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Exchange Rate Uncertainty and Export Decisions in the UK

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Abstract

Using data on UK manufacturing firms, we examine the effects of exchange rate uncertainty on firm decisions on export market entry and export intensity. The use of micro data and new measures of exchange rate uncertainty enable us to test for hysteresis effects in a new way and to test the sensitivity of results to a range of different measures. The results show that exchange rate uncertainty has little effect on firms' export participation but a significant impact on export intensity.

JEL classification: D81, F23, F31, F36

Keywords: Exchange rate uncertainty, export share, hysteresis effects

Outline

Non-Technical Summary

Large exchange rate fluctuations since 1970's have generated increased interest in investigating the effects of exchange rate movements on international trade. The theoretical papers on exchange rate uncertainty-trade relationship and on uncertainty-investment relationship provide a framework for a hysteresis effect of uncertainty on trade. It is first shown by Baldwin (1988) that, when market-entry costs are sunk, a large enough exchange rate fluctuation can induce entry or exit, which leads to a change in market structure and thus generates persistent effects. In an "option" approach, Dixit (1989a), Dixit (1989b) and Krugman (1991) further show that the size of hysteresis increases with exchange rate uncertainty. Despite the clear placement of firms at the heart of these models of exchange rates and international trade, the majority of the empirical evidence is based on macro data. This occurs despite the recent increase in empirical work in international trade that has begun to use firm level micro data to investigate the behaviour of exporters. This paper aims to examine empirically the effects of exchange rate uncertainty on firm export decisions using firm level micro data for UK manufacturing firms.

Of the difficulties of estimating the relationship between exchange rate uncertainty and trade using macro data, two issues are worth highlighting. First, the test for a simple correlation between the two may be misspecified, if, as the theoretical models show, there is a hysteresis effect between exchange rate uncertainty and trade. And the relative scarcity of observations of entry and exit makes it difficult to observe the effects on export entry and exit. Second, some existing measures of exchange rate uncertainty do not take into account the expected component of exchange rates and firms' hedge behaviour. The concept of uncertainty should refer to the unexpected portion of a variable only. These issues form the areas of research explored in this paper.

We aim to contribute in two main respects. One is to test the hypothesis of hysteresis effects of exchange rate uncertainty on firm export behaviour, using new measures of exchange rate uncertainty to overcome the difficulties in the empirical test mentioned above. Our empirical results provide evidence that increased exchange rate uncertainty increases the inertia in firms export share decision, whereas there is no significant evidence for hysteresis effects in the export participation decision. In addition, because there is no singularly accepted measure of uncertainty, this paper contributes to the literature by testing the sensitivity of the results to a range of different measures. We construct three trade-weighted measures of exchange rate uncertainty, none of which have been previously applied to the question of exchange rates uncertainty and exports in a micro setting, although are motivated by previous research. We do find that there is some sensitivity to these different measures, where this is driven by the observations for one particular year. Once we control for the ejection of the UK from the ERM in September 1992, we find that only the measure of uncertainty that captures the direction of the uncertainty (whether an appreciation or depreciation was expected) is robustly correlated with exports.

1. Introduction

Large exchange rate fluctuations since the 1970's have generated interest in investigating the effects of exchange rate movements on international trade.[1] It was first shown by Baldwin (1988) that when market-entry costs are sunk, large exchange rate fluctuations can induce entry or exit into export markets and also persistence in firm's export market participation.[2] However, despite the clear placement of firms at the heart of models of uncertainty in exchange rates and trade, the majority of empirical evidence remains based on macro data. This remains true even with the recent increase in empirical evidence on the role firms play in exports (Greenaway and Kneller, 2007a).

Of the difficulties with estimating the relationship between exchange rate uncertainty and trade using macro data, two perhaps best highlight the advantages of applying micro data. First, in the aggregate data the test for a simple correlation may be mis-specified if, as theoretical models show, there is hysteresis in the response of trade to exchange rate uncertainty. In macro data the relative scarcity of observations of entry and exit makes it difficult to observe the effects on the extensive margin. Second, the literature often relies on measures that do not take into account the expected component of exchange rates. The opportunity for firms to hedge against exchange rate movements highlights the importance of this. These issues underpin this paper.

In addition to providing the first evidence for UK manufacturing firms we contribute to the literature in two other respects. The first is to account for the hysteresis effects on firm export behaviour by modelling both the extensive and intensive margin of firm exports. Second, we construct three trade-weighted measures of exchange rate uncertainty, none of which have been previously applied in a micro setting. As there is no single accepted measure of uncertainty we show that it is important to test the sensitivity of the results to a range of different measures.[3]

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[1] In particular, empirical studies of the impact of exchange rate uncertainty on trade flows have become an important area within international finance. It is believed that uncertainty may depress trade. See IMF (1984) for an early, Cote (1994) and McKenzie (1999) for later surveys, and Clark et al. (2004) for a new and recent literature review.

[2] In an "option" approach, Dixit (1989a), Dixit (1989b) and Krugman (1991) further show that the size of hysteresis increases with exchange rate uncertainty. One of the models' applications is foreign trade under exchange rate uncertainty. By introducing the standard financial economics technique of option appraisal, an exporting firm is regarded as owning an option to leave the export market, and a non-exporter an option to enter. The cost of exercising the option is considered when a firm decides to enter or exit. Since the value of the option increases with uncertainty, the gap between the trigger point for entry and that for exit will increase with the degree of uncertainty. These gaps produce hysteresis, which increases with exchange rate volatility.

[3] In part this results from there being no generally accepted model of firm behaviour subject to risk of exchange rate uncertainty. "Theory cannot provide definitive guidance as to which measure is most suitable" (Clark et al, 2004).

2. Measures of Uncertainty

As summarized in Clark et al (2004), the standard deviation of the first difference of the logarithmic spot exchange rate is the most widely used measure in the trade-exchange rate volatility literature. While this has the advantage of being relatively easy to construct it is not without criticism, where these largely centre on the conditions under which volatility and uncertainty are captured by the same measure. The extent to which exchange rate volatility is a source of uncertainty depends on the degree to which exchange rate movements are predictable. This suggests the appropriate measure should be related to deviations between actual and predicted exchange rates. The methodology adopted by many, such as Campa (2004), has been to focus on the canonical conditional variances from ARCH/GARCH models to predict exchange rates and calculate uncertainty accordingly. Such measures are likely to differ markedly from the actual forecasting behaviour of firms, who are unlikely to have available financial instruments to hedge.

In this paper we measure uncertainty based on the trade-weighted difference between the current spot rate and previous period's forward rate.[4] This measure assumes that firms attempt to forecast and can reduce the uncertainty faced accordingly.

$$s_t = f_{t-1} + \varepsilon_t$$

where f_{t-1} is the forward rates in the period of *t-1*, s_t is the spot exchange rates in time *t,* and ε_t is the forecast error/residual.

Our first measure is calculated as the standard deviation of the residuals of the forecasting model in futures markets. It therefore bears a strong relationship with the more usual standard deviation of spot exchange rates, and indeed we find that its correlation with this is 0.91. The final two measures are based on the forecast errors themselves ($\varepsilon_t = s_t - f_{t-1}$). The first is the absolute value of the forecast error, while the second includes the direction of the error. The use of the difference between current spot and the previous forward rates assumes that hedging is available to each exporter to cover all international transactions and is costless.

Important in the construction of these trade-weighted uncertainty measures are data for spot and forward rates for currencies of the UK's main export destinations by industry. Here we draw on information in Greenaway, Kneller and Zhang (2007), who show that changes in 3-digit industry level real effective exchange rates (REER) rely principally on the Euro

[4] Early examples using the forecast error include Bélanger et al. (1992) and Dell'Ariccia (1999). But their measures are not standard deviations, nor trade-weighted. It should be noted that the measures of uncertainty mentioned above are backward-looking, as the past volatility is used to predict present risk (Dell'Ariccia, 1999).

(German Mark) and US dollar exchange rates. We use exchange rate data (spot and forward) for these (Euro/GBP and USD/GBP) and compute the weighted average industry specific exchange rate uncertainty by using normalized export weights for the two currency areas in each 3-digit industry.[5] The exchange rate data is from *Datastream*. Since the period between placing an order (signing a contract) and receiving payment is typically three months, we follow Bélanger et al. (1992) and Dell'Ariccia (1999) in choosing the 3 month forward rate. The data is monthly (spot and 3 month forward rates) measured at mid-month, expressed as foreign currency per GBP. Uncertainty in each time period is then calculated as follows:

i. the standard deviation of the 12 monthly differences between logarithms of spot rate and 3 month forward rate predicted 3 months earlier (positive if appreciation, negative if depreciation): SD (ε_t) (FSSD, hereafter);
ii. the average of the 12 monthly differences between logarithms of spot rate and 3 month forward rate predicted 3 months earlier: ($\sum \varepsilon_t$)/12 (AVG, hereafter); a positive value implies an unexpected appreciation in uncertainty, a negative value unexpected depreciation.
iii. the average of the absolute value of the 12 monthly differences: ($\sum | \varepsilon_t |$)/12 (ABS, hereafter).

To capture short run uncertainty, we lag each 3 months, i.e. for each year the 12 monthly data is from October of the previous year to September of the current year. The average of differences (AVG), which can either be negative or positive, captures the direction of exchange rate uncertainty; whereas the standard deviation (FSSD) and the average of absolute differences (ABS) are two proxies for the size or magnitude of the uncertainty.

Table 1 shows correlations between the three measures. The FSSD measure is strongly correlated with ABS, with a correlation of 0.75. AVG in contrast would appear to behave very differently, and the correlation with FSSD is negative. All correlations are small in size. Using the direction of the forecast error clearly captures a different aspect of uncertainty.

In Figure 1 we present the uncertainty measures across time for 8 representative industries. One feature of the data is worthy of note and has a significant bearing on the empirical evidence presented below. There is a large change for the UK for 1993 under all of the measures. This coincides with the UK's withdrawal from the European Exchange Rate

[5] We include China, Hong Kong, Taiwan, Singapore and Canada into the US dollar area as the currencies in these areas were pegged the US dollar for most of the period we investigate.

Mechanism (ERM), known colloquially as "Black Wednesday" (16 September 1992).[6] The data show that in the period leading up to this the forward rate expectation was that sterling would remain within the allowed fluctuation bands of +/-6%. The devaluation of sterling meant that the spot rate in period *t* was therefore very different from the expectation in period t-1, when export contracts were written. This is captured as an unexpected depreciation of sterling under the AVG measure and an increase in volatility under the FSSD and ABS measures.

3. Firm Date and Methodology

3.1 Firm data

Our firm level panel dataset is constructed from the Bureau Van Dijk database *Financial Analysis Made Easy* (FAME) database and from *OneSource,* used by amongst others, Girma et al. (2004) and Greenaway and Kneller (2007b). The data cover the 17 year period from 1988 to 2004. After removing firms with missing values we are left with a sample of 44, 252 observations on 5,876 companies. It has an unbalanced structure, with an average of 8 observations per firm.[7]

3.2 Methodology

We adopt a two-stage sample selection model. Our econometric analysis accounts for both decisions and the fact that they are interdependent.[8] Two equations are estimated,

$$y^*_{it} = x_{i,t-1}\beta + u_{it} \text{ (outcome equation: export intensity/export share);} \quad (1)$$

$$d^*_{it} = z_{i,t-1}\gamma + v_{it} \text{ (selection equation: export participation);} \quad (2)$$

with $y_{it} = y^*_{it}$ *if* $d_{it} = 1$ $\qquad y_{it} = 0$ *if* $d_{it} = 0$

and $d_{it} = 1$ *if* $d^*_{it} > 0$ $\qquad d_{it} = 0$ *if* $d^*_{it} \leq 0$

Thus, the observed y_{it}, which is the export share, is zero when the firm decides not to export ($d_{it} = 0$) and positive when it exports ($d_{it} = 1$). The distribution of the error terms (u_{it}, v_{it}) is assumed to be bivariate normal with correlation ρ. The two equations are related if $\rho \neq 0$. In this case estimating only the export share regression would induce sample selection bias in the

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[6] As our annual uncertainty measures are calculated using 3-month lagged monthly data, annual measures for 1993 are computed by monthly data from October 1992 to September 1993. The effects of the ejection from the ERM thus appear in the data in 1993.

[7] See Greenaway, Kneller and Zhang (2007) for summary statistics of characteristics of UK manufacturing firms.

[8] Kneller and Pisu (2005) and Karpaty and Kneller (2005) adopt the same methodology.

estimate of β due to the error term u_{it}, and the regressor x would be correlated. To avoid this problem both equations must be estimated via maximum likelihood or a two-step method proposed by Heckman (1979). We employed the former as it is more efficient.[9]

The independent variables used in the selection equation are as follows: $Uncertainty_{it}$: the 3-digit industry –specific exchange rate uncertainty; $inREER_{it}$: the 3-digit industry-specific REER as in Greenaway, Kneller and Zhang (2007); emp_{it} : the log number of employees; $Wage_{it}$: the average wage; $laborprod_{it}$: labour productivity; $foreign_i$: a dummy equal to 1 if the firm is foreign owned, and 0 otherwise; exp_{it}: a dummy variable equals to 1 if firm i exported in year t, and 0 otherwise.

4. Results

The results of the baseline sample selection model are shown in Table 2. These suggest differences between the effects of uncertainty on the intensive and extensive margins and between different measures of uncertainty. In no case do we find a correlation between uncertainty and the extensive margin, but a significant correlation for two of the three measures for the intensive margin. The exception is the absolute forecast error (ABS) in Column 3. The two significant measures of uncertainty have differently signed effects on the intensive margin however. In Column 1 greater uncertainty positively affects the export intensity of firms; whereas in Column 2 greater uncertainty leads to lower trade.

While in some models uncertainty is predicted to have a positive relationship with exports, this is unexpected. As indicated above the correlation for this measure relies on the behaviour of uncertainty measures in 1993. To check the sensitivity of our results to the events of the UK's ejection from the ERM we drop the observations in 1993 and repeat the analysis. The results are shown in Table 3. Column 1 we now find that the effects of FSSD become insignificant in both the export entry and export intensity equations. In contrast, the coefficient for AVG in Column 2 is still negative and significant.[10] According to our results, whether or not the uncertainty changes greatly in magnitude, it has little impact on the export behaviour of firms. What matters is the direction of the asymmetric uncertainty movements.

[9] See Greene (2003) for the discussion.
[10] The results using the conventional standard deviation of first differences of the logarithmic spot exchange rates (SD) as the measure and dropping observations for 1993 show that the coefficient for SD in export intensity equation is still positive and strongly significant as before.

5. Conclusions

In this paper we investigate the responsiveness of exports of UK firms to different measures of exchange rate uncertainty. We find conclusively that they have no effect on the decision to participate in export markets. Of the effect on the intensive margin of firm exports there is an unexpected positive relationship for measures that do not control for the direction of the forecast error. This correlation is driven by the use of a single year of data. Once controlled for we find that only the direction of uncertainty, whether an appreciation or depreciation was expected is important for exports. Our results provide an indirect way to test the hysteresis hypothesis.

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Table 1: Correlation Matrix for Uncertainty Measures

	FSSD	ABS	AVG
FSSD	1.000		
ABS	0.748	1.000	
AVG	-0.445	0.127	1.000

Figure 1: 3-digit Industry Specific Exchange Rate Uncertainty

Note:
FSSD: the standard deviation of the 12 monthly differences between spot rate and forward rate.
AVG: the average of the 12 monthly differences between spot rate and forward rate.
ABS: the average of the 12 monthly absolute value of differences between spot rate and forward rate.

Table 2: Heckman Selection Model (MLE): Uncertainty

	(1) Uncertainty: FSSD		(2) Uncertainty: AVG		(3) Uncertainty: ABS	
	Export Dummy	Export Share	Export Dummy	Export Share	Export Dummy	Export Share
Lag Export dummy	3.04 (39.99) ***		3.04 (39.94) ***		3.04 (39.95) ***	
LagIndustry REER	0.002 (0.32)	-0.004 (-2.03) **	0.00201 (0.32)	-0.0037 (-1.98) **	0.00215 (0.34)	-0.00393 (-2.02) **
Lag log of employment	0.0435 (2.31) **	0.0021 (0.47)	0.0435 (2.31) **	0.00212 (0.45)	0.0435 (2.31) **	0.00206 (0.44)
Lag log of wage	0.036 (0.74)	0.0914 (3.08) ***	0.0366 (0.74)	0.091 (3.07) ***	0.0363 (0.73)	0.0915 (3.09) ***
Lag log of labor prod.	0.0374 (1.19)	-0.01 (-1.08)	0.0374 (1.19)	-0.010 (-1.07)	0.0374 (1.19)	-0.0101 (-1.09)
Lag log of age	-0.0244 (-1.56)	-0.0097 (-2.55) **	-0.0244 (-1.56)	-0.0097 (-2.53) **	-0.0244 (-1.56)	-0.0096 (-2.53) **
Foreign dummy	0.132 (4.27) ***	0.058 (6.80) ***	0.1316 (4.26) ***	0.058 (6.81) ***	0.1318 (4.26) ***	0.058 (6.80) ***
Uncertainty (FSSD)	2.30 (0.15)	4.486 (1.83) *				
Uncertainty (AVG)			3.23 (0.34)	-5.144 (-2.18) **		
Uncertainty (ABS)					-0.42 (-0.03)	-0.623 (-0.27)
Uncertainty (SD)						
Lambda (std. error)	-0.034 (0.006)***		-0.0339 (0.006)***		-0.034 (0.006)***	
Rho (std. error)	-0.1327 (0.021)***		-0.1323 (0.021)***		-0.1331 (0.021)***	

Observations: 44, 251 Firms: 5, 876

Notes: (i) Z statistics in parentheses, robust standard errors adjusted for 83 clusters in 3-digit industries.
(ii) *significant at 10%; ** significant at 5%; *** significant at 1%
(iii) ρ is the estimated correlation between the error terms of the two equations; if it is different from zero it suggests that the two equations are related and that the selection model is appropriate; λ is the estimated coefficients of the inverse Mills ratio; if it is different from zero it suggests that there is sample selection.

Table 3: Heckman Selection Model (MLE): Robustness

	(1) Uncertainty: FSSD without 1993		(2) Uncertainty: AVG without 1993	
	Export Dummy	Export Share	Export Dummy	Export Share
Lag Export dummy	3.04 (40.12) ***		3.04 (40.07) ***	
LagIndustry REER	0.003 (0.45)	-0.0042 (-2.07) **	0.0028 (0.41)	-0.004 (-2.04) **
Lag log of employment	0.0429 (2.20) **	0.0028 (0.59)	0.04295 (2.20) **	0.0028 (0.59)
Lag log of wage	0.0425 (0.88)	0.097 (3.72) ***	0.0427 (0.88)	0.097 (3.71) ***
Lag log of labor prod.	0.033 (1.05)	-0.011 (-1.13)	0.033 (1.06)	-0.011 (-1.13)
Lag log of age	-0.0253 (-1.60)	-0.0104 (-2.80) ***	-0.0254 (-1.61)	-0.0104 (-2.79) ***
Foreign dummy	0.139 (4.26) ***	0.058 (6.87) ***	0.139 (4.26) ***	0.058 (6.88) ***
Uncertainty (FSSD)	-3.01 (-0.18)	3.34 (1.46)		
Uncertainty (AVG)			6.56 (0.66)	-4.43 (-2.01)**
Lambda (std. error)	-0.0335 (0.006)***		-0.033 (0.006)***	
Rho (std. error)	-0.1305 (0.022)***		-0.1300 (0.022)***	

Notes: See notes for Table 2.