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EXCHANGE RATE VOLATILITY AND TRADE

A Survey

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Abstract

This paper provides an extensive survey of the literature on exchange rate volatility and trade, examining both the theory that underlies the work in this area and the results of empirical studies published since 1988.

Despite the widespread view that an increase in volatility will reduce the level of trade, this review reveals that the effects of volatility are ambiguous. There is no real consensus on either the direction or the size of the exchange rate volatility - trade level relationship. Overall, a larger number of studies find that volatility tends to reduce the level of trade, but when the effect is measured, it is found to be relatively small.

Several reasons can explain this tenuous relationship: (i) even for risk-averse businesses, an increase in risk does not necessarily lead to a reduction in the risky activity, (ii) the availability of hedging techniques makes it possible for traders to avoid most of exchange risk at little cost, (iii) exchange rate volatility may actually offset some other forms of business risk, and (iv) exchange rate volatility can create profitable trading and investment opportunities.

Résumé

La présente étude offre un panorama des recherches faites sur les liens qui existent entre la volatilité des taux de change et les échanges internationaux. L'auteure y examine d'une part les fondements théoriques des travaux effectués dans ce domaine et, d'autre part, les résultats des études empiriques publiées depuis 1988.

Même si la perception générale est que l'accroissement de la volatilité des taux de change abaisse le niveau des échanges commerciaux, la présente étude montre que les effets de la volatilité sont ambigus. Un véritable consensus ne se dégage ni sur le sens ni sur l'importance des liens entre la volatilité des taux de change et les échanges commerciaux. Dans l'ensemble, parmi les études consultées, la majorité arrivent à la conclusion que la volatilité du cours de la monnaie tend à abaisser le niveau des échanges, mais lorsque l'effet est mesuré, on constate qu'il est relativement mineur.

La faiblesse de ce lien peut s'expliquer de plusieurs façons : i) un accroissement du risque n'entraîne pas forcément une diminution des activités à risque même pour les entreprises qui ont une aversion pour le risque; ii) les techniques de couverture permettent aux entreprises de réduire considérablement, à peu de frais, le risque de change; iii) la volatilité des taux de change peut en fait compenser d'autres types de risque; et iv) la volatilité des taux de change peut créer des conditions propices à des échanges commerciaux et à des investissements rentables.

1 Introduction

The consequences of exchange rate volatility on trade have long been at the centre of the debate on the optimality of alternative exchange rate regimes.[1] Proponents of fixed rates argue that since the advent of the floating regime, exchange rates have been subject to excessive volatility and deviations from equilibrium values have persisted over sustained periods of time. In their view, exchange rate volatility deters industries from engaging in international trade and compromises progress in trade negotiations. In contrast, proponents of flexible rates argue that exchange rates are mainly driven by fundamentals, and that changes in fundamentals would require similar, but more abrupt, movements in fixed parities. Therefore, a system of fixed rates would not reduce unanticipated volatility. Moreover, greater exchange rate flexibility facilitates balance of payments adjustment in response to external shocks and, hence, reduces the need to raise protective tariff barriers or to impose capital controls to achieve equilibrium.

Exchange rate volatility can affect trade directly, through uncertainty and adjustment costs, and indirectly, through its effect on the structure of output and investment and on government policy. In this paper, we emphasize the direct effects, although admittedly, the indirect effects may have an even greater role to play. It is also worth mentioning that the literature is largely based on a partial-equilibrium approach that precludes inferences about welfare. As a consequence, the empirical findings cannot be used to conclude that one exchange rate system is necessarily preferable to another, as other factors would have to be taken into consideration.

The theory is reviewed in Section 2. The analysis is based on the assumption that a firm's willingness to engage in international trade depends on its assessment of its long-term profitability. In the simplest trade models, higher exchange risk is expected to increase the uncertainty of profits of export sales in foreign currency and, hence, lead risk-averse exporters to reduce their supply of exports, an effect that increases with the degree of risk aversion. Clear-cut results, however, require restrictive assumptions of the underlying utility functions. The effect of volatility also depends on the degree of risk exposure. The latter is a function of the currency denomination of contracts, hedging possibilities, the presence of imported inputs, and other factors. There are two reasons why the firm may not be able to completely eliminate unforeseen variations in revenues expressed in domestic currencies. Forward markets may not be fully developed or the firm may be uncertain as to the amount of foreign exchange that it may want to cover.[2] Hedging should be relatively simple and inexpensive for a trading firm with short lags between order and delivery. It may, however, prove more difficult and costly for a manufacturing firm with a longer-term planning horizon.

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1. See Fenton and Murray (1993) for a review of the literature on optimum currency areas.
2. Forward markets do not represent the only option available to the firm. Large corporations have adopted various other strategies to cope with exchange rate risk.

The simple models apply to undiversified firms whose profitability is unambiguously related to the movements in one exchange rate. It is assumed that uncertainty about the future level of the exchange rate represents the only source of risk to the firm and that production and trade decisions have to be made before the uncertainty gets resolved. Inventories are ignored and firms cannot allocate their sales between domestic and export markets. For a diversified firm in a multicountry model, there is no unambiguous relationship between exchange rate variability and the supply of traded goods. One must take into account the ability of the firm to reduce its exposure to exchange rate risk and the way movements in exchange rates are related to those in other economic variables. Exchange risk is highly diversifiable and may be relatively minor compared to the benefits of trade. Recent models focus on the profit opportunities created by greater exchange rate uncertainty. When the exchange rate becomes more variable, the probability of making large profits increases. Exporting can be seen as an "option" that is exercised in favourable conditions. The value of the option increases when the variability of the exchange rate increases. This positive effect on the utility of the firm has to be weighed against the negative effects created by greater uncertainty for the risk-averse firm.

The effect of exchange rate volatility on trade prices depends on the degree of competition and the relative degree of risk aversion and risk exposure of importers and exporters. If exporters bear the risk, prices will increase. If importers do, prices may fall. Invoicing in the home currency does not eliminate the exporter's risk, as quantity demanded becomes uncertain. An increase in exchange rate volatility may also have a secondary effect on trade prices, reducing the pass-through of changes in competitiveness.

Numerous attempts have been made to quantify the effects of exchange rate volatility on trade. In Section 3, we briefly review the conclusions of previous surveys of the literature and summarize the empirical results published since 1988. There is no unique way of measuring exchange risk, and the criteria used for selecting a particular measure are discussed at the beginning of the section. Indeed, in several recent studies, the emphasis is placed on obtaining an appropriate proxy for risk. No consensus has emerged, however. Some studies use short-term volatility measures based on standard deviations of the exchange rate, others use longer-term proxies for uncertainty and misalignment. GARCH models are estimated in a few cases. More attention has also been devoted to estimation techniques in the recent work.

Most studies use time series. Even though theory indicates that the effect of exchange rate volatility depends on the nature of the firm, the work is largely based on aggregate data. Evidence on the effect of exchange rate volatility on aggregate export volumes for industrial countries is mixed. The only recent studies that focus on Canadian trade flows are those of Bélanger et al (1988, 1992). They estimate regressions for Canada-U.S. trade flows for five broad sectors and conclude, in their latest paper, that they cannot find any significant effects of exchange rate risk.

To summarize, our review of the most recent theoretical and empirical work does not allow one to draw any strong conclusion about the relationship between exchange rate volatility and trade. Overall, a larger number of studies find that exchange rate volatility tends to reduce the level of trade, but when measured, the effect is relatively small.

2 Theory

The analysis of exchange rate volatility effects on trade is based on the producer theory of the firm under uncertainty. In this section, we first describe the early international trade models and then review more recent approaches.

2.1 Basic uncertainty trade models

The traditional models examine the behaviour of undiversified firms, whose profitability is directly and unambiguously related to the movement in one bilateral exchange rate. The variability of that exchange rate is assumed to measure the risk to the firm in conducting trade.

An early example is provided by Clark (1973), who develops a model of an exporting firm that produces under perfect competition a homogeneous commodity that is sold entirely abroad. In the simplest version of the model, the firm uses no imported inputs and the price of the exported good in foreign currency is an exogenous variable. The firm is paid in foreign currency and hedging is limited. Output is constant over the planning horizon. Uncertainty about future exchange rates translates into uncertainty on future export receipts in domestic currency. The firm must decide on a level of exports that takes this uncertainty into account. It maximizes the expected value of utility, which is assumed to be a quadratic function of profits expressed in the home currency ($U(\pi) = a\pi + b\pi^2$). With risk aversion ($b < 0$), the first-order condition requires that marginal revenue exceed marginal cost. The firm must be compensated for the exchange risk it bears. The supply curve shifts leftwards and the volume of production and trade is reduced. A risk-averse firm wants to reduce its risk exposure. By reducing sales, both expected profits and the variance of profits decline, but expected utility increases. If inputs were imported, the contraction in the supply of exports would be smaller. The variance in profits would not rise in proportion to the increase in the variance of the exchange rate. Only in the extreme case of perfect correlation between revenues and costs in domestic currency terms would greater variability have no effect on the variance of profits.

Baron (1976b) relaxes the assumption of perfect competition to analyse the effect of exchange rate volatility on prices, highlighting the role of invoicing currency. When the exporter invoices in foreign currency, as in the preceding example, he or she faces price risk. The quantity demanded is known, since prices do not change during the contract period, but the revenue stream and profits are uncertain. When invoicing in the home currency, the exporter faces quantity risk.

Quantity demanded is uncertain because the price facing the buyer is uncertain. In addition to revenues, costs of production become uncertain.[3] In both cases, the risk-averse firm wants to reduce its risk exposure but the price effect will differ. If the firm invoices in foreign currency, an increase in risk results in a price increase (the supply curve shifts up). The higher price reduces expected profits (demand is elastic at the optimal price) but increases expected utility. If the firm invoices in domestic currency, its response will depend on the properties of the demand function in the destination market. If the function is linear, Baron shows that prices decline. The price decline leads to increased demand, but the price-cost margin diminishes, which reduces the expectation and variance of profits.

In their seminal paper, Hooper and Kohlhagen (1978) also examine the effects of exchange rate volatility in a bilateral framework, where the only source of uncertainty is the nominal exchange rate. They first derive demand and supply functions for individual firms and then aggregate them to obtain a reduced-form equation for the market equilibrium price and quantity. The key parameters in their model are the currency denomination of the contracts, the proportion of forward hedging and the relative degrees of exporters' and importers' risk aversion. A fraction of the contracts is assumed to be priced in foreign currency and a fraction of transactions is hedged in the forward market. These parameters are exogenous and determine the degree of risk exposure. Exchange rate variability affects only the portion of profits that is not hedged.

The demand for imports is a derived demand schedule, with imports being treated as inputs used in fixed proportion for production of goods sold entirely in the domestic market. The importer, although assumed to be a price-taker in the import market, faces a known demand curve for his product. An increase in exchange rate volatility increases the variance of profits and shifts the demand curve downwards, leading to a decline in quantity and prices. The size of the response increases with the magnitude of the price elasticity of the demand curve, the degree of risk aversion, and the degree of exposure to risk. Export supply is modelled in a monopolistic market framework. As in Clark, exporters are assumed to sell all their output in the foreign market. An increase in exchange risk leads to a contraction of the supply curve. Quantities are reduced and prices increase. The reduced-form of the model shows a clear negative relationship between exchange rate variability and the volume of trade. The price effect, however, is ambiguous. An increase in exchange risk will lead to a reduction in trade prices if importers bear the risk. The price will fall as import demand falls. However, if exporters bear the risk, the price will rise as exporters will charge an increasingly higher risk premium.

3. Note that if the exporter uses imported inputs in production, costs are uncertain in both cases.

2.2 Extensions

Several assumptions are critical in obtaining the result that an increase in exchange rate volatility necessarily reduces the level of trade. Risk aversion is assumed. Perfect hedging against exchange risk is impossible or costly. Exchange rate variability represents the only source of uncertainty to the firm. The firm cannot adjust its production and exports once the uncertainty gets resolved and, therefore, changes in the exchange rate do not create any opportunities to make profits. In this section, we examine the implications of relaxing these assumptions.

2.2.1 Risk aversion

• *The assumption of risk aversion is not sufficient to conclude that exchange rate volatility reduces the level of trade. The result depends on the properties of the utility function.*

In the above models, the negative link between exchange rate volatility and trade increases with the degree of risk aversion. If agents are risk neutral, exchange rate uncertainty does not affect the firm's decision. However, even in the case of risk aversion, theory does not allow one to conclude that an increase in risk necessarily leads to a reduction in the risky activity. An increase in risk has both a substitution and an income effect, which work in opposite directions. It lowers the attractiveness of the risky activity, leading agents to reduce that activity (substitution effect). However, it also lowers the expected total utility of the activity, and to compensate for that drop, additional resources might be devoted to the activity (income effect).

De Grauwe (1988) derives a model of a firm operating under perfectly competitive conditions that can allocate its production between domestic and foreign markets. The effect of an increase in exchange risk (a mean-preserving spread) will depend on the convexity properties of the utility function, which in turn depends on the degree of risk aversion. If agents are sufficiently risk averse, an increase in risk raises the expected marginal utility of export revenue and induces them to increase their export activity. Very risk-averse individuals worry about the worst possible outcome, and therefore, when risk increases, they may export more to avoid the possibility of a drastic decline in their revenues. As De Grauwe (1988, 67) puts it, "although exporters are universally made unhappy by the volatility of exchange rates,... some may decide that they will be better off by exporting more." De Grauwe emphasizes that the results obtained by Hooper and Kohlhagen follow from the restriction that is imposed on the utility function. Constant absolute risk aversion is assumed, which eliminates the income effect of changes in risk. [4]

4. Dellas and Zilberfarb (1993) also show that the effect of volatility depends on the risk aversion parameter. If the utility function is of the constant relative risk aversion family, an increase in risk decreases the volume of trade only if the coefficient of risk aversion is less than unity.

One can note finally that Giovannini (1988) shows that even with risk neutrality, exchange rate volatility can affect the export pricing decision of a firm. We will return to this point in Section 2.3.

2.2.2 Hedging opportunities

• *The availability of forward cover reduces the effect of exchange rate volatility.*

There might be several reasons why firms cannot, or choose not, to completely eliminate exchange risk through forward contracts.[5] For developing countries, forward exchange markets may simply not exist. For industrial countries, short-term exchange risk can probably be easily hedged in forward exchange markets. It is well known that large corporations have adopted various strategies to cope with exchange risk. Managing futures portfolios will nonetheless entail a cost. Hedging risk over a longer horizon is much more difficult, as forward contracts are typically offered for relatively short horizons and exchange needs cannot be known with precision. Hedging possibilities will therefore vary, depending on the nature of a firm. For a trading firm with short lags between order and delivery, securing against risk may be relatively simple and inexpensive. However, for a manufacturing firm that enters into sales contracts applicable to long periods, hedging may prove to be more difficult and costly.

Several studies have examined how the presence of a forward exchange market affects the link between exchange rate volatility and trade. The earlier international trade models (for example, Ethier 1973 and Baron 1976a) conclude that with perfect forward markets and no other sources of uncertainty but the exchange rate, the volume of trade is unaffected by exchange rate volatility. The level of output only depends on the forward rate, while exchange rate volatility affects the hedging decision. More recently, Viaene and de Vries (1987, 1992) have reexamined this question. In their latter study, they emphasize that even in the presence of a forward market, spot exchange rate volatility can affect indirectly the volume of trade through its effect on the forward rate. They show that an increase in exchange rate volatility has opposite effects on exports and imports because exporters and importers are on opposite sides of the forward market. The sign of the trade balance (or the net foreign currency exposure in the case of partial foreign currency invoicing) and the aggregate measure of risk aversion determine which flow benefits. This follows from the fact that the equilibrium forward rate is determined by the total supply and demand for forward foreign currency. Exports lose (benefit) and imports benefit (lose) when the trade balance is positive (negative), or alternatively when the forward risk premium is positive (negative). According to the authors, this result explains why several empirical studies cannot find significant coefficients on the volatility variable, since the trade balance can reverse sign over time. As well,

5. Theoretical analyses of optimal forward covering include Ethier (1973), Baron (1976a), Kawai and Zilcha (1986) and Eldor and Zilcha (1987).

it is consistent with the finding of a positive effect in equations for U.S. exports to Japan, since Japan consistently ran surpluses with the U.S., and a large part of their trade is conducted in U.S. dollars.

2.2.3 Other sources of uncertainty

• *For the modern firm, exchange rate volatility may represent a relatively minor and highly diversifiable risk.*

One obvious criticism of the earlier models is that exchange rate volatility is not likely to represent the only source of uncertainty for a firm. Therefore, to correctly evaluate its effect, one needs to know how the exchange rate moves with the other factors that influence the firm's profits. In the international trade literature, it has long been recognized that it might be more appropriate to focus on real rather than nominal exchange rate fluctuations. If changes in prices are fully or partly offset by changes in exchange rates, then exchange rate variability may have little effect on the firms's profit. In fact, reducing nominal exchange rate variability could actually increase the risk on profits, if it created a deviation from purchasing power parity. Cushman (1983) derives a model similar to that of Hooper and Kohlhagen but expressed in real terms. Traders are assumed to maximize the utility of expected profits adjusted by home-country price deflators. Both prices and the nominal exchange rate are uncertain. An increase in real exchange rate uncertainty reduces trade quantity. Price effects are ambiguous, depending among other factors on the currency invoicing practice.

In a multicountry world, movements in one exchange rate can be offset by other factors, such as movements in other exchange rates or interest rates. Cushman (1986) shows that the relative variability between more than two currencies can play a role in affecting the pattern of bilateral trade flows. If an exporter can sell goods in different countries, trade will be deflected away from the markets where exchange risk has increased the most. Omission of third-country exchange risk could therefore lead to perverse results in estimating bilateral trade flow equations. This might explain why some studies have found a positive link between bilateral exchange rate variability and trade flows.

More generally, the finance literature that focusses on the behaviour of diversified firms shows that what is relevant is the effect of exchange rate volatility on the risk and return of the firm's overall set of activities (for example, Makin 1978). The diversified firm holds a portfolio of assets and liabilities denominated in a variety of currencies, and exports and imports affect both accounts receivable and accounts payable. In a portfolio-diversification framework, even if the variability of the rate of return on a particular security is high, that security can still be attractive if it diversifies the portfolio as a whole.

It has been argued that among the various risks incurred by a firm, exchange rate uncertainty may be relatively minor compared to the expected benefits of trade (see, for example, McCulloch 1983). Exchange risk is highly diversifiable and international operations may provide an important means of diluting risks associated with domestic transactions, rather than constitute an independent addition to risk. Willett (1986) conjectures that exchange rate volatility will affect the composition of trade proportionately more than the overall level of trade. The latter will be influenced by what is happening to international risks relative to domestic risks. In his view, the reason why exchange rate volatility has not had a large dampening effect on trade is that there has not been much of a differential increase in international risk relative to domestic risk. The variability of exchange rates certainly increased substantially compared to the variability of national inflation rates, but it was not out of line with increases in the volatility of domestic interest rates and stock markets.

2.2.4 Profit opportunities

• *Movements in exchange rates do not just represent a risk, they create opportunities to make profits.*

An additional reason why exchange rate volatility is unambiguously bad for trade in the basic models is that the exchange rate does not affect the real opportunities facing the firm. The firm is constrained to make a production and export decision before the exchange rate is known. As well, inventories are ignored. If these assumptions are relaxed, changes in the exchange rate do not only represent a risk, they create opportunities to make profit. It is generally the case that price uncertainty may increase the average profits of the firm. De Grauwe (1992) presents the results for the simple case of a price-taking firm in a model without adjustment costs. When the price is high, the firm increases output to benefit from the higher revenue per unit. It gains a higher profit for the units it would have produced anyway and, in addition, it expands its output. When the price is low, the firm does the opposite. By so doing, it limits the reduction in its total profit. This positive effect on the utility of the firm has to be compared with the negative effects created by greater uncertainty for the risk-averse firm.

Gros (1987) concentrates on the effect of exchange rate variability in the presence of adjustment costs. He derives a model of a competitive firm whose entire output is exported. Risk neutrality is assumed. It is shown that an increase in exchange rate variability increases the firm's investment if some factors of production can be adjusted instantaneously. The intuition behind this result is that, for any given amount of the quasi-fixed production factor (capital), production is an option. If the output price, that is, the exchange rate for the exporting firm, is high, production can be increased by using more of the flexible factor so that profits increase more than proportionately; if prices are low, production can be reduced, limiting losses. The extent to which the firm can make

use of this option depends on capacity. If the variability of prices increases, the probability of extreme prices increases. A high capital stock is therefore more desirable, since it allows the firm to react more to extremely high prices while the losses at low prices are still limited. The export supply function shifts upwards over time. If the function is convex in the exchange rate, that is, if the elasticity exceeds one, exports will rise. Otherwise, the result is ambiguous. Note that in this study, exchange rate variability affects exports through its effect on investment. Therefore, in empirical work, one would not expect to get any significant role for that variable in an export supply equation that includes capital stock as well.

The implications of exchange rate volatility for imports of investment goods are analogous. In a general equilibrium context, maintaining the assumption that all output is exported, exchange rate variability has no effect on investment and trade. For given foreign demand, not all exporters can respond to favourable exchange rate movements by increasing supply at unchanged national currency prices. However, if there were more than one sector in the economy, the earlier result would apply.

The "option" framework has been used in the literature on trade hysteresis. The latter is not really concerned with the direct effects of exchange rate volatility but emphasizes an indirect, or second-order, role. Increased volatility makes the option of entering and exiting the market more valuable, and therefore firms will adopt a wait-and-see attitude. A higher exchange risk means a higher probability that the exchange rate becomes more profitable in the future. Dixit (1989) shows that an increase in exchange rate volatility widens the hysteresis bands, implying that the industry becomes less responsive to exchange rate movements.[6]

Franke (1991) uses this framework to analyse the direct effects of exchange rate volatility on the export strategy of a firm in an intertemporal infinite horizon setting. The export strategy is associated with transaction costs. A firm that starts exporting incurs the costs of entering the foreign market. If it stops exporting, it incurs exit costs. The firm weighs the entry (exit) costs associated with entering (abandoning) a foreign market against the profits (losses) created by exports. The firm is risk-neutral and operates in a monopolistic competition framework. It maximizes the net present value of expected cash flows from exports, which is an increasing function of the real exchange rate. Uncertainty is modelled by the real exchange rate, which is assumed to follow a mean-reverting process. A firm benefits from increased exchange rate volatility if the present value of cash flows grows faster than that of entry and exit costs. A sufficient condition is that the cash flow function is convex in the exchange rate. In that case, it is shown that any given firm will on average enter sooner and exit later when exchange rate volatility

6. For a survey of the trade hysteresis literature, see Harris (1993).

increases sufficiently, and that the number of trading firms will on average increase. Therefore, trade will benefit from exchange risk. The potential for increased volatility to promote trade is linked to the imperfection in the goods market. Violations of the law of one price create arbitrage opportunities for international trade. The increase in exchange rate volatility increases the potential price differences and creates more scope for profitable commodity arbitrage through international trade.

Sercu and Vanhulle (1992) address a similar question. They identify two major caveats in Franke's analysis, the assumptions of risk neutrality and of mean-reverting real exchange rates. If firms perceive that deviations from purchasing power parity (PPP) are only temporary, it is not surprising that they are willing to trade for some time even if it produces losses. Instead, Sercu and Vanhulle assume risk aversion, but perfect hedging, and a random process for the real exchange rate. They also replace entry and exit costs by other types of friction. They analyse the behaviour of an established exporter for which the initial entry cost is sunk. When the exchange rate drops below a certain level, the firm has the choice between suspending trade temporarily or abandoning trade completely. In the first case, the firm continues to incur some costs – like maintaining the equipment and the contact with the market – while in the second case, all expenditures are stopped without any chance of reentry. In this analysis, the maintenance costs play a role similar to those of exit and reentry costs. Sercu and Vanhulle provide analytical solutions or numerical results for monopoly and price-taking firms. In all cases, an increase in exchange risk raises the value of the exporting firm and lowers the exchange rate that triggers abandonment. A plant that would cease activities under a low risk regime will continue to produce and sell for some time. The firm is more willing to sustain losses, and engage in dumping, before abandoning the market, a finding that appears consistent with the rise in antidumping cases filed over the world.

2.2.5 Trade composition

A recent study by Kumar (1992) argues that exchange risk may decrease the net volume of trade but increase intraindustry trade. If exchange risk reduces net trade (which is calculated as the difference between gross trade and intraindustry trade), it must be resulting from a reduction in comparative advantage. When comparative advantages diminish, economies become more similar, less specialized, and intraindustry trade increases. The effect on gross trade is ambiguous. To support that result, Kumar uses a two-country general equilibrium model with scale economies and product differentiation in which he adds exchange risk. He assumes risk aversion, incomplete forward markets, foreign currency invoicing and PPP. Each country produces two goods, agricultural and manufactured goods, with a single input, labour. The home country has a comparative advantage in manufacturing and is a net exporter, while the foreign country has a comparative advantage in agricultural production and is the sole exporter of that good. An increase in exchange risk is analogous to a negative technological change. In the home country, resources

flow from the manufactured goods sector to the agricultural sector since the latter is not exposed to exchange risk. In the foreign country, both sectors are exposed, but because the manufacturing sector is assumed to have some market power – it can raise its mark-up – its relative productivity increases. Therefore, resources flow to the manufacturing sector. An increase in exchange risk reduces the intercountry differences in relative productivity and inhibits net trade.

2.3 Export pricing

Hooper and Kohlagen (1978) conclude that the effect of exchange rate volatility on trade prices is ambiguous, depending on the relative degree of risk aversion of exporters and importers and their degree of risk exposure, which in turn depends on the invoicing currency and the extent of forward cover.

In the recent literature on exchange rate pass-through, three studies examine the role of uncertainty on export pricing decisions of a firm operating in a monopolistic competition framework. Giovannini (1988) shows that exchange rate uncertainty can affect expected profits and decisions of a risk-neutral exporter. This arises because producers have the ability to discriminate between home and foreign markets and to choose the currency of invoicing. Financial markets are perfect, but goods markets are imperfect in that firms have to commit themselves to given prices at the beginning of each period. When export prices are set in foreign currency, domestic or export prices are not affected by exchange risk. However, when export prices are set in domestic currency, expected profits vary with exchange risk. Expected profits might actually increase, leading firms to lower export prices. A sufficient condition would be that both demand and cost functions are linear.

Mann (1989) examines both the direct effects and the secondary effects of exchange rate volatility. The latter refers to how the pass-through is affected by volatility. With highly volatile exchange rates, changes in competitiveness are less important in affecting pricing strategies, and firms tend to stabilize export prices in the currency of the destination market. The magnitude of the pass-through varies with the degree of risk aversion. An increase in exchange risk is likely to increase the price facing the foreign buyer, whatever the choice of invoicing currency. However, the effect on home-currency prices depends on the size of the pass-through elasticities. The higher the degree of exporter's risk aversion, the more likely home-currency prices increase with increased risk. The higher the degree of importer's risk aversion, the more likely that the exporter will absorb some of the exchange risk so that home-currency prices may fall. Since the buyer's risk aversion matters only in the case of home-currency invoicing, a negative correlation between exchange risk and export prices in home currency suggests a home-currency invoicing strategy.

Feenstra and Kendall (1991) extend Mann's analysis by taking into account optimal forward covering. Their analysis draws together several results obtained in previous papers. They examine the link between the estimated risk premium and the influence of exchange rate volatility on export prices. When prices are set in the home currency, firms cannot cover on the foreign exchange market, since demand is uncertain. Therefore, even in the presence of forward exchange markets, the earlier result holds that an increase in exchange risk reduces export prices. However, when firms set prices in foreign currency, they can cover all revenues, and the extent to which firms cover will depend on how the forward rate compares with the expected future spot exchange rate (the risk premium). If there is no risk premium, firms will fully cover revenues and exchange rate volatility will not affect the firm's profit-maximizing decision. However, if the forward rate is below the expected future spot rate, the firm faces a trade-off between expected profit and the variance of profit and chooses to cover only a portion of revenues.[7] In that case, export prices increase. From this analysis, Feenstra and Kendall conclude that if the risk premium is negative and significant, the effect of exchange rate variability in aggregate export price equations is ambiguous – and likely to be insignificant – as it combines the negative response of firms invoicing in the home currency and the positive response of firms invoicing in foreign currency. On the other hand, if the risk premium is insignificant, exchange rate variability should have a negative effect on prices, as it combines the absence of reaction from exporters invoicing in foreign currency and the negative effect of firms invoicing in the home currency.

2.4 Conclusion

Microeconomic theory does not allow one to draw any firm conclusion on the consequences of exchange rate volatility for international trade. To obtain the result that exchange rate volatility necessarily reduces the level of trade, one has to rely on a rather stringent set of assumptions. Price effects are always ambiguous, depending on the market structure, the currency denomination of contracts, and the availability of forward cover.

Because microeconomic theory does not provide any clear-cut conclusions, some alternative assumptions have been offered. For example, it has been argued (De Grauwe 1988) that real exchange rate misalignments will generate a net increase in protectionist pressures and therefore negatively affect trade. The idea is that producers in the countries whose currencies become overvalued and see their profits squeezed will organize themselves to pass protectionist legislation and that this legislation will tend to stay in place when the currency later drops and even becomes undervalued. This assumption is intuitively appealing. However, exchange rate changes are unlikely to be the only source of an industry's difficulties, and industries seeking protection are

7. If the forward rate is above the expected future spot rate, the model predicts that firms cover more than 100 per cent of their sales.

often those experiencing chronic competitiveness problems. Moreover, there can be no presumption that exchange rate misalignments are more likely to occur under a flexible exchange rate system than under a fixed rate system. Indeed, proponents of flexible rate systems would argue that such a system allows the exchange rate to move in response to shocks, thereby easing the adjustment process (by requiring less flexibility in money wages) and reducing the output and unemployment costs.[8]

What theory clearly indicates is that the effect of exchange rate volatility depends very much on the structure of the firm. Several characteristics will determine how movements in exchange rates interact with other variables to influence the firm's profitability and its ability to successfully hedge against exchange rate uncertainty. Among these characteristics, one can note the size of the firm, its capital-labour ratio, the durability of the product, the diversification of sales, and the use of imported intermediate inputs. This would suggest that a sectoral approach – although still lacking in many respects – would be more appropriate than an aggregate approach in empirical testing. What the literature also suggests is that to properly assess the effect of exchange rate volatility, one should try to measure its incremental contribution to some overall measure of risk.

3 Empirical studies

Given the inconclusive results of the theoretical models, it is not surprising that numerous studies have attempted to quantify the effects of exchange rate volatility on trade. In this section, we summarize the conclusions of previous surveys of the literature and review in more detail the work published since 1988. Before doing so, we discuss the issues related to the definition and measurement of exchange rate risk.

3.1 Measurement of risk

When one attempts to measure the effects of exchange rate variability on trade, the first question to answer is "What is the best proxy for the uncertainty and adjustment costs that traders face as a result of exchange rate movements?" There is probably no unique answer to this question, as different types of uncertainty will be important for different kinds of enterprises or for the economy as a whole. There are issues concerning the measurement of the exchange rate itself: whether it should be bilateral or effective, real or nominal, and the appropriate way of measuring risk: short-run versus long-run horizon, *ex ante* versus *ex post*, sustained deviations from trend versus period-to-period movements.

8. For a thorough discussion of the costs of a monetary union, see Corden (1972).

The choice between bilateral and effective rates depends on whether one wishes to measure uncertainty facing the economy as a whole or that facing individual traders, and the degree to which traders are diversified. Short-run fluctuations in nominal exchange rates are relevant for trading firms undertaking individual transactions in which purchase and selling prices are known in advance. However, these transactions may well be the exception rather than the rule and could in any case be hedged at a low cost. When the planning horizon is extended, the relevant exchange rate becomes that between domestic costs of production and foreign prices converted into domestic currency. It is therefore generally argued that real exchange rate volatility is the variable that matters.[9]

If the trader's involvement extends over a long period of time and involves a sequence of transactions, short-run fluctuations in exchange rates may be self-cancelling and longer-run fluctuations may be more likely to affect decisions. It may be the divergence from the underlying trend, or equilibrium value, rather than the movement from one period to the next, that is the most significant source of uncertainty. As Bleaney puts it: "Misalignment does not necessarily entail volatility, and although volatility does entail some degree of misalignment, it may not be of sufficient magnitude or duration to be of real concern." (Bleaney 1992, 558) He therefore advocates the use of longer-run measures of volatility to better account for either persistence or mean-reversion of the exchange rate.

The two measures of risk most commonly found in the empirical work are measures based on the standard deviation of the level or percentage change of the exchange rate, and measures based on the difference between the actual and forward exchange rate. Use of the latter reflects the view that fluctuations in exchange rates are not necessarily synonymous with risk as long as they are anticipated by market participants and reflected in the forward rate. However, the forward rate may not be an unbiased predictor of future exchange rate movements. Others argue that there might be a high correlation between the forward spread and the actual change in the exchange rate, such that this measure would reflect changes in competitiveness rather than risk.

The use of standard deviation (or variance) to measure volatility is also subject to criticism, since the exchange rate has a skewed distribution (heavy tails). [10] As well, the exchange rate seems to be characterized by "volatility clustering," which means that successive price changes do not seem to be independent.[11] Other methods of measuring volatility have therefore been proposed. For example, Pozo (1992) uses a GARCH model to compare real exchange rate volatility across

9. When using the real exchange rate, the choice of price index becomes an issue.
10. This means that the exchange rate has a greater proportion of large price changes than would a data set that is normally distributed.
11. Large changes tend to be followed by large changes while small changes are followed by small changes. See, for example, Pozo (1992).

regimes over the 1900-40 period. He concludes that the average higher volatility depicted during flexible regimes is the result of an explosion of volatility at the start of the period. After that initial explosion, the level of uncertainty experienced during both regimes is similar.[12] Measures based on ARCH or GARCH models have been used to test the effect of volatility on trade in some recent studies.

3.2 Results

Farrel, De Rosa and McCown (1983) and the IMF (1984) present detailed surveys of the early empirical work. They conclude that the majority of studies are unable to establish a systematically significant link between measured exchange rate variability and the level of trade, whether on an aggregate or on a bilateral basis. Bilateral results are somewhat more supportive of the view that volatility has a negative effect on trade. However, the majority of these studies include relatively few observations on the floating exchange rate period.

Bélanger and Gutiérrez (1990) survey the empirical work published over the 1978 to 1988 period. Overall, the evidence is inconclusive.[13] The aggregate studies produce contradictory results, while the sectoral studies, far less numerous, provide more support to the assumption that exchange rate variability reduces the volume of trade. The magnitude of these effects appears small, however.

The studies we reviewed are listed in Table 1. In the recent papers, emphasis is placed on the appropriate measurement of risk and the estimation technique. The only studies focussing on Canada are those of Bélanger et al. (1988, 1992). In both studies, the authors examine the impact of nominal exchange rate volatility on Canada-U.S. trade flows in five sectors: food products, industrial supplies, capital goods, automotive vehicles and consumer goods. The risk measure is based on three-month forecast errors on the forward market.[14] In their first paper, equations are modelled for U.S. exports to Canada. In addition to the risk measure, capacity, output and relative price terms are included. Single equation and multiple equation instrumental variable estimation methods are used and the sample period extends from 1976 to 1987. Volatility has a negative and significant impact in two sectors, industrial supplies and autos. The latter result is surprising given the integrated nature of the auto industry. The estimated effect is in the range of 3 per cent to 4 per cent. For food and consumer goods, the effect is positive but not statistically significant.

12. See also Andersen and Grier (1992). They use a non-parametric measure for comparing volatility across the 70s and 80s for seven currencies. In contrast with results obtained with classical measures, their results do not lead to the conclusion that variability has increased over time. Increases in variability occur only in specific percentiles of the data.
13. More succinct reviews of the empirical literature can also be found in Edison and Melvin (1990) and Kumar and Whitt (1992).
14. In their second paper, they also construct a measure that isolates the risk premium in the forecast error using a method developed by Pagan and Ullah (1988).

Table 1. Recent studies on exchange rate volatility and trade

Study	Data period and country	Risk measure	Specification and estimation method	Main results
Bailey and Tavlas (1988)	quarterly 1975-86 U.S.	2 measures: short-run volatility (absolute value of quarterly percentage change in real effective exchange rate) and misalignment (deviation between REER and FEER)	aggregate U.S. export volumes OLS	not significant
Bélanger et al. (1988)	quarterly 1976-87 Canada-U.S.	squared of forecast error defined as 90-day forward spread	U.S. export volumes to Canada: 5 sectors IVE, GIVE	significant and negative in two sectors
Brada and Méndez (1988)	annual 5 years (1973 to 1977) bilateral trade among 30 countries	dummy for exchange rate regime	cross-section	level of trade significantly higher in floating rate regime
De Grauwe and Verfaille (1988)	annual 1979-85 bilateral trade among 15 industrial countries	variance of annual changes of real exchange rate	cross-section	level of trade significantly stronger within EMS than outside EMS
Koray and Lastrapes (1989)	monthly 1961-71 1975-85 U.S. bilateral trade	12-month moving standard deviation of growth rate of real exchange rate	U.S. bilateral import from 6 countries (including Canada) VAR	weak negative relationship
Mann (1989)	quarterly 1977-87 U.S., Japan, W.G.	3 or 6-month moving average of monthly percentage change in nominal effective rate	export prices for 5 industries OLS	few significant results
Perée and Steinherr (1989)	annual 1960-85 U.S., Japan, U.K., W.G., Belgium	2 measures of long-run uncertainty (misalignment)	aggregate export volume and bilateral exports to U.S. OLS	insignificant for U.S. aggregate equation, often significant (negative) in other equations
Lastrapes and Koray (1990)	monthly 1975-87 U.S.	12-month moving standard deviation of growth rate of real (and nominal) exchange rate	aggregate export and import volumes and output VAR	weak relationship
Asseery and Peel (1991)	quarterly 1972-87 Australia, Japan, U.K., U.S., W.G.	squared residual from ARIMA process fitted to real exchange rate	aggregate export volumes error correction technique	significant and positive except for U.K.

Table 1. Recent studies on exchange rate volatility and trade *(continued)*

Bini-Smaghi (1991)	quarterly 1976-84 W.G., France, Italy intra-EMS trade	standard deviation of weekly rates of change of intra-EMS effective exchange rate within a quarter	prices and volumes of exports of manufactured goods to EMS countries OLS	significant and negative effects in volumes; mostly significant effects on prices
Feenstra and Kendall (1991)	quarterly 1975-88 U.S. bilateral imports	GARCH model	import prices IVE, 3SLS	significant negative for U.K. and W.G., insignificant for Japan
Bélanger et al. (1992)	quarterly 1975-87 Canada-U.S.	2 measures: squared of forecast error defined as 90-day forward spread; and non-parametric method to isolate risk premium in forecast error	U.S. imports from Canada: 5 sectors IVE, GIVE	not significant
Kumar (1992)	annual 1962-1987(88) U.S., W.G., Japan	standard deviation of monthly percentage change in real exchange rate over 12-month period	intraindustry trade, net trade and ratio of intraindustry to net trade	mixed results
Savvides (1992)	annual 1973-86 62 countries	standard deviation of change in exchange rate	cross-section	only unanticipated real exchange rate variability significant and negative
Gagnon (1993)	quarterly	based on regression for real exchange rate between U.S. and 5 industrial countries	calibrated using U.S. trade with 5 countries simulation analysis	not statistically significant
Frankel and Wei (1993)	annual 1980,1985,1990 63 countries	standard deviation of first difference of log of nominal (and real) exchange rate	cross-section OLS and IV	small effect, negative in 1980, positive in 1990
Kroner and Lastrapes (1993)	monthly 1973-89 (90) U.S., U.K., W.G., Japan, France	GARCH model	aggregate export volumes and prices joint estimation	significant, varied signs and magnitudes

Despite the attention given to the estimation technique, the results of Bélanger et al. are not too convincing, since several of the explanatory variables do not have the expected signs. They argue that in fact, they may be estimating an import demand function. As a result, in their second piece, they focus on the same sectors but opt to estimate U.S. import demand equations. They experiment with various lags of the risk variable. Of the forty estimates reported for risk, only two are statistically significant. The risk effect switches from negative to positive as the timing is changed. They conclude that they are unable to detect any stable economically and statistically significant negative impact of exchange risk on U.S. imports from Canada.

Several studies have presented results for multilateral trade volumes of the United States. and other major industrial countries. Bailey and Tavlas (1988) report standard tests of the effect of volatility on aggregate U.S. export volumes over the 1975 to 1986 period. They examine the impact of short-term volatility as well as misalignment (based on the deviation between the current exchange rate and the equilibrium rate as computed by Williamson 1985).[15] Both measures are insignificant. Perée and Steinherr (1989) focus on the problem of finding meaningful proxies for long-run exchange rate uncertainty. They construct two measures: the first one combines a proxy for uncertainty (based on the largest exchange rate movement over a 10-year horizon) and misalignment, the second one uses the integral of misalignment over the past period (10 years). The latter measure reflects the assumption that uncertainty increases when both the degree and duration of misalignment increase. They estimate equations for export volumes of five industrial countries over the 1960 to 1985 period. For the United States, the uncertainty variables are never significant, while for the other countries, their effect is negative and often significant. They attribute the asymmetry in the results to the fact that American exports are largely invoiced in U.S. dollars and that U.S. companies are more diversified, benefiting from a large domestic market that allows them more easily to compensate exchange rate uncertainty. The authors also report regression results for bilateral exports to the United States. Except for Japan, increased uncertainty appears to reduce trade volumes.

Asseery and Peel (1991) also examine the influence of volatility on multilateral export volumes of five industrial countries. The novelty in their paper is the use of an error correction framework. It is argued that the non-robust results found in previous empirical work may be due to the fact that the export variable and some of its determinants are potentially non-stationary integrated variables. The volatility measure is based on the residuals from an ARIMA process for the real exchange rate. For all countries except the United Kingdom, they find that volatility has a significant positive effect on exports over the 1973 to 1987 period.

15. Williamson's measure is based on the assumption that the "fundamental equilibrium exchange rate" is the real exchange rate that leads to a sustainable current account balance given the long-run capital movements.

The study by Kroner and Lastrapes (1993) examines the impact of volatility on multilateral export volumes and prices using a joint estimation technique in the context of a parameterized model of conditional variance (multivariate GARCH-in-mean model). In contrast with conventional two-step estimation procedures, the model imposes rationality on the variance forecasts. The model restricts the variance that affects trade to be the same as generated by the data. The conditional variance has a statistically significant impact on the reduced-form equations for all countries (based on likelihood ratio tests). For the individual coefficients, the effect of volatility on volumes is estimated with greater precision for the United States. The sign and magnitude of the effects differ widely across the countries, the magnitude being generally stronger for prices. For the United States, France and Japan, the effect of volatility is found to be only temporary. Volatility has a negative effect on trade volumes only for the United States and the United Kingdom. For the other countries, the coefficient is positive. For export prices, volatility has a negative effect in U.S. and German equations, and a positive effect in others. Kroner and Lastrapes show that the results are not robust to using the conventional estimation strategy (estimating the export equation separately and substituting the GARCH measure by a six-month rolling sample variance).

Koray and Lastrapes (1989) and Lastrapes and Koray (1990) use VAR models to examine the effect of exchange rate volatility on trade. The major advantage of this approach is that it does not impose exogeneity on the variables in the system. Exchange rate volatility may affect variables other than trade and, at the same time, it may be affected by some macro variables. In their first paper, they examine the link between real exchange rate volatility and U.S. bilateral imports from five countries, including Canada. Estimations are made separately for a fixed (1961-71) and a flexible (1975-85) exchange rate period. In addition to real exchange rate volatility, each model contains U.S. and foreign money supplies, output, prices and interest rates and the nominal exchange rate (for the fixed rate period). They conclude that, although it increased from the fixed to the flexible rate regime, the relationship between volatility and trade is weak. This conclusion is based on the observation that a fairly small proportion of the variance in U.S. imports is explained by innovations in volatility. For U.S. imports from Canada, the estimated contribution is about 4 per cent. The largest effect is obtained in the Japanese case (about 11 per cent). It is worth noting, however, that although these contributions may appear small, they are often similar or greater than those of the other variables in the system. Except for France, permanent shocks to volatility tend to depress imports. The results also suggest that exchange rate volatility is not a purely exogenous source of instability, as in all cases, at least one macro variable explains a significant proportion of the error variance of volatility.

In their second paper, Lastrapes and Koray use a similar approach but focus on U.S. multilateral exports and imports during the flexible rate period. They draw the same general conclusions. Compared to the other variables in the system, exchange rate volatility plays a

relatively minor role in explaining imports, exports and real output. The responses to volatility shocks are small and statistically insignificant. As well, the state of the economy strongly affects volatility. Innovations in money, interest rates and prices make a particularly large contribution. These results support the view that exchange rate volatility is a symptom of macroeconomic instability rather than an independent cause.

The conclusion that exchange rate volatility does not play a large role in explaining trade flows is corroborated by a simulation analysis performed by Gagnon (1993). In his paper, the author derives a dynamic optimizing model characterized by rational expectations and adjustment costs. The model of risk-averse traders finds that exchange rate variability reduces the level of trade. In contrast to previous research, the magnitude of the effect is assessed through various parameterizations of the model. It is shown that an increase in real exchange rate volatility of the size that occurred after the breakdown of Bretton Woods may have reduced the volume of trade by 1 to 3 per cent. These effects would be too small to detect statistically, although they are economically significant given the magnitude of global trade. Gagnon notes, however, that these estimates are overstated, since the model ignores several features that would serve to minimize the effect of risk, such as inventories and futures markets, and that the degree of risk aversion that is assumed is almost certainly too large.

In contrast to these papers, Bini-Smaghi (1991) finds strong support for the conventional assumption about volatility effects on trade. Bini-Smaghi focusses on trade in manufactured goods within the European Monetary System (EMS). Equations are estimated over the 1976 to 1984 period for export volumes and prices of Germany, France and Italy. It is found that volatility, measured by the standard deviation of weekly rates of changes of the intra-EMS effective rate for the quarter, has a negative and significant effect on export volumes in all three countries. It also has a significant effect on prices. The sign of the latter is negative for Germany and positive for the other two countries. These results would suggest that, for France and Italy, a larger proportion of risk is borne by the exporters, which is consistent with the finding that a smaller proportion of their exports is invoiced in home currency. Bini-Smaghi claims that the inability of previous studies to detect a significant effect was due to the lack of appropriate disaggregated data, the equations' misspecification (improper account of the dynamics) and the unsatisfactory way of measuring risk. To prove their point, they present regression results using different data (as used in previous research) and specification. In these alternative regressions, the estimated effect of volatility becomes less significant. They also estimate equations that include both expected (based on autoregressive estimates) and unexpected volatility. Only the latter is significant in equations for France and Italy. For Germany, both variables have a significant effect.

Two studies focus on the effect of volatility on trade prices. Mann (1989) tests the effect of exchange rate trend and volatility on U.S., Japanese and German export prices for five industrial categories.[16] Destination-weighted exchange rates for these industries are constructed. Exchange risk always has a negative effect on export prices for the United States, suggesting that buyers of U.S. products absorb the risk. The effect is significant at 10 per cent for three industries. For Japan and Germany, the effect, often positive, is generally insignificant. Feenstra and Kendall (1991) test their assumption about the connection between the estimated risk premium and the impact of exchange rate volatility on prices. Regressions for U.S. import prices from the United Kingdom, Japan and Germany are presented. The exchange rate variance is estimated as a GARCH model. A significant negative time-varying risk premium is found for the yen but not for the pound and mark. The pass-through equation, which includes the variance, is reformulated as a PPP equation with the exchange rate as the dependent variable. It is found that the variance is insignificant in the Japanese export prices equation, while it has a negative and significant effect in U.K. and German equations, which confirms the assumptions of the paper that were described in Section 2.3.

Four studies use cross-section regressions. De Grauwe and Verfaille (1988) attempt to explain why, despite the apparent success of the EMS in stabilizing exchange rates over the 1979-85 period and the evidence suggesting that misalignments among the EMS currencies appeared smaller than those between floating currencies, intra-EMS trade grew at a substantially slower pace than trade among the other industrialized countries.[17] Bilateral export volumes of 15 industrial countries are used. Exports are a function of demand and supply (foreign and domestic income), relative prices, a dummy for customs union (assumed to work through a higher income elasticity on the import side), a measure of long-term real exchange rate volatility (the variance of the annual changes of the exchange rate), and misalignment as an indicator of protectionist pressure. Both exchange rate variability and misalignment have a negative and significant effect on export growth. In terms of magnitude, De Grauwe and Verfaille find that income and exchange rate variability are the most important factors in explaining export growth. Volatility is estimated to have reduced the growth rate of exports outside the EMS by 8 to 10 per cent over the 1979 to 1985 period, while intra-EMS trade was reduced by just 0.7 per cent. There are two reasons for the slower trade growth within the EMS: weaker income growth and a lower income elasticity of export demand, as the trade integration process levelled off. The authors note that the question remains as to whether low exchange rate variability is correlated with low growth of output. In a comment, Melitz (1988) holds that there are a number of serious shortcomings in their approach. In particular, he argues that their measure of volatility (based on consecutive monthly observations of annual changes) is insignificant, as it uses overlapping observations and therefore cannot measure annual volatility properly.

16. The industries are those of grinding, lapping, polishing machinery; electromechanical hand tools; air and gas pumps and compressors; pumps for liquids; typing and typesetting machinery.
17. Misalignment is based on deviations from PPP rates.

The study by Brada and Méndez (1988) differs from previous ones in that it examines the effect of exchange rate regime, rather than volatility per se, on the volume of trade. Its results contradict those of De Grauwe and Verfaille. The study uses a gravity model of bilateral trade flows, which includes domestic and foreign incomes, population, distance between countries, and dummy variables for the exchange rate system and trade arrangements. The model is estimated with data on 30 developed and developing countries for each year from 1973 to 1977. With one exception, the coefficients on the exchange rate regime are significant at 5 per cent. In all cases, trade flows are larger between countries with floating rates than between countries with fixed rates. The reduction in trade under a fixed rate regime ranges from 27 to 61 per cent. The authors conclude that even though exchange rate volatility reduces trade among countries, its effects are less than those of the restrictive commercial policies often imposed under fixed rates systems. Instead of relying on exchange rate movements to achieve payments equilibrium, fixed exchange rate countries must rely on changes in domestic incomes and prices, or impose trade restrictions. As the latter are more acceptable politically than the former, the demand for imports is often controlled by tariff and non-tariff barriers in countries with overvalued currencies.

Frankel and Wei (1993) also use a gravity model of bilateral trade flows to test the effect of nominal and real exchange rate volatility. Regressions are estimated for 1980, 1985 and 1990 using a data set covering 63 countries. Given the likelihood of simultaneity bias in the regressions – governments may deliberately try to stabilize bilateral exchange rates with their major trading partners – the authors report instrumental variable (IV) estimations in addition to ordinary least squares. The bias seems to be confirmed by the data, as the magnitude of the estimated effect of exchange rate volatility is reduced considerably with the IV method. They find that nominal and real volatility has a negative and significant impact on trade flows in 1980. The effect is positive but insignificant in 1985. It remains positive and becomes statistically significant in 1990. The change in sign could indicate that the development of exchange risk hedging instruments has diminished the negative effect of volatility over time. In all cases, the magnitude is very small. Their preferred estimate suggests that a doubling of exchange rate volatility within Europe, as would happen if variability returned from its 1990 to its 1980 level, would reduce the volume of trade within the region by 0.7 per cent. Given that their results do not appear very robust, they conclude that the effect, if it is there at all, is small in magnitude.

Savvides (1992) uses a two-step estimation method to test the assumption that only the unanticipated component of exchange rate volatility affects trade. Annual data for 62 industrial and developing countries are used to estimate regressions over the 1973 to 1986 period. The degree of openness and terms of trade shocks are found to have a significant effect on real exchange rate volatility. The effect of expected and unexpected variability, based on the equation results, is tested on export volumes. Only the latter is negative and significant. Nominal exchange rate variability

does not have a significant effect either. The author presents results for industrial countries and lesser-developed countries separately. The same conclusion holds concerning the impact of volatility. Although it is not mentioned in the text, the results for industrial countries are not too convincing, as the income and relative price terms are insignificant (the income term even has the wrong sign).

The final study reviewed is that by Kumar (1992), who tests his assumption regarding the differential effect of volatility on intraindustry versus net trade. Equations are estimated for the United States, Japan and Germany. The results partly support Kumar's assumptions. Risk increases intraindustry trade and reduces net trade in the United States, as predicted by the model. For Japan, risk reduces net trade but does not affect intraindustry trade, while for Germany, it increases intraindustry trade but does not affect net trade.

3.3 Conclusion

Our review of the most recent empirical studies leads us to conclude, as others have done in the past, that the evidence on the effect of exchange rate volatility is mixed. Results of the different studies are difficult to compare since the sample period, countries and more importantly, the measure of risk vary widely. In several cases, long-run measures are used that may be a better proxy for trend changes in the exchange rate than volatility. Overall, a larger number of studies appear to favour the conventional assumption that exchange rate volatility depresses the level of trade (De Grauwe and Verfaille 1988, Koray and Lastrapes 1989, Perée and Steinherr 1989, Bini-Smaghi 1991 and Savvides 1992). With the exception of De Grauwe and Verfaille, the magnitude of that effect would be rather small. On the other hand, Asseery and Peel (1991) and Kroner and Lastrapes (1993) find evidence of a positive effect of volatility on export volumes of some industrial countries (the two studies, however, get conflicting signs for the United Kingdom). There is some indication that unanticipated volatility has a more significant impact.

The absence of strong effects may be related to the use of aggregate data, although the only study focussing on sectoral trade volumes provides insignificant results as well (Bélanger et al.). Even though a sectoral approach would be more appropriate, the difficulty in obtaining good quality disaggregated data has presumably limited research. The VAR approach is interesting in that it does not impose exogeneity on the variables in the system. We are not aware of any study, however, that tries to account for the other sources of uncertainty faced by the firms.

The recent literature suggests that exchange rate volatility, rather than having a direct effect on trade volumes, may well have a greater influence through investment location decisions. It would therefore affect trade through its effect on capacity and the lags could be fairly long. It has been argued, however, that a reduction in the costs of transacting between two regions may lead to

more, rather than less, geographical concentration of industries.[18] Therefore, a reduction in exchange rate volatility or, in the limiting case, the adoption of a common currency, would not necessarily lead to stronger inward investment. Although it is unlikely to produce more clear-cut results, it might be interesting to reexamine the evidence for Canada.

18. See, for example, Krugman (1992).

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