Price Stability or Export Competitiveness ?

A DCC Analysis of Exchange Rate Correlation between the Australian and Kiwi Dollars

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Abstract

This paper proposes a simple asymmetric DCC model to investigate possible asymmetric dynamics in exchange rate correlation between the Australian and Kiwi dollars. We ask whether price stability dominates, or is dominated by, export competitiveness in the objective functions of the two countries' policymakers. Our results show that the exchange rates of the two currencies are more strongly correlated during appreciations than during depreciations against four world currencies, indicating a stronger desire of the Australian and New Zealand governments to maintain price stability than to maintain high export competitiveness. It is also implied that the value of portfolio diversification involving assets from the two countries varies over time, and would be overstated if asymmetry in exchange rate correlations between the two currencies was ignored.

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1. Introduction

The literature on the relation among spot exchange rates for different currencies has focused on testing for the existence of cointegration. The main issue addressed is whether foreign exchange markets are efficient, and mixed conclusions have been reached (See, for example, Baillie and Bollerslev, 1989; Diebold *et al*, 1994; Baillie and Bollerslev, 1994; and Nielsen, 2004). The detected presence of a cointegrating relation among exchange rates could be due to countries belonging to a common regional monetary system. For example, in the European Monetary System (EMS), member countries were committed to coordinating their currencies to prevent them from deviating too far away from others in the system. The resultant restrictions on the movements between currencies forced them to have a common trend (Norrbin, 1996), although this implies that the foreign exchange markets within the EMS were inefficient.

Another important aspect of the relation among exchange rates is their correlations, and the literature has paid much less attention to this aspect. As one of the two contributions, the present paper investigates asymmetric dynamics in exchange rate correlations for the first time in the literature. Correlation between exchange rates may be dynamic, time-varying and asymmetric, which has important implications for international portfolio diversification. For example, one popular strategy used in practice for achieving international portfolio diversification is to invest in similar assets (e.g., government bonds) in multiple markets (e.g., countries A and B's bond markets). The correlation between bonds A and B's nominal values measured by, say, the US dollar depends on the correlation between the exchange rates of countries A and B's currencies against the US dollar. If the exchange rate correlation varies over time, the amount of such diversification will also change over time. Moreover, in the case of asymmetric correlations, the value of diversification may be overstated if the increase in either downside or upside correlations is not taken into account.

Asymmetry in exchange rate correlations is possible due to several reasons. For example, if two rival countries' policymakers prefer price stability to export competitiveness, their currencies would show greater correlations during appreciations than during depreciations. Conversely, the domination of export competitiveness over price stability in the policymakers' preference would more likely lead the two currencies to fall together than to rise together, although this asymmetry could also be attributed to the portfolio rebalancing behavior of investors. Recently, Patton (2006) examines asymmetric exchange rate dependence between the Deutsch mark and the Japanese yen, and detects greater dependence for depreciating than for appreciating against the US dollar.

As the second contribution, we propose a simple asymmetric dynamic conditional correlation (ADCC) model which modifies the standard DCC model (Engle, 2002) in the spirit of the asymmetric GARCH (AGARCH) model. Our ADCC model proves to be capable of detecting possible asymmetry in correlation without greatly increasing model complexity and the computational burden in estimation. In addition, since our model allows for news impact parameters, we can derive the "news impact surface" (Kroner and Ng, 1998) from the estimated model parameters to examine the correlation asymmetry in a three-dimensional plot. The plot shows intuitively the differences between joint positive and joint negative shocks in terms of their impacts on exchange rate correlation.

We apply this model to the exchange rates of the Australian and Kiwi dollars vis-a-vis four most important currencies in the world. Our key results may be summarized as follows. First, exchange rate correlations between the Australian and Kiwi dollars are found to be time-varying and show strong dynamics. Second, we find that the Australian and Kiwi dollars are more strongly correlated during joint appreciations than during joint depreciations. This latter result can be explained with the reference to the policy targets agreements between the monetary and fiscal authorities in, respectively, Australia and New Zealand (NZ). Based the empirical evidence provided, we argue that price stability dominates export competitiveness in the preferences of the two countries policymakers, unlike the Japanese and German counterparts whose preferences are to the contrary as shown in Patton (2006).

The remainder of the paper is laid out as follows. Section 2 outlines econometric methodology including the ADCC model and the news impact surface. We then report empirical results in section 3 and interpret the results in section 4. Section 5 offers summary and concluding remarks.

2. The asymmetric DCC model and the news impact surface

Let r_t = [r_{1t}, r_{2t}]' be a 2×1 vector containing two exchange rate return series, and r_{it} is obtained by taking the log difference of the exchange rate. We fit a reduced-form VAR model to r_t as follows:

$$A(L)r_t = z_t \tag{1}$$

where $A(L)$ is a polynomial matrix in the lag operator L, and z_t = [z_{1t}, z_{2t}]' is a 2×1 vector containing two detrended return series, z_{1t} and z_{2t}. Now let e_t = [e_{1t}, e_{2t}]' be a 2×1 vector containing two standardized residuals, $e_{1t} = z_{1t}/\sqrt{h_{1t}}$ and $e_{2t} = z_{2t}/\sqrt{h_{2t}}$, where the two conditional variances h_{1t} and h_{2t} are estimated using the univariate GARCH(M_i, N_i) model:

$$h_{it} = w_i + \sum\nolimits_{l=1}^{M_i} a_{il} z_{it-l}^2 + \sum\nolimits_{q=1}^{N_i} b_{iq} h_{it-q}, \qquad i = 1, 2 \tag{2}$$

The purpose of estimating (2) is to obtain IID e_t which, not z_t nor r_t, should be used in the dynamic conditional correlation (DCC) model (Engle, 2002).

To capture possible asymmetry in the correlation, we borrow the idea from the asymmetric GARCH model and modify the standard DCC model (Engle, 2002) in the following manner:

$$Q_t = \left(1 - \sum\nolimits_{p=1}^{P} a_p - \sum\nolimits_{s=1}^{S} b_s\right)\bar{Q} + \sum\nolimits_{p=1}^{P} a_p \left(e_{t-p} + g_p\right)\left(e_{t-p} + g_p\right)' + \sum\nolimits_{s=1}^{S} b_s Q_{t-s} \tag{3}$$

which is referred to as ADCC(P, S) model. In (3), Q_t = {$q_{ij,t}$} (i, j = 1, 2) is the conditional covariance, and $\bar{Q} = \{\bar{q}_{ij}\}$ is the unconditional covariance, of {e_{it}}. The parameter g introduces asymmetry to the model. If $g = 0$, equation (3) collapses to the standard DCC model. If $g > 0$, joint positive shocks ($e_{1t} > 0$ and $e_{2t} > 0$) will have a greater impact on Q_t than joint negative shocks ($e_{1t} <$ 0 and $e_{2t} < 0$), which we refer to as "positive asymmetry" for convenience. If $g < 0$, the opposite will result, which we term "negative asymmetry".

The conditional correlation matrix for e_t is computed as:

$$R_t = \left(diag\{Q_t\}\right)^{-1} \cdot Q_t \cdot \left(diag\{Q_t\}\right)^{-1} \qquad (4)$$

The elements in R_t, $r_{ij,t}$, represent the conditional correlations between $e_{i,t}$ and $e_{j,t}$, and equal $q_{ij,t} / \sqrt{q_{ii,t} q_{jj,t}}$.

The log likelihood to be maximized with respect to model parameters consists of two parts (Engle, 2002):

$$L(q, f) = L_V(q) + L_C(q, f) \qquad (5)$$

The volatility part $L_V(q)$ is expressed as:

$$L_V(q) = -\frac{1}{2}\sum_{t=1}^{n}\sum_{i=1}^{2}\left[\log(2p) + \log(h_{it}) + \frac{z_{it}^2}{h_{it}}\right] \qquad (6)$$

where $D_t = diag\left\{\sqrt{h_{it}}\right\}$ and q is a vector of the parameters in (2). The correlation part $L_C(q, f)$ reads:

$$L_C(q, f) = -\frac{1}{2}\sum_{t=1}^{n}\left[\log\left|R_t\right| + e_t^{'} R_t^{-1} e_t - e_t^{'} e_t\right] \qquad (7)$$

where f is a vector of the parameters in (3). Following Engle (2002), we apply a two-step approach to maximizing (5). The first step is to find $\hat{q} = \operatorname{argmax}\left\{L_V(q)\right\}$, while the second step is to maximize $L_C(\hat{q}, f)$ with $\hat{q}$ obtained from the first step.

We use Kroner and Ng's (1998) notion of the "news impact surface" to examine graphically the correlation asymmetry. For the ADCC(1,1) model, we have:

$$f(e_1, e_2) = \frac{\tilde{c}_{12} + a(e_1 + g)(e_2 + g) + b\bar{r}_{12}}{\sqrt{\left[\tilde{c}_{11} + a(e_1 + g)^2 + b\right]\left[\tilde{c}_{22} + a(e_2 + g)^2 + b\right]}} \qquad (8)$$

as the correlation news impact surface. The value of $\tilde{c}_{12}$ determines the location, not the shape, of the surface in a three-dimension graph. We choose to centre the surface at 0 when $e_1 = e_2 = 0$ (i.e., $f(0,0) = 0$), and so set $\tilde{c}_{12}$ to be $-ag^2 - b\,\bar{r}_{12}$. $\tilde{c}_{11}$ and $\tilde{c}_{22}$ are set to equal $(1- a - b)$.

3. Empirical results

The prices of the Australian dollar (AUD) and the Kiwi dollar (NZD) in terms of the US dollar. (USD), the Euro (EUR), the Japanese yen (JPY) and the UK sterling (GBP) are investigated, as these four economies constitute the major trading partners of Australia and NZ. The data on the eight exchange rate series were sourced from the Pacific Exchange Rate Service website (http://fx.sauder.ubc.ca/). We use weekly data for two reasons: one is to avoid daily market microstructure complications, and the other is because different public holidays make NZD's daily observations mismatch AUD's. For the rates against USD, JPY and GBP, the sample period spans January 1991 to March 2006; and for the rates against EUR, January 1999 to March 2006. Returns are calculated as the first difference of the natural logarithm of the exchange rate.

We fit a VAR model to each of the four pairs of exchange rate return series r_{it} (i = AUD, NZD) and use the Schwarz Information Criterion (BIC) in determining the optimal autoregressive order (1 for the rates against USD, JPY and GBP, and 3 for the rates against EUR). The detrended return series z_{it} from the estimated VAR models are then used in estimating the GARCH(M_i,N_i) and ADCC(P,S) models. Comparing the log likelihood functions from different lag specifications, i.e., M_i, N_i = 1, 2 and P, S = 1, 2, the largest one is associated with M_i, N_i = 1 and P, S = 1. This seems to be consistent with many studies in the literature (e.g., Lee, 2006). We thus choose GARCH(1,1) and ADCC(1,1) for empirical investigation.

Table 1 reports the estimation results of the univariate GARCH(1,1) model for each detrended return series and the test results for each resultant standardized residual series. The two rates against USD have the highest persistence in volatility, while the two rates against EUR have the lowest persistence in volatility. More importantly, the test results in Panel B of Table 1 indicate that the standardized residuals are all IID at the 5% level or lower, although most of them fail the normality tests. This failure is not crucial, as in the absence of conditional normality the estimation results have a standard QMLE interpretation.

The more interesting results are displayed in Table 2, regarding the ADCC model. Most of the estimated parameters are statistically significant at a higher than 1% level. The LM test statistics (Tse, 2000) and the χ^2-test statistics (Engle and Sheppard, 2001) allow us to reject the null hypothesis of constant correlation for all the four pairs mostly at a higher than 1% level, although the four unconditional correlation coefficients range between 0.706 and 0.858. Moreover, as the main concern of this paper, all the g parameters are highly significant, judged by both the t-statistics (all at the 1% level) and the likelihood ratio test statistics (2 at the 1% level and 2 at the 5% level).

Figures 1-4 contain the correlation news impact surfaces from the estimates displayed in Table 2. Each surface is evaluated in the region $e_{i,t}$ = [-3, 3] for i = AUD, NZD. The asymmetry in correlation is clear from each figure: a larger response of the correlation to news in the "+,+" quadrant than in the "-,-" quadrant. It is therefore suggested that all the four conditional correlations between the two exchange rates are more responsive to joint positive than negative shocks.

The above econometric analysis provides strong evidence that the Australian and Kiwi dollars are more correlated during joint appreciations than during joint depreciations. This result is robust, as it holds for the four alternative prices of the Australian and Kiwi dollars.

4. Interpretation of the results

Since the asymmetry in the dynamics of exchange rate correlations is positive, the most likely cause is that the Reserve Bank of Australia (RBA) and the Reserve Bank of New Zealand (RBNZ) have a stronger desire to maintain price stability than to maintain export competitiveness.

Price stability and full employment are two policy objectives stated in the policy targets agreement between the Australian monetary and fiscal authorities, and between the NZ monetary and fiscal authorities.[1] Keeping inflation low contributes to price stability, while maintaining export

[1] See http://www.rba.gov.au/MonetaryPolicy/third_statement_on_the_conduct_of_monetary_policy_2006.html, and http://www.rbnz.govt.nz/monpol/pta/0124848.html.

competitiveness is consistent with full employment. However, as implied by the Phillips curve, there exists a short-run tradeoff between price stability and export competitiveness: high (low) export competitiveness may be associated with low (high) price stability, other things being equal. Policymakers' preference between price stability and export competitiveness will be reflected in their policy responses to exchange rate shocks.

Australia is NZ's rival in terms of exports, with meat trade[2] and tertiary education being two good examples of many exportable goods and services. NZ is Australia's top export destination, according to Australian Trade Minister Mark Vaile.[3] Thus we have reasons to believe that the two countries will not ignore changes in the value of the other's currency, as such changes may affect export competitiveness/price stability of both economies.

Let us consider, as an example, a situation where the Australian dollar depreciates vis-a-vis world currencies, due to policy or non-policy shocks. This would encourage Australia's exports but discourage NZ's exports, since the latter become expensive relative to the former. A rise in Australia's exports is likely to cause Australia's inflation to rise, while a fall in NZ's exports may be followed by a fall in NZ's inflation, given all other economic variables. Thus, as a result of depreciation of the Australian dollar, NZ may be faced with low export competitiveness but high price stability. If NZ cares more about export competitiveness than about price stability, her policymakers will likely intervene to let the Kiwi dollar depreciate by a magnitude which matches the Australian dollar's depreciation. In this scenario, decreases in the Australian dollar should have a high correlation with decreases in the Kiwi dollar. On the other hand, if the NZ policymakers care more about price stability than about export competitiveness, they will likely do nothing to the value of the Kiwi dollar. Thus, the two currencies should have a low correlation during their depreciations.

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[2] See http://www.stuff.co.nz/stuff/0,2106,3803830a3600,00.html.

[3] See http://www.austrade.gov.au/corporate/layout/0,,0_S1-1_CORPXID0054-2_-3_PWB110424923-4_-5_-6_-7_,00.html.

Conducting a similar reasoning for the case where the Australian dollar appreciates, we may conclude that the two currencies would show greater correlations during appreciations (depreciations) than during depreciations (appreciations) against a third currency, if the NZ policymakers prefer price stability (export competitiveness) to export competitiveness (price stability).

Note that when one of the four world currencies strengthens, there may be a shift of funds from AUD and NZD into the world currency, while when the world currency weakens some of these funds may shift into AUD as AUD is a more important currency compared to NZD. This suggests that portfolio-rebalancing behavior can only lead to greater correlation during depreciations of AUD and NZD against the world currency than during appreciations. Since we have detected positive asymmetry rather than negative asymmetry for AUD and NZD vis-a-vis all the four world currencies, portfolio rebalancing has to be ruled out as a possible cause; and only asymmetric responses of the Australian and NZ policymakers to exchange rate shocks are a possible cause. Thus our results should be viewed as evidence that price stability dominates export competitiveness in the objective functions of the two countries' policymakers.

5. Conclusion

Correlation among spot exchange rates is as an important topic as cointegration among them, since its studies can provide useful information on the changing values of international portfolio diversification and on the preference of policymakers. Surprisingly, however, this topic has received little academic attention. To fill this void, we investigate possible asymmetric dynamics in exchange rate correlations.

We do so by introducing a simple asymmetric DCC model, and apply the model to the exchange rates of AUD and NZD vis-a-vis four important world currencies, namely, USD, EUR, JPY and GBP. The issue addressed is whether price stability dominates, or is dominated by, export competitiveness, in the Australian and NZ policymakers' objective functions. Our results are robust in that the exchange rates of the two Australasian economies are more strongly correlated during appreciations than during depreciations against all the four important world currencies. This suggests a stronger desire of the Australian and NZ governments to maintain price stability than to maintain high export competitiveness. Our work thus provides the first ever evidence that positive asymmetry in the dynamics of exchange rate correlations is possible. In addition, our findings also imply that anyone compiling an optimal portfolio allocation involving assets from Australia and NZ needs to consider this issue: the value of diversification appears to be time-varying, and may be overstated if ignoring asymmetry in exchange rate correlations between the two countries' currencies.

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Table 1 Estimation and test results for the GARCH(1,1) model

Parameter	USD/AUD	EUR/AUD	JPY/AUD	GBP/AUD	USD/NZD	EUR/NZD	JPY/NZD	GBP/NZD
Panel A Estimation results of the GARCH(1,1) model for each detrended return series z_{it}								
w_i	0.013	1.024**	0.119	0.052	0.004	1.185**	0.560	0.226
	(1.529)	(3.889)	(0.665)	(0.656)	(1.105)	(9.981)	(1.659)	(0.684)
a_i	0.041**	0.241**	0.063	0.059	0.039**	0.179*	0.138*	0.150
	(2.935)	(2.703)	(1.161)	(0.962)	(2.976)	(2.315)	(2.108)	(1.063)
b_i	0.948**	0.000	0.879**	0.909**	0.960**	0.000	0.546*	0.703*
	(53.82)	(0.000)	(6.416)	(9.118)	(70.56)	(0.000)	(2.337)	(2.083)
Panel B Diagnostic statistics for each standardized residual series e_{it}								
Ljung-Box $Q(20)$	13.06	30.49	26.16	18.65	19.21	20.64	20.91	25.23
for e_{it}	[0.875]	[0.062]	[0.161]	[0.545]	[0.508]	[0.419]	[0.402]	[0.193]
Ljung-Box $Q(20)$	16.30	17.07	20.13	18.54	24.21	22.72	10.71	20.58
for e_{it}^2	[0.698]	[0.649]	[0.450]	[0.552]	[0.233]	[0.303]	[0.953]	[0.422]
ARCH(1) LM test	0.273	0.092	1.048	0.251	0.587	0.248	0.002	0.002
for e_{it}	[0.601]	[0.762]	[0.306]	[0.616]	[0.443]	[0.619]	[0.960]	[0.963]
Skewness for e_{it}	-0.319**	-0.408**	-0.502**	0.036	-0.341**	-0.121	-0.472**	0.248**
Kurtosis for e_{it}	0.402*	0.507*	1.164**	2.598**	0.593**	0.255	1.374**	2.290**
Jarque-Bera	18.40**	13.85**	76.72**	218.5**	26.48**	1.754	89.99**	177.7**
for e_{it}	[0.000]	[0.001]	[0.000]	[0.000]	[0.000]	[0.416]	[0.000]	[0.000]

The estimated GARCH(1,1) model is $h_{it} = w_i + a z_{it-1}^2 + b h_{it-1}$ for i = AUD, NZD. In parentheses are the t-statistics. * indicates significance at the 5% level. ** indicates significance at the 1% level.

Table 2 Estimation results for the asymmetric DCC(1,1) model

Parameter/Statistic	USD/AUD vs USD/NZD	EUR/AUD vs EUR/NZD	JPY/AUD vs JPY/NZD	GBP/AUD vs GBP/NZD
a	0.018**	0.002	0.026*	0.020**
	(3.779)	(1.636)	(2.289)	(4.111)
b	0.972**	0.998**	0.608**	0.927**
	(109.3)	(184.4)	(3.078)	(55.97)
g	0.261**	0.642**	0.705**	0.327**
	(3.883)	(3.159)	(2.555)	(3.026)
log-likelihood	-1907.60	-982.191	-2187.71	-2098.89
$\bar{r}_{12}$	0.706	0.788	0.858	0.818
LM test for H_0: constant R	5.064*	9.686**	11.21**	13.64**
c^2 – test for H_0: $R_t = R$	292.7**	180.5**	343.2**	274.4**
Likelihood ratio test for H_0: $g = 0$	7.400**	6.184*	7.694**	5.954*

The estimated asymmetric DCC(1,1) model is $Q_t = (1 - a - b)\bar{Q} + a(e_{t-1} + g)(e_{t-1} + g)' + bQ_{t-1}$. * indicates significance at the 5% level. ** indicates significance at the 1% level.

Figure 1: Correlation News Impact of the USD/AUD and USD/NZD Exchange Rates

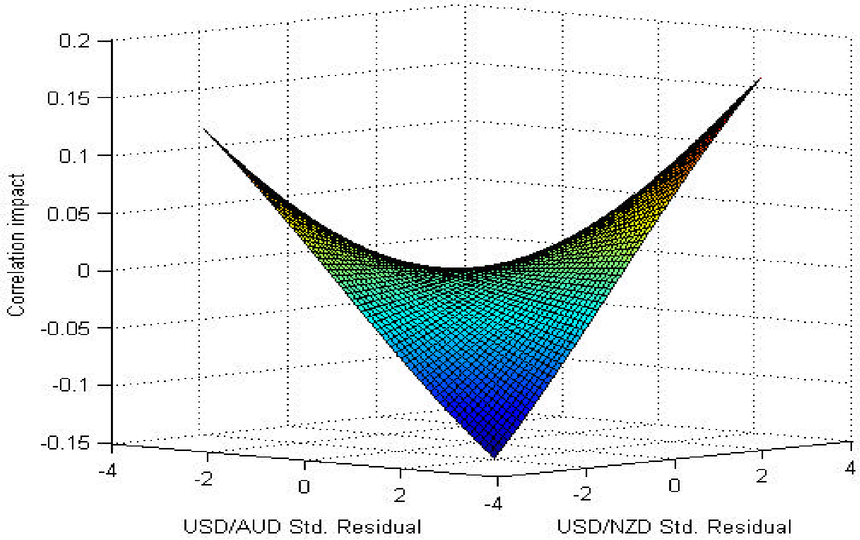

Figure 2: Correlation News Impact of the EUR/AUD and EUR/NZD Exchange Rates

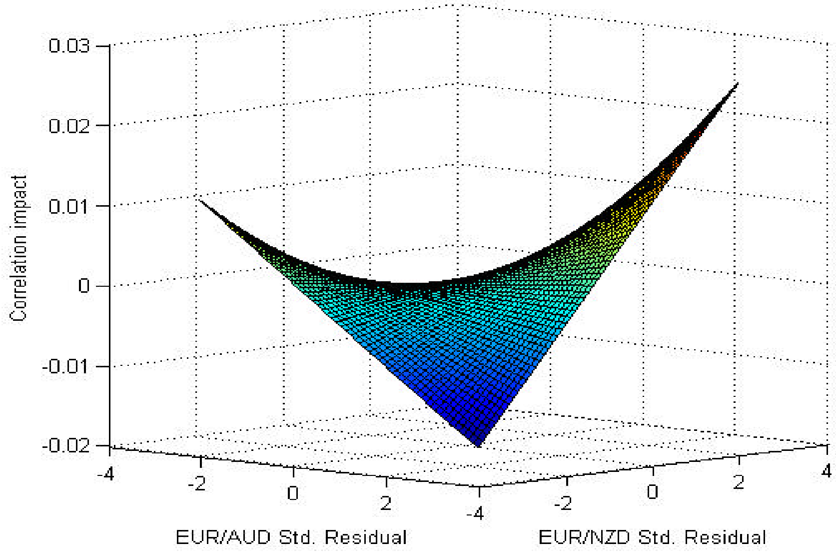

Figure 3: Correlation News Impact of the JPY/AUD and JPY/NZD Exchange Rates

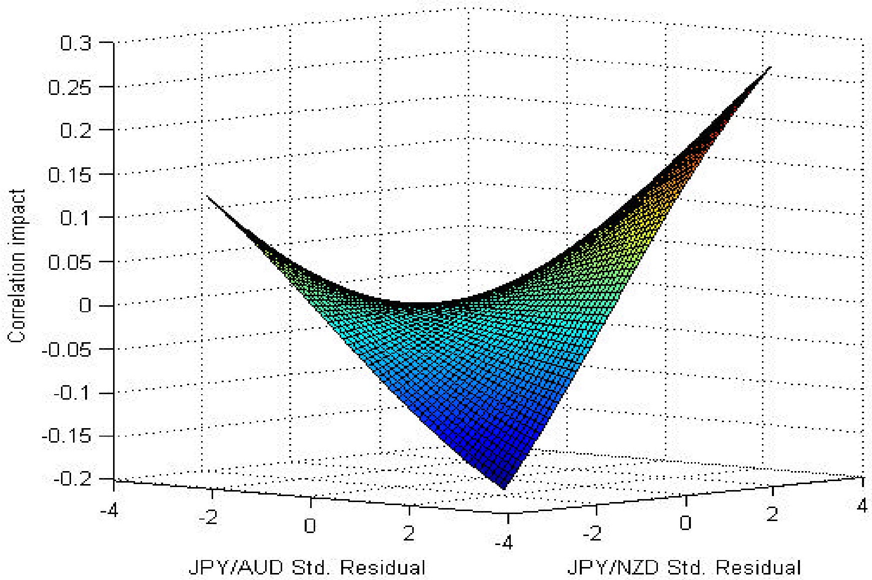

Figure 4: Correlation News Impact of the GBP/AUD and GBP/NZD Exchange Rates