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Short-Run and Long-Run Effects of Exchange Rate Volatility on the Volume of Exports: A Case Study for Pakistan

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Abstract

This paper investigates empirically the impact of exchange rate volatility on Pakistan's exports to its major trading partners under the floating exchange rate regime for the period 1985 to 2001. Estimates of the co-integrating relations are obtained using Johansen's technique, and estimates of the short-run dynamics are obtained utilizing an error-correction model. The major findings indicate that increases in exchange rate volatility approximated by the conditional variance of exchange rates exert a significant negative effect upon the volume of exports in the short-run.

Key words: ARCH; exchange rate volatility; exports; error-correction model

JEL classification: F14; F31; F41

1. Introduction

After the collapse of the fixed exchange rate system among major industrial countries, many developing countries responded by attempting to sustain fixed exchange rate parities. Over time, however, the majority of these countries have also moved toward flexible exchange rate adjustments (see Agenor and Montiel, 1999; Caramazza and Aziz, 1998). Frequent adjustments have resulted in a high degree of volatility in exchange rate movements that may affect trade flows. However, the existing economic literature presents conflicting evidence pertaining to the relationship between exchange rate volatility and trade flows.

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A number of studies have argued that exchange rate volatility hinders exports. If traders are risk-averse, uncertainty in the exchange rate causes them to trim down their activities to reduce their exposure to the effects of exchange rate volatility. This view is based on the notion that if exchange rate volatility increases, profit risk increases, which in turn reduces the benefits and consequently the volume of exports; see for example Akhtar and Hilton (1984), Coes (1981), Cushman (1988, 1983), Kenen and Rodrick (1986), Koray and Lastrapes (1989), Thursby and Thursby (1987), Chowdhury (1993), Arize (1995, 1999), Peree and Steinherr (1988), and Adjaye (1998). In contrast, Asseery and Peel (1991), Franke (1991), Giovannini (1988), Kroner and Lastrapes (1993), and Sercu and Vanhulle (1992) have found contrary evidence: that there has been a positive significant relationship between trade flows and exchange rate volatility.

In the context of Pakistan's economy, few studies have considered exchange rate volatility as a determinant of export demand and its impact on the volume of exports; see for example Aftab and Aurangzeb (2002), Akhter and Malik (2000), Khan and Aftab (1995), and Hasan and Khan (1994). Kumar and Dhawan (1991) is an exception. However, the this study was not focused on stationarity and co-integration properties of the underlying series, and the authors did not use an autoregressive conditional heteroskedastic (ARCH) type model to measure volatility—something that is now considered to be standard practice. Hence, our study represents the first attempt to apply such an approach to the case of Pakistan.

The objective of this paper is to analyze the impact of exchange rate volatility on the volume of Pakistan's exports with its major trading partners by applying multivariate co-integration techniques to estimate the long-run export demand function as developed by Johansen (1988) and Johansen and Juselius (1990). In addition, the paper investigates the short-run relationship within the vector error-correction modeling (VECM) framework. Furthermore, we estimate exchange rate volatility within an ARCH framework and its generalization GARCH; see Engle (1982, 1983) and Bollerslev (1986).

The paper contributes in two ways. First, it examines the extent to which exchange rate volatility affects exports among the other export demand variables. Second, on the methodological side, using Johansen co-integration VECM modeling and the Pagan and Schwert (1990) criterion for the selection of an optimal ARCH/GARCH model, we obtain results that are more robust. The remainder of the paper is organized in four sections. Section 2 presents the specification of the model and the methodology used. Section 3 describes the data. Empirical results are discussed in Section 4. The last section concludes and provides policy implications.

2. Model Specification and Econometric Framework

The traditional specification of the long-run equilibrium export demand in the flexible exchange rate environment has the following general form:

$$X_t^d = \alpha_0 + \alpha_1 Y_t^f + \alpha_2 RP_t + \alpha_3 \sigma_t + \varepsilon_t , \tag{1}$$

where X_t^d denotes total exports in real terms, Y_t^f is a measure of real economic activity (GDP adjusted with an index of industrial production) of a trading partner, RP_t represents relative prices and is measured as the ratio of domestic export price to the export price of the trading partner, σ_t is a measure of volatility, and ε_t is a random disturbance. All variables are in logarithmic form.

If foreign income rises, the demand for exports is expected to rise, so α_1 is expected to be positive. If relative prices rise, the demand for exports is expected to fall, therefore α_2 is expected to be negative. However, at this point it is difficult to identify the effect of exchange rate uncertainty on exports, so α_3 could be negative or positive. Before moving to the next section, it is necessary to derive an operational measure of exchange rate uncertainty. In this paper, the exchange rate volatility is obtained within an ARCH-GARCH framework.

We assume that the exchange rate is generated as

$$e_t = \xi_t \beta + u_t \text{, with } u_t \sim \mathrm{N}(0, \sigma_t^2), \tag{2}$$

$$\sigma_t^2 = v_t \alpha , \tag{3}$$

where e_t is the log difference of the exchange rate series (a proxy for returns on the exchange rate), ξ_t is a vector of variables in the information set O_t given at time t and contributing to the conditional mean of e_t, and v_t is a vector of variables also in the information set at t and contributing to the conditional variance of e_t. The estimation of the parameter vectors $\{\alpha_t, \beta_t\}$ can be obtained using maximum likelihood. Several specific assumptions must be made concerning the elements of the vectors ξ_t and v_t on which the mean of the exchange rate is conditioned. First, we assume that exchange rate uncertainty is generated by an ARMA(p,q) process:

$$e_t = \gamma_0 + \sum_{i=1}^{p} \gamma_i e_{t-i} + u_t - \sum_{j=1}^{q} \gamma_j u_{t-j} . \tag{4}$$

It is further assumed that the disturbances from equation (4) are not autocorrelated and that equation (3) can be modeled as a pth order ARCH process:

$$\sigma_t^2 = h_0 + \sum_{i=1}^{p} h_i u_{t-i}^2 . \tag{5}$$

We follow the strategy proposed by Pagan and Schwert (1990) to select the optimal model among many possible candidate choices of ARCH-GARCH specifications. We also require that all candidate models satisfy two additional criteria: convergence within 25 iterations and statistically significant parameter estimates; see McKenzie (1997) for details. The optimal model selected on the basis of the Pagan and Schwert (1990) procedure within the class of well-behaved models in terms of convergence and statistical adequacy is then used to estimate exchange rate volatility. In most cases, we find a first- or second-order ARCH process is an appropriate model to measure exchange rate volatility, except in the case of France where we find an ARCH process of order three. For the order of the selected ARCH models for each bilateral exchange rate series, see Table 1 in Appendix A.

To examine whether there is a long-run equilibrium relationship among the variables in equation (1), we employ the method of multivariate co-integration developed by Johansen and Juselius (1990). The basic idea of co-integration is that two or more variables may be regarded as defining a long-run equilibrium relationship if they move close together in the long run, even though they may drift apart in the short run (see Engle and Granger, 1987).

Prior to testing for co-integration, the time-series properties of the individual variables in equation (1) should be investigated. If the variables are stationary, conventional regression procedures are appropriate. However, if the variables are nonstationary with time-dependent means and variances, then tests of co-integration are necessary to establish long-run relationships. The Dickey-Fuller and the Phillips-Perron tests are employed to test the unit root.

If a long-run relationship exists among the variables, Granger causality tests should be conducted within a VECM to avoid misspecification. The Granger causality test is implemented by calculating the F-statistic based on the null hypothesis that the coefficients of the lagged values of independent variables are not statistically different from zero. If the null hypothesis is not rejected, then it can be concluded that the independent variable does not Granger-cause the dependent variable. Finally, in order to examine the dynamic properties of the model, we plot the cumulative coefficients of the lags of the exchange rate volatility variable obtained from the VECM.

3. Data and Variable Definitions

This study employs monthly data from 1985:1 to 2001:12 on Pakistan's export volumes, domestic export price index, bilateral exchange rates with ten major trading partners (Canada, France, Germany, Italy, Japan, Netherlands, Singapore, Spain, UK, and USA), and trading partner export price indexes and indexes of industrial production as proxies for income. All variables are taken directly from International Financial Statistics publications of the IMF and the Statistical Bulletin of State Bank of Pakistan except for the measure of exchange rate volatility. All the indices used in this study have base year 1995. The nominal bilateral exchange rate with trading partners is also taken from International Financial Statistics. The series of conditional variance of each bilateral exchange rate is obtained using ARCH-GARCH methodology. We focus on nominal instead of real exchange rate variability since the former is a monetary instrument that policy makers can directly influence, particularly in developing countries. In practice, however, both nominal and real exchange rates move very closely and the choice of which one to use is not likely to affect significantly the measured volatility or the econometric results; see Tenreyro (2003).

4. Empirical Results

Unit-Root and Co-integration Tests

The results of the augmented Dicky-Fuller and the Phillips-Perron tests for the aggregate variables and the country-specific variables are reported in Tables 2 and 3, respectively. The results indicate that all variables are stationary at first difference at least at the 5% level of significance. Hence, the results confirm that all the series under consideration are integrated of order one.

The next step is to apply the system-based co-integration procedure as developed by Johansen in order to test the presence of long-run equilibrium relationships among the variables in equation (1). The procedure is applied both for the aggregate export demand function of the ten trading partners (using a weighted average of exports, export prices, and exchange rate volatility variables of the ten trading partners) and for the country-specific export demand function for USA, UK Germany, and Japan. The results obtained from the Johansen method are reported in Tables 4 and 5, respectively.

Starting with the null hypothesis of no co-integration ($r = 0$) among the four variables (exports, foreign income, relative prices, and exchange rate volatility), the trace and maximal eigenvalue statistics are reported, and they both reject the null hypothesis at the 5% significance level. Hence, we conclude that there is at least one co-integrating equation in most cases, except in the case of the aggregate model and the US model, where both $\lambda_{\max}$ and λ_{trace} tests suggest the existence of two co-integrating equations. Since a co-integrating relationship occurs whenever the trend in one variable can be expressed as the linear combination of the trends in other variables, it is always possible to get more than one linear combination that will be stationary. We are interested in normalization on the basis of real exports, though the fundamentals of our analysis do not change if we use some other normalization since we would still be operating at a long-run equilibrium.

Long-Run Co-integrating Vector Estimates

The long-run parameters estimated using the Johansen technique are normalized on the basis of the exports variable by setting its estimated coefficient at -1. The coefficients are given in Table A. The long-run coefficients of relative prices and foreign income are significant and have the expected signs, while the exchange rate volatility coefficient is negative but insignificant. The demand for Pakistan's exports would, therefore, appear to be income elastic, relative price inelastic, and unaffected by exchange rate uncertainty in the long run.

Despite some variations in the magnitude of the coefficients across destination markets, the general results for Pakistan's aggregate exports to its major trading partners are corroborated by the country-specific analysis. In each case, growth in foreign industrial production has a positive and significant influence on export demand. The estimated coefficient of the relative price variable is negative and significant in all cases. Price elasticity is less than one in all cases with the exception of exports to Japan, where we find significant price elasticity with a magnitude greater than unity. The country specific results appear to confirm that demand for Pakistan's exports is relative price inelastic.

Table A. Estimated Long-Run Parameters

Coefficients Normalized on the Basis of Real Exports					
Variables	Coeff[a]	Coeff[b]	Coeff[c]	Coeff[d]	Coeff[e]
X_t^d	−1	−1	−1	−1	−1
RP_t	−0.94*	−0.95*	−1.85*	−0.80*	−0.50*
Y_t^f	1.86*	1.21*	1.74*	1.13*	3.41*
σ_t	−0.11	−0.19	−0.17	−0.07	−0.14
Constant	0.89	2.77*	2.32*	5.28*	−14.4*

Note: * represents significance at the 5% level.

[a] normalized vector for the aggregate export demand function for all ten trading partners

[b] normalized vector for the export demand function for Germany

[c] normalized vector for the export demand function for Japan

[d] normalized vector for the export demand function UK

[e] normalized vector for the export demand function USA

Short-Run VECM Estimation

According to Engle and Granger (1987), co-integrated variables must have a VECM representation. The major advantage of the VECM representation is that it avoids problems of spurious correlation between dependent and explanatory variables and makes use of any short- and long-run information in the data. Table B presents the Granger-causality results in the VECM framework. The sign of the cumulative coefficients and their respective F-statistics are given in Table B. (Detailed results behind Table B are given in Table 6 of Appendix A). The lag length for each variable and the sequence in which the variables are entered in the VECM were selected using Akaike (1969) information, the final prediction error (FPE), and the Caines et al. (1981) specific gravity (SGC) criterion respectively.

The symbol Δ is the first difference operator and the ε_t are disturbances. The regressor EC_{t-1} corresponds to the one-year lagged error-correction term. The EC_{t-1} term carries the theoretically predicted sign and is significant at the 5% level in all cases; see Table 5 in Appendix A. With the dynamic specification of the model, the short-run dynamics are influenced by the deviation from the long-run relationship as captured by EC_{t-1}. The speed of adjustment (measured by the coefficient of the EC_{t-1} term) is quite rapid, and 25% to 40% of the disequilibrium is eliminated in one month. These results indicate that the adjustment of real exports to any change in the right hand side variables of the model does not take a long time to return to equilibrium; market forces in the export market restore equilibrium rapidly.

Table B. Error-Correction Specification

Aggregate VECM:

$$\Delta X_t = -\sum_{i=1}^{2} \beta_{1i} \Delta X_{t-i} - \sum_{j=1}^{2} \beta_{2j} \Delta RP_{t-j} + \sum_{k=1}^{2} \beta_{3k} \Delta Y_{t-k}^{f} - \sum_{m=1}^{4} \beta_{4m} \Delta \sigma_{t-m} - \beta_5 EC_{t-1} + \varepsilon_t$$

[24.71]* [4.28]** [3.87]** [3.83]** (-2.99)**

Country-Specific VECMs:

Germany:

$$\Delta X_t = -\sum_{i=1}^{2} \beta_{1i} \Delta X_{t-i} - \sum_{j=1}^{3} \beta_{2j} \Delta RP_{t-j} + \sum_{k=1}^{1} \beta_{3k} \Delta Y_{t-k}^{f} - \sum_{m=1}^{3} \beta_{4m} \Delta \sigma_{t-m} - \beta_5 EC_{t-1} + \varepsilon_t$$

[37.80]* [8.62]* [15.15]* [6.81]* (-5.00)*

Japan:

$$\Delta X_t = -\sum_{i=1}^{2} \beta_{1i} \Delta X_{t-i} - \sum_{j=1}^{2} \beta_{2j} \Delta RP_{t-j} + \sum_{k=1}^{4} \beta_{3k} \Delta Y_{t-k}^{f} - \sum_{m=1}^{3} \beta_{4m} \Delta \sigma_{t-m} - \beta_5 EC_{t-1} + \varepsilon_t$$

[10.45]* [5.93]** [4.73]** [4.23]** (-3.58)*

United Kingdom:

$$\Delta X_t = -\sum_{i=1}^{2} \beta_{1i} \Delta X_{t-i} - \sum_{j=1}^{2} \beta_{2j} \Delta RP_{t-j} + \sum_{k=1}^{4} \beta_{3k} \Delta Y_{t-k}^{f} - \sum_{m=1}^{4} \beta_{4m} \Delta \sigma_{t-m} - \beta_5 EC_{t-1} + \varepsilon_t$$

[28.28]* [7.52]* [4.75]** [7.02]* (-4.38)*

United States:

$$\Delta X_t = -\sum_{i=1}^{2} \beta_{1i} \Delta X_{t-i} - \sum_{j=1}^{1} \beta_{2j} \Delta RP_{t-j} + \sum_{k=1}^{2} \beta_{3k} \Delta Y_{t-k}^{f} - \sum_{m=1}^{4} \beta_{4m} \Delta \sigma_{t-m} - \beta_5 EC_{t-1} + \varepsilon_t$$

[33.72]* [14.02]* [6.00]** [5.49]** (-4.09)*

Notes: The values in parentheses are t-statistics. The values in square brackets are F-statistics. * and ** denote significance at the 1% and 5% levels.

The results indicate that exchange rate volatility in all cases with the exception of the UK affects real exports negatively in the short run. A possible interpretation of the positive sign of the exchange rate volatility coefficient for the UK case could be that longstanding business relations between many Pakistani and British trading partners include arrangements to help eliminate exchange rate risk, such as open account agreements, especially for intra-firm trade between divisions of multinational firms. Therefore, in general, we conclude that increases in exchange rate volatility force risk-averse producers to favour domestic over international trade or international partners that shelter them from this uncertainty. Therefore, overall, exports are negatively affected by uncertainty in exchange rates.

Cumulative Coefficient Plots

We also plot the cumulative coefficients of the exchange rate volatility variable obtained from the VECM. For cumulative coefficients, see Table 7 in Appendix A.

Figure 1. Aggregate VECM

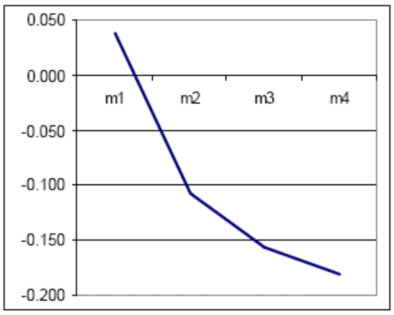


Figure 2. VECM for Germany

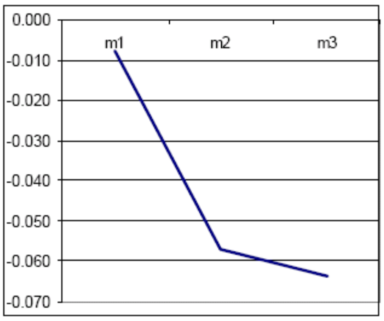


Figure 3. VECM for Japan

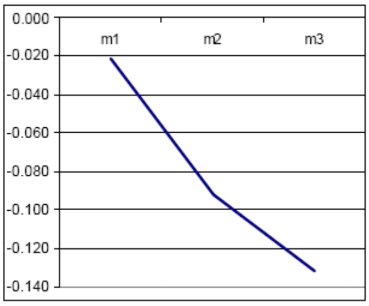
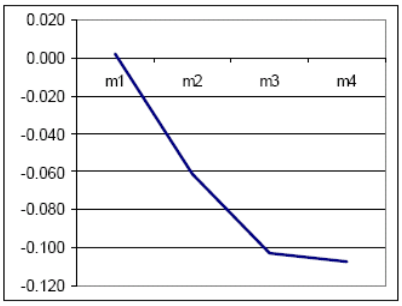


Figure 4. VECM for US



Notes: Figures 1 to 4 present cumulative coefficient plots of the lags of the σ_t variable obtained from the VECM models.

The above plots suggest that the growth in real exports is responsive to the increase in exchange rate volatility up to four months. The implication of this is that the negative effect due to exchange rate uncertainty lasts up a quarter and after that real exports return to its equilibrium level.

5. Summary and Conclusions

In this paper we examine the impact of exchange rate volatility on Pakistan's exports to its major trading partners using monthly data from January, 1985, to December, 2001. The impact of exchange rate volatility on exports is examined using Johansen co-integration methods, and exchange rate volatility is measured using an ARCH model. The results indicate the presence of a long-run equilibrium relationship between real exports, foreign income, relative prices, and exchange rate volatility.

Short-run relationships are estimated in a VECM framework and suggest that

that there is a negative causality running from the volatility to exports in all cases (except UK), implying that domestic producers are generally risk-averse. In other words, increased exchange rate volatility increases uncertainty about future exchange rate behavior. Therefore, exporters prefer to sell in domestic markets rather than foreign markets, adversely affecting exports.

It is worth noting that the approach we employ in this study is characterized by a number of econometric features. First, the data set used in this study covers the era in which Pakistan adopted a floating exchange rate, and this allows us to address the stability over time of the estimated dynamic models during this period. Second, by considering a VECM, this study avoids spurious regression problems. In terms of adjustments made to the long-run equilibrium, the error-correction term EC_{t-1} is statistically significant. Finally, each estimated model satisfies several recently developed diagnostic tests.

Our results support the hypothesis that exchange rate volatility has a negative effect on real exports. Exporters are risk-averse in Pakistan. This means that, with an increase in exchange rate volatility, exporters reduce their exports in order to reduce their risk exposure. Therefore, a stabilization policy aimed at mitigating excessive exchange rate volatility is an appropriate strategy to promote exports in a country like Pakistan.

Appendix A

Table 1. Order of the Selected ARCH Models for Each Bilateral Exchange Rate

Country Name	ARCH[*q*]
Canada	[2]
Germany	[1]
Spain	[1]
France	[3]
UK	[2]
Italy	[1]
Japan	[1]
Netherlands	[1]
Singapore	[2]
USA	[2]

Table 2. Results of Unit Root Test for Variables in Aggregate Export Function

	ADF Test at First Differences		PP Test at First Differences	
	Without Trend	With Trend	Without Trend	With Trend
X_t^d	−6.73*	−6.84*	−27.38*	−27.38*
RP_t	−4.71*	−4.71*	−8.35*	−8.33*
Y_t^f	−3.14**	−4.38**	−5.59*	−7.94*
σ_t	−9.54*	−9.51*	−19.13*	−19.08*

Note: *, **, and *** denote significance at 1%, 5%, and 10% levels.

Table 3. Results of Unit Root Test for Variables in Country-Specific Export Functions

	ADF Test at First Differences		PP Test at First Differences	
	Without Trend	With Trend	Without Trend	With Trend
Germany:				
RP_t	−4.47*	−4.46*	−8.48*	−8.46*
Y_t^f	−2.96***	−3.15**	−22.10*	−22.11*
σ_t	−8.93*	−8.91*	−45.04*	−44.95*
Japan:				
RP_t	−7.12*	−7.17*	−8.72*	−8.69*
Y_t^f	−2.83***	−3.31***	−19.21*	−19.64*
σ_t	−10.83*	−10.80*	−30.43*	−30.34*
United Kingdom:				
RP_t	−5.79*	−5.77*	−8.71*	−8.69*
Y_t^f	−3.02**	−3.40***	−20.16*	−20.73*
σ_t	−11.43*	−11.40*	−30.68*	−30.58*
United States:				
RP_t	−5.99*	−5.99*	−8.47*	−8.44*
Y_t^f	−3.28**	−3.32***	−12.16*	−12.14*
σ_t	−9.40*	−9.38*	−24.93*	−24.87*

Note: *, **, and *** denote significance at 1%, 5%, and 10% levels.

Table 4. Johansen Co-integration Test Results of Aggregate Export Demand Function (Variables: Real Exports, Foreign GDP, Relative Prices, and Exchange Rate Volatility)

Maximal Eigenvalue Test				**Trace Test**			
Null H_0	**Alternative** H_1	**Eigen-Value**	**Critical Value (95%)**	**Null** H_0	**Alternative** H_1	**LR-ratios**	**Critical Value (95%)**
$r = 0$	$r = 1$	40.65	28.14	$r = 0$	$r > 1$	94.68	53.12
$r = 1$	$r = 2$	37.95	22.00	$r \leq 1$	$r > 2$	54.03	34.91
$r = 2$	$r = 3$	9.93	15.67	$r \leq 2$	$r > 3$	16.08	19.96
$r = 3$	$r = 4$	6.15	9.24	$r \leq 3$	$r > 4$	6.15	9.24

Note: r denotes the number of co-integrating vectors.

Table 5. Johansen Co-integration Test Results of Country-Specific Export Demand Functions (Variables: Real Exports, Foreign GDP, Relative Prices, and Exchange Rate Volatility)

Maximal Eigenvalue Test				Trace Test			
Null H_0	**Alternative** H_1	**Eigen-Value**	**Critical Value (95%)**	**Null** H_0	**Alternative** H_1	**LR-ratios**	**Critical Value (95%)**
Germany:							
$r=0$	$r=1$	35.77	28.14	$r=0$	$r>1$	72.59	53.12
$r=1$	$r=2$	16.47	22.00	$r\leq1$	$r>2$	36.82	34.91
$r=2$	$r=3$	10.47	15.67	$r\leq2$	$r>3$	20.35	19.96
$r=3$	$r=4$	9.88	9.24	$r\leq3$	$r>4$	9.88	9.24
Japan:							
$r=0$	$r=1$	38.31	28.14	$r=0$	$r>1$	69.42	53.12
$r=1$	$r=2$	14.76	22.00	$r\leq1$	$r>2$	31.11	34.91
$r=2$	$r=3$	13.57	15.67	$r\leq2$	$r>3$	16.35	19.96
$r=3$	$r=4$	2.78	9.24	$r\leq3$	$r>4$	2.78	9.24
United Kingdom:							
$r=0$	$r=1$	41.07	28.14	$r=0$	$r>1$	77.46	53.12
$r=1$	$r=2$	16.86	22.00	$r\leq1$	$r>2$	36.39	34.91
$r=2$	$r=3$	13.95	15.67	$r\leq2$	$r>3$	19.53	19.96
$r=3$	$r=4$	5.58	9.24	$r\leq3$	$r>4$	5.58	9.24
United States:							
$r=0$	$r=1$	42.32	28.14	$r=0$	$r>1$	83.23	53.12
$r=1$	$r=2$	22.02	22.00	$r\leq1$	$r>2$	40.91	34.91
$r=2$	$r=3$	11.76	15.67	$r\leq2$	$r>3$	18.89	19.96
$r=3$	$r=4$	7.13	9.24	$r\leq3$	$r>4$	7.13	9.24

Note: r denotes the number of co-integrating vectors.

Table 6. Detailed Summary of Country-Specific VECM

Variables	Aggregate	Germany	Japan	UK	USA
ΔX^{d}_{t-1}	−0.254 (3.67)	−0.248 (3.29)	−0.121 (1.59)	−0.210 (2.80)	−0.318 (4.29)
ΔX^{d}_{t-2}	−0.166 (3.04)	−0.136 (2.30)	−0.028 (0.41)	−0.135 (2.21)	−0.192 (3.18)
ΔRP_{t-1}	−0.344 (0.91)	−0.452 (0.79)	0.026 (0.06)	−0.253 (0.48)	−1.306 (2.59)
ΔRP_{t-2}	−0.109 (0.29)	−1.034 (1.64)	−0.482 (1.03)	−0.213 (0.40)	
ΔRP_{t-3}		1.046 (1.90)			
ΔY^{f}_{t-1}	2.924 (1.32)	0.994 (1.44)	0.155 (0.11)	1.149 (0.89)	4.083 (0.81)
ΔY^{f}_{t-2}	−2.314 (1.07)		−2.237 (1.54)	−1.871 (1.39)	−2.257 (0.46)
ΔY^{f}_{t-3}			−0.501 (0.36)	0.199 (0.14)	
ΔY^{f}_{t-4}			3.000 (2.42)	0.645 (0.48)	
$\Delta \sigma_{t-1}$	0.039 (1.27)	−0.008 (0.31)	−0.021 (0.77)	0.086 (4.10)	0.002 (0.13)
$\Delta \sigma_{t-2}$	−0.054 (1.55)	−0.029 (0.83)	−0.046 (1.36)	0.052 (2.08)	−0.031 (1.67)
$\Delta \sigma_{t-3}$	−0.049 (1.40)	−0.007 (0.29)	−0.040 (1.31)	0.054 (2.14)	−0.042 (2.25)
$\Delta \sigma_{t-4}$	−0.024 (0.79)			0.029 (1.31)	−0.004 (0.25)
Dum7	−0.328 (10.44)	−0.317 (7.81)	−0.292 (6.11)	−0.342 (7.37)	−0.200 (4.45)
Dum12	0.152 (5.40)	0.207 (5.46)	0.064 (1.42)	0.131 (3.23)	0.312 (7.35)
EC_{t-1}	−0.242 (2.99)	−0.414 (4.99)	−0.245 (3.58)	−0.329 (4.38)	−0.316 (4.09)
Summary Statistics					
Adj. R^2	0.60	0.60	0.35	0.51	0.57
DW	2.01	2.01	2.06	1.85	1.68
F_{corr}	0.93	0.93	1.78	1.74	2.77
F_{het}	1.04	1.04	1.68	0.32	1.02

Notes: Figures in parentheses are t-statistics. The (one-tail) 5% and 10% critical values are 1.67 and 1.3. DW tests first-order residual autocorrelation. F_{corr} is the F-statistic of the LM test for m^{th}-order residual autocorrelation. F_{het} is F-stats for LM test for testing autoregressive conditional heteroskedasticity. Dum7 and Dum12 are seasonal dummies introduced to capture the impact of the first and last year of the fiscal and annual year respectively.

Table 7. Summary of VECM and Cumulative Coefficients

Coefficients from the VECM				
	Aggregate	Germany	Japan	US
m1	0.039	−0.008	−0.021	0.002
m2	−0.054	−0.029	−0.046	−0.031
m3	−0.049	−0.007	−0.040	−0.042
m4	−0.024			−0.004
Cumulative Coefficients				
m1	0.039	−0.008	−0.021	0.002
m2	−0.108	−0.057	−0.092	−0.061
m3	−0.157	−0.064	−0.132	−0.103
m4	−0.181			−0.107

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