the financial sector and lead to movements in interest rates, which dampen the effects on production. But when disturbances occur on the financial markets, it is beneficial if the link is cut by a fixed exchange rate.

Today, standard textbooks also emphasize that the exchange rate is an asset price, which is influenced by expectations about future realizations of the exchange rate and other fundamentals. Recent research has provided examples of how expectations may become self-fulfilling and destabilizing under certain conditions. But these examples do not show that destabilizing speculation is unavoidable, because the outcome depends on what is assumed about monetary policy (see, for example, Ljungqvist, 1994, and Obstfeld, 1996).

As noted in Section 2.4, changes in nominal exchange rates are not generally unrelated to fundamentals. Some empirical findings still support the speculations hypothesis. First, short-run (monthly or quarterly) changes in nominal exchange rates seem mainly driven by noise. Second, macroeconomic variables are generally not more or less stable under fixed than flexible exchange-rate regimes. The exception is the real exchange rate, which is clearly more volatile when the nominal exchange rate is flexible, because price levels are rigid. But many, not mutually exclusive, interpretations of these observa-

tions are possible. It is certainly conceivable that a monetary policy aimed at a pegged exchange rate can stabilize nominal and real exchange rates, through stabilizing expectations (if the policy is credible), and through stabilizing fundamentals (for example, by making fiscal and monetary policy more stable). It is also possible that flexible exchange rates move around for no obvious reason. But the empirical record may also reflect that changes in monetary policy regimes are endogenous. Fixed exchange rates may have been abandoned when real disturbances have become more severe. And macroeconomic stability may have been preserved through nominal (and real) exchange-rate flexibility. The former interpretations seem to lie behind the argument for the EMU, while the latter view is consistent with Friedman's.

Unfortunately, historical relations between macroeconomic fluctuations and exchange-rate policies may be of limited use when it comes to predicting the effects of the EMU. Most of our experience comes from regimes characterized by more or less exchange-rate flexibility. A European monetary union is an experiment without precedent. What the discussion in this section makes clear is that the nature of exchange-rate uncertainty is very much determined by monetary policy. This suggests that whether the EMU leads to more or less uncertainty depends on specific details of the ECB's policy. But further discussion of this topic is outside the scope of this paper.

4. Other microeconomic benefits of the EMU

Of the 16 mechanisms through which the EMU is expected to have its strongest effects, according to *European Economy* (1990, Section 1.3), three are related to exchange-rate variability and uncertainty:

- A reduction in nominal exchange-rate uncertainty between the EMU countries is expected to increase the efficiency and volume of investment.
- If the EMU leads to more investment, this is expected to create higher growth, at least in the medium run.
- The substitution of a single Community currency for national currencies is expected to lead to an advantageous reduction regarding terms-of-trade variability.

This paper primarily deals with the sources of exchange-rate uncertainty and the effects on firm profits. These mechanisms are impor-

tant to understand before the effects on investment, growth, terms of trade, and overall economic efficiency can be evaluated. This section briefly reviews some of the arguments about such effects.

Theory tells us that the relationship between uncertainty and investment can be either positive or negative. The effects depend on investors' risk aversion, whether investments are irreversible and on the specific form of the profit function; see for example Caballero (1991)[22]. To empirically determine the direction of the effects has also proven hard, and the issue is far from settled (see Leahy and Whited, 1995, for a survey). Moving from the question of uncertainty in general to exchange-rate uncertainty specifically, one does not find very much empirical work. Goldberg (1993) and Campa and Goldberg (1995a, b) studied how exchange-rate movements affect investment in different industries. Campa and Goldberg (1995a) find weak, generally not significant evidence of a depressing effect from exchange-rate uncertainty (variability) on investment.

Exchange-rate uncertainty may influence investment if firms hedge against exchange-rate fluctuations by diversifying internationally, investing abroad. The results of Goldberg and Kolstad (1994) point to the existence of such an effect on bilateral foreign direct-investment patterns among the U.S. and Canada, Japan and the UK. Aizenmann (1994) offers a theoretical analysis. But Adler and Dumas (1983, sec. VII) argue that other motives, such as purchases of control, probably are much more important explanations for foreign direct investments and multinational companies than hedging.

How growth would be affected by the EMU integrates very many issues, not the least the previously discussed effects on investment. We noted that empirical evidence of positive effects from investment of limiting exchange-rate variability are weak or inconclusive. Given the problem of establishing a clear theoretical link between investment and (long-run) growth, it should come as no surprise that there is even less evidence of growth effects from lower exchange-rate volatility. Regarding the advantageous effects of exchange-rate stability on the variability of terms of trade, the situation is somewhat more clear. As previously noted, real exchange rates are more volatile when nominal exchange rates are more flexible. There is also strong evidence that the export price of a traded good often differs between different importing markets and that the differences are associated

[22] Dixit and Pindyck (1994) provide a thorough treatment of investment under uncertainty.

with changes in nominal exchange rates (see Section 2.1). We suspect that these pieces of evidence support the conjecture that terms of trade are more stable when exchange rates are fixed. But it is not clear that this is advantageous. Because the exchange rate may function as an automatic stabilizer, increased nominal exchange-rate flexibility may be associated with increased stability in production even if (or rather, because) relative prices become more volatile.

Most empirical studies find no significant or only weak, negative relations between trade levels and exchange-rate variability. Edison and Melvin (1990) provide a comprehensive survey. A calibration exercise by Gagnon (1993) also suggests that there is little potential for exchange-rate fluctuations (of realistic magnitudes) to depress trade significantly. But note that there are studies, for example, by De Grauwe and de Bellefroid (1989) and Arize (1995), which point in the opposite direction and that the EMU is essentially a project without precedent. A monetary union may lead to more competition and more trade through mechanisms that we have not observed before (but see Section 2.3 for related arguments).

While the evidence of positive effects from exchange-rate stability on trade, investment, and growth seems rather weak, a simple thought experiment suggests that some stability, at least within small enough currency areas, is desired. Suppose that every Swedish city had its own currency. It seems reasonable that creating a larger currency area with fixed exchange rates would stimulate trade, investment, and growth, not only through reduced uncertainty about trade conditions but also through lower conversion costs. Indeed, the most obvious gain from creating a common currency is sometimes argued to be the elimination of transaction costs. The direct costs of exchanging currencies would go down. Also, some resources that firms devote to the management of foreign exchange could be freed. Of course cost would remain for transactions in any currency that does not belong to the EMU. In *European Economy* (1990), it is estimated that the exchange transaction costs range from 0.1 percent to 0.9 percent of GDP (for the EU members at the time). The smaller the currency and the less sophisticated the country's financial markets are, the higher the transaction cost will be. Wihlborg (1995) makes a simple calculation suggesting that banks' revenues from currency transactions represent about 0.1 percent of Swedish GDP. The gains do not seem to be large enough, on average, to play a critical role when evaluating the overall effects on the Swedish economy in join-

ing the EMU. But the gains may be very unequally distributed. Small firms are likely to gain much more than large firms.

An argument, which we have not explicitly discussed, is that the EMU would be beneficial if lower exchange-rate uncertainty would create lower real interest rates, through lower risk *premia*. But the microeconomic approach in this paper deals with fundamental mechanisms behind such a potential link between monetary unification and interest rates. If risk *premia* go down, this must be because firms' (and households') perceived uncertainty goes down. We noted that the effects of the EMU in this regard are hard to predict.

5. Conclusions

The purpose of this paper is to review the argument that the EMU leads to benefits from lower exchange-rate uncertainty. We believe that our difficulty with providing a clear conclusion has more to do with the complexity of the problem as such, rather than our incompetence. Krugman (1993, p 22) gives one testament to the difficulty of the task:

> Equally conceivably, the hidden microeconomic benefits of a common currency are so overwhelming in the U.S. that Europe should follow suit even though the macroeconomic costs would be much greater. We just don't know. It is not that there are conflicts among the estimates. There are simply no estimates at all. At this point you may ask me how I propose to remedy this gap. The short answer is that I don't know.

Nevertheless, we must make a judgment about whether or not the larger degree of exchange-rate stability that the EMU can offer is likely to be beneficial. Our review leads us to conclude that these arguments speak against the idea that the EMU will be beneficial:

- Firms can adjust to exchange-rate changes through, for example, pricing and invoicing policies. Given that firms can price-to-market and change their price setting policies in response to exchange-rate fluctuations, it is not clear that they benefit from lower exchange-rate volatility.
- Exchange-rate uncertainty is not independent of other sources of macroeconomic uncertainty. In response to shocks to the real economy, flexible exchange-rate changes may work as automatic

stabilizers. Fixed exchange rates may lead to a higher degree of macroeconomic uncertainty.

- The empirical record does not suggest that there are any strong links between exchange-rate uncertainty on the one hand and such phenomena as investments, trade, and growth on the other.

But these arguments seem to speak for the EMU:

- Given the complicated nature of the relations between exchange-rate fluctuations and firm profits, there are reasons to expect that it is hard for firms to hedge against exchange-rate uncertainty (and macroeconomic uncertainty in general). Case studies and surveys also show that firms do not hedge perfectly. Market imperfections may constitute an argument for a government insurance policy through macroeconomic policy.
- The EMU could lower uncertainty if it implies that macroeconomic policy becomes more predictable, for example, because of more coordination between countries.
- Changes in fixed but adjustable exchange rates, such as the sharp drops in the value of the Swedish crown in 1981-1982 and 1992-1993, have been associated with large changes in relative prices of goods and production factors and hence with large swings in profit margins of exporters and importers. Monetary policies may have amplified the volatility in firms' profits compared to what it would have been under either a completely fixed or a fully flexible exchange rate. If Sweden is faced with a choice between the EMU and a unilaterally pegged exchange rate, then the EMU may be preferable.
- EMU may lead to a higher degree of market integration, for example, by lowering protectionist pressures stimulated by exchange-rate fluctuations.

In addition, resources are gained if the EMU leads to lower transaction costs. But this is not directly related to exchange-rate uncertainty, and the argument was not discussed in detail in this paper.

We do not think that it is possible to decide whether the arguments for the EMU are stronger than the arguments against. Three circumstances are particularly noteworthy. First, whether or not the EMU will lower exchange-rate uncertainty very much depends on the countries that will participate. For Sweden, the dependence on the U.S. dollar is not necessarily smaller than the dependence on the

German mark. Whether the dependence on countries outside the EMU is larger than on countries inside the EMU, depends, for example, on whether the UK, Denmark, and Finland are outside or inside. Second, the exposure to exchange-rate fluctuations (*vis-à- vis* different foreign currencies) differs between firms and industries. The EMU may benefit some and harm others. Because we do not have a clear picture of firms' overall economic—as opposed to transaction—exposure to exchange-rate fluctuations, an assessment of the total effect is impossible to make. Third, European monetary unification is a large structural change, the consequences of which are hard to predict from historical evidence of other monetary policy regimes. The estimated coefficients that describe, for example, the degrees of exchange-rate exposure, pricing-to-market and exchange-rate pass-through are not deep parameters, which are invariant to monetary policy.

We conclude with a comment on this quotation from "One market, one money" (*European Economy*, 1990, p. 63):

> The gains from the suppression of exchange-rate variability in terms of increased trade and capital movements are difficult to measure because firms can in many cases insure against this risk using sophisticated foreign-exchange market operations.

Our review leads us to conclude that yes, the gains are hard to measure. But *not* because firms can insure themselves using sophisticated operations. Quite the contrary, because exchange-rate uncertainty is such a complex phenomenon and so hard to measure, firms do not hedge most of their (long-term) exposure. That firms cannot hedge seems to be an important argument (perhaps the important argument) for a monetary policy that stabilizes exchange rates.

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