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Abstract

Recent sharp declines in commodity prices and the simultaneous depreciation of the Canadian dollar (CAD) relative to the U.S. dollar (USD) have rekindled an interest in the relationship between commodity prices and the CAD-USD exchange rate. In this note, we evaluate the individual predictive ability in terms of point forecasts and directional accuracy of energy and non-energy commodity prices, the Canada-U.S. interest rate differential, and the USD multilateral factor – which captures co-movements of major currencies relative to the USD – in explaining movements in the nominal CAD-USD exchange rate at the daily, monthly and quarterly frequencies. We not only confirm that both energy and non-energy commodity prices are each individually helpful in explaining contemporaneous movements in the nominal CAD-USD exchange rate, but also find that the USD multilateral factor has a stronger predictive ability.

Bank classification: Econometric and statistical methods; Exchange rates

Résumé

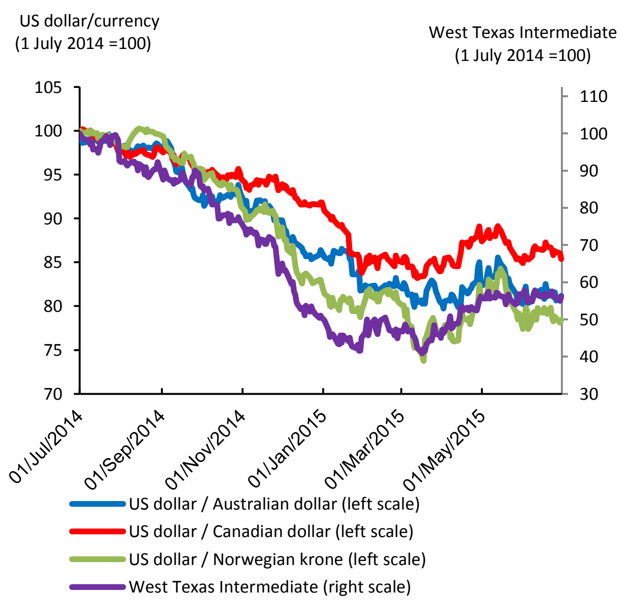
Les baisses marquées affichées récemment par les prix des produits de base et la dépréciation simultanée du dollar canadien ($ CAN) par rapport au dollar américain ($ US) ont ravivé l’intérêt à l’égard du lien entre les prix des produits de base et le taux de change entre les deux monnaies. Dans la présente étude, nous évaluons le pouvoir prévisionnel des prix des produits de base énergétiques et des produits de base non énergétiques, de l’écart de taux d’intérêt entre le Canada et les États-Unis, et du facteur d’ajustement multilatéral par rapport au dollar américain (qui mesure la covariation des grandes monnaies par rapport au $ US) pour expliquer les variations du taux de change nominal $ CAN-$ US – tant pour ce qui est des prévisions ponctuelles que pour l’exactitude directionnelle –, et ce, à une fréquence journalière, mensuelle et trimestrielle. Nous confirmons non seulement que les prix des produits de base énergétiques et non énergétiques contribuent, les uns comme les autres, à expliquer les mouvements actuels du taux de change nominal $ CAN-$ US, mais aussi que le facteur d’ajustement multilatéral par rapport au dollar américain a une plus forte capacité prédictive.

Classification de la Banque : Méthodes économétriques et statistiques; Taux de change

Section 1 | Introduction

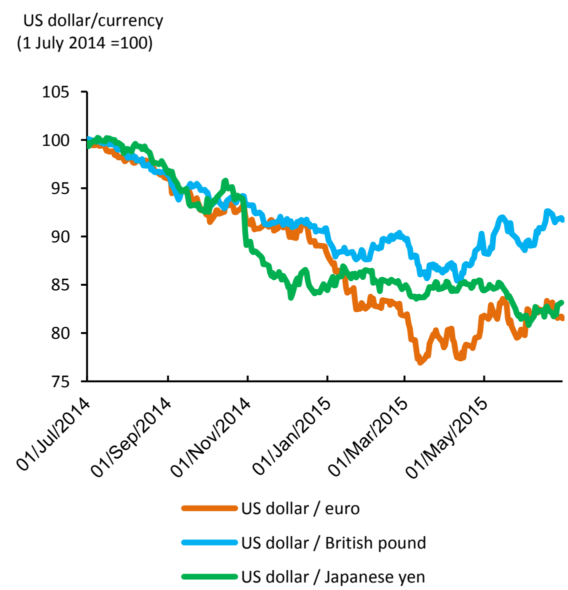
It is widely known that exchange rate fluctuations of net commodity exporting countries are correlated with commodity price movements (Chen and Rogoff 2003). This was manifested most recently during the second half of 2014 when the currencies of many net commodity exporters, including the Canadian dollar (CAD), experienced sizable depreciations against the U.S. dollar (USD) as oil prices collapsed sharply (**Figure 1**). A recent paper by Ferraro et al. (2015) reported that oil prices have a strong predictive ability in explaining the movements of the CAD-USD exchange rate at the daily frequency, but the predictive ability diminishes at the monthly and quarterly frequencies. In this note, we extend their analysis and assess the contemporaneous predictive ability (in terms of point forecasts and directional accuracy) of commodity price changes for the CAD-USD nominal exchange rate depreciation at the daily, monthly and quarterly frequencies. We consider multiple data frequencies, as in Ferraro et al. (2015), in order to capture the differences in the short-run versus longer-run link between these variables.

Figure 1. Currencies of many net commodity exporters depreciated as oil prices declined sharply...



Source: FRB via Haver Analytics Last observation: 30 June 2015

Figure 2. ...but other currencies also depreciated during the second half of 2014



Source: FRB via Haver Analytics Last observation: 30 June 2015

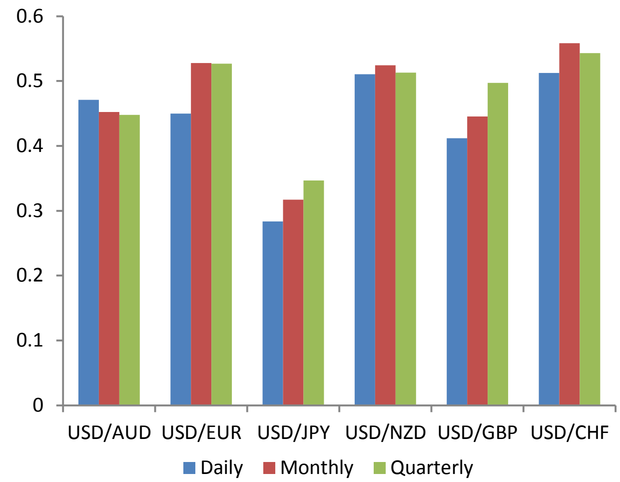
Although commodity price changes have been found to be an important driver of the Canadian dollar (e.g., in nominal terms, Ferraro et al. 2015; in real terms, Amano and van Norden 1995; Issa et al. 2008; Cayen et al. 2010), they may not be the only or the most important drivers. In fact, since the second half of 2014, commodity currencies were not the only currencies that depreciated in value relative to the USD (**Figure 2**), suggesting that commodity prices alone cannot fully explain the recent depreciation of the CAD-USD exchange rate. Given this co-movement in exchange rates (**Figures 1 and 2**), our investigation assesses the predictive ability of a USD multilateral adjustment factor for CAD-USD exchange rate changes. The USD multilateral factor parsimoniously represents co-movements of exchange rates that have been found helpful in the context of forecasts for various currencies (e.g., Engel et al. 2015; Greenaway-McGrevy et al. 2015). We also consider the Canada-U.S. interest rate differential as a predictor.

Section 2 | Data description

Our data set is at the daily frequency (2 January 1985 – 30 June 2015), and includes the following variables:

- bilateral nominal Canadian dollar exchange rate per U.S. dollar (first difference of the logarithm),[1]
- Bank of Canada energy commodity price index (first difference of the logarithm),
- Bank of Canada non-energy commodity price index (first difference of the logarithm),
- Canada-U.S. interest rate differential (difference between the Bank of Canada overnight rate and the U.S. three-month commercial paper rate),
- USD multilateral factor, which corresponds to the first principal component of the changes in the bilateral nominal exchange rates (in logarithm) of the Australian dollar (AUD), British pound (GBP), the euro (EUR), Japanese yen (JPY), New Zealand dollar (NZD) and Swiss franc (CHF) relative to the USD.[2]

Figure 3. Correlation of bilateral exchange rates with the USD multilateral factor (factor loadings daily, monthly and quarterly frequencies)



Source: Bank of Canada calculations

Figure 3 shows that the first principal component is associated with a broad-based adjustment of the USD. Because the factor loadings are all positive, all currencies relative to the USD move in the same direction in response to movements in the first principal component. As such, the USD multilateral adjustment factor captures macroeconomic and financial developments affecting the overall strength of the USD, which are not necessarily related to economic developments in Canada.

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[1] We use the nominal exchange rate since a daily measure of inflation is not available. Interpolating a monthly or quarterly measure of inflation at a daily frequency would be problematic for testing predictive ability, since it would require future realized data that would not have been available at the time the forecasts were made.

[2] The energy and non-energy commodity price indices are from the Bank of Canada. The other data are obtained from Haver Analytics.

Monthly data are constructed from the first business day of the month and quarterly data are from the first business day of the second month of the quarter.[3]

Section 3 | Model

In order to assess the predictive ability of economic fundamentals for the nominal exchange rate, we follow Ferraro et al. (2015) and estimate the following simple model:

$$s_t = \alpha + \beta x_t + u_t\,, \;\; t = 1, \dots, T, \qquad (1)$$

where s_t is the change in the log CAD-USD nominal exchange rate, x_t is an economic fundamental, u_t is the regression error and T is the total sample size.[4] The economic fundamentals that we consider are the energy commodity price index, the non-energy commodity price index, the interest rate differential and the USD multilateral factor.[5] Each economic fundamental is used in the model separately.

We estimate equation (1) with rolling in-sample windows to obtain one-step-ahead (i.e., one-day-, one-month- or one-quarter-ahead) forecasts conditional on the realized value of the economic fundamental. We denote the one-step-ahead pseudo out-of-sample forecast by s_{t+1}^f:

$$s_{t+1}^f = \widehat{\alpha_t} + \widehat{\beta}_t x_{t+1}, \;\; t = R, R+1, \dots, T-1, \qquad (2)$$

where $\widehat{\alpha_t}$ and $\widehat{\beta}_t$ are the parameter estimates from the rolling window $\{t-R+1, t-R+2, \dots., t\}$ and R is the size of the in-sample estimation window. Rolling window estimates account for potential time variation in the relationship between the exchange rate and economic fundamentals. We find substantial evidence for time variation in the slope coefficients $\widehat{\beta}_t$ for the models with the commodity prices and the USD multilateral factor. Given the uncertainty regarding the optimal window size, we report results based on various window sizes, ranging from 10 to 50 per cent of the full sample.

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[3] We also tested models with the Aruoba, Diebold and Scotti (2009) index of U.S. business cycle conditions and measures of oil price volatility and uncertainty as alternative predictors. However, their predictive gains were economically small or statistically insignificant.

[4] Note that this is not a standard out-of-sample forecast exercise since the realized values of the economic fundamentals are used. Following Ferraro et al. (2015), we consider this an out-of-sample fit exercise.

[5] Using oil prices (West Texas Intermediate) as in Ferraro et al. (2015) led to qualitatively similar results as when using the energy commodity price index.

Section 4 | Results

In this section we evaluate the predictive ability of economic fundamentals for the CAD-USD exchange rate using two criteria: point forecasts and directional accuracy.[6]

Point forecasts:

We evaluate the out-of-sample fit by comparing the mean-squared prediction errors (MSPE) from each of our models relative to those from the random walk without drift model (or no-change forecast).[7] The statistical significance of the gains in predictive accuracy is assessed based on the Diebold-Mariano (1995) test of equal predictive ability.

We find that the relative MSPEs from the model specifications with the energy commodity price index, the non-energy commodity price index and the USD multilateral factor are below one at the daily, monthly and quarterly frequencies, indicating that these models outperform the random walk model (**Table 1**).[8] The largest gains are achieved with the USD multilateral factor as an explanatory variable.[9] In contrast, the model with the interest rate differential is systematically outperformed by the random walk model.

In terms of statistical significance, there is stronger evidence for predictive ability of the CAD-USD exchange rate at the daily frequency than at the monthly and quarterly frequencies (**Figure 4**), which is consistent with findings in Ferraro et al. (2015). In particular, the model specifications with the energy commodity price index, the non-energy commodity price index and the USD multilateral factor forecast significantly better than the random walk model at the daily frequency, and the most statistically significant gains are obtained with the USD multilateral factor.[10] At monthly and quarterly frequencies, there is less evidence in favour of significant gains relative to the random walk forecasts. This suggests that the statistical significance of these variables for predicting the CAD-USD exchange rate is rather short-lived.[11] One rationale for this result is that commodity

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[6] We present results based only on regressions using the realized value of the explanatory variable, since regressions based on the lagged value of the explanatory variable did not typically improve on the forecasting performance of the random walk model.

[7] We follow the literature and use the random walk model as our benchmark (see, for example, Ferraro et al. 2015). In general, it is found to be a tough model to beat in the context of exchange rate forecasting.

[8] Note that the non-energy commodity price index does not outperform the random walk model at the quarterly frequency for most estimation windows.

[9] As a robustness check, we also estimated the USD multilateral factor from a principal component analysis on rolling windows. The results were qualitatively unchanged, suggesting little evidence in favour of time variation in the factor loadings.

[10] As an additional robustness check, we also used the trade-weighted USD major currencies index (excluding Canada) from the Federal Reserve Board as a predictive variable in equation (1). We found that the predictive ability of this trade-weighted USD index is roughly similar to that of the USD multilateral factor obtained from the principal component analysis.

[11] Note that one must use caution when comparing the MSPE results and the statistical significance of the results across different sampling frequencies, since the total sample size varies across frequencies (T=7403 for daily; T=366 for monthly; and T=122 for quarterly). Hence, one cannot formally exclude that stronger statistical evidence in favour of

markets (e.g., the oil market) are typically subject to temporary shocks, in that commodity prices exhibit very little persistence. As a result, at a lower frequency, the statistical significance of the informational content of commodity prices for the CAD-USD exchange rate tends to diminish.

Directional accuracy:

We next evaluate directional accuracy by calculating **success ratios**, which indicate the proportion of times the model correctly predicts whether the Canadian dollar depreciates or appreciates relative to the U.S. dollar. The Pesaran-Timmermann (2009) test statistic is used to determine the statistical significance of directional accuracy.

The success ratio of each model indicates that the model specifications with the energy commodity price index, the non-energy commodity price index and the USD multilateral factor correctly predict the direction of movements in the CAD-USD exchange rate more frequently than the random walk model at the daily, monthly and quarterly frequencies (**Table 2**). Similar to the point forecast results, the model with the USD multilateral factor yields the highest success ratios, and the interest rate differential yields the lowest success ratios among the four predictors.

The statistical significance of directional accuracy for different sample frequencies also exhibits a similar pattern as that for point accuracy, and is stronger at the daily frequency than at the monthly and quarterly frequencies (**Figure 5**). The model specifications with the energy commodity price index, the non-energy commodity price index and the USD multilateral factor predict the direction of exchange rate movements significantly better than the random walk model at the daily frequency, but are less robust at the monthly and quarterly frequencies.

Section 5 | Conclusion

In this note, we have confirmed that energy and non-energy commodity prices are useful for explaining contemporaneous variations of the Canadian dollar. Specifically, we find that commodity prices have significant explanatory power for the CAD-USD nominal exchange rate at the daily frequency. However, their statistical significance for both point forecasts and directional accuracy is found to diminish at lower frequencies, suggesting that their correlation with the exchange rate is more pronounced in the short run. This is in line with existing literature (Ferraro et al. 2015) and suggests that the frequency of the data is important in identifying the predictive power of commodity prices.

In addition, we find that, while commodity prices (energy and non-energy) are indeed important drivers of the CAD, the USD multilateral factor has stronger predictive ability, suggesting that exchange rate co-movements best explain the variations in the CAD-USD exchange rate.

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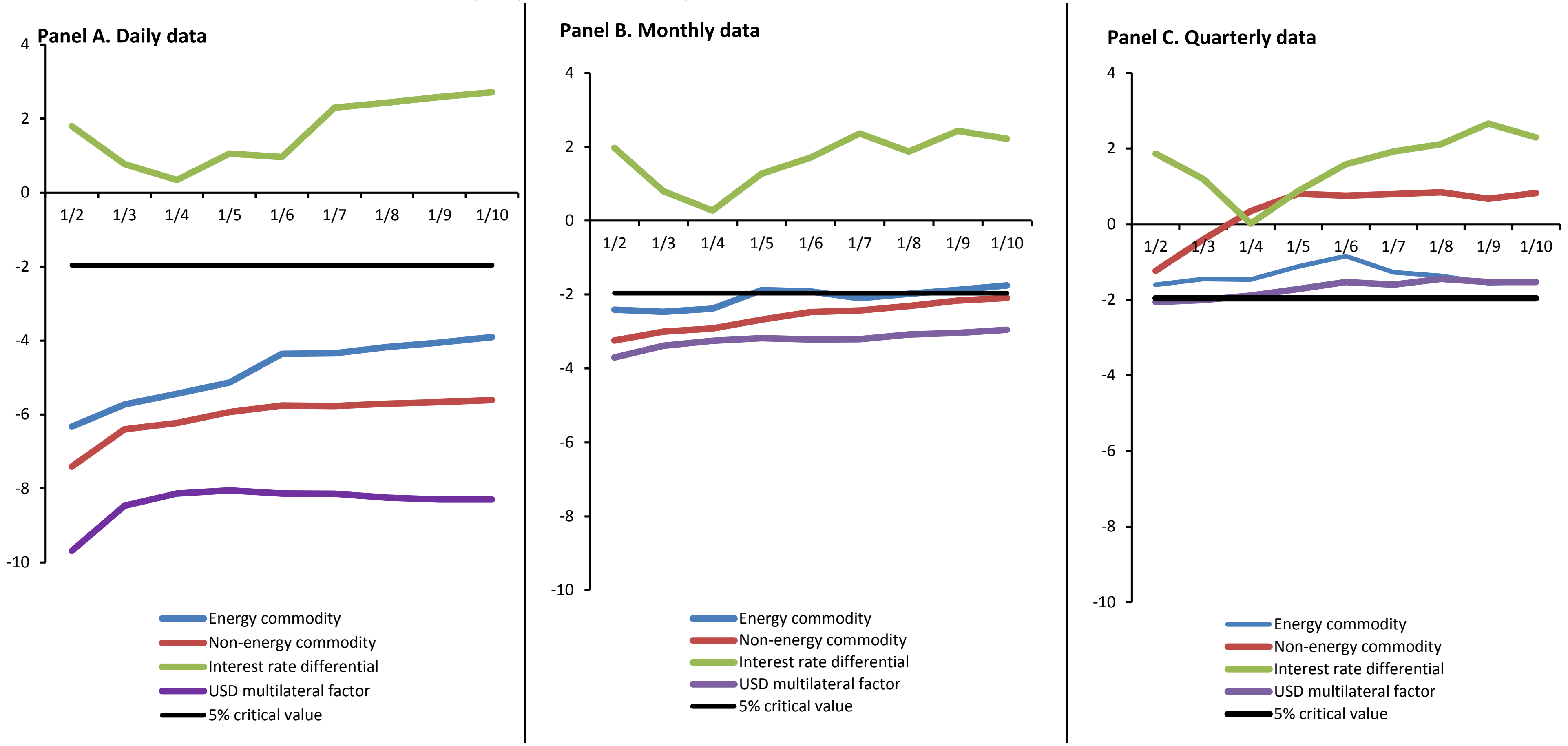
the simple model relative to the random walk model could be found in longer sample sizes with monthly and quarterly data.

Table 1. Relative mean-squared prediction errors

	Daily			Monthly			Quarterly		
Window size	1/2	1/3	1/4	1/2	1/3	1/4	1/2	1/3	1/4
Energy commodity	**0.956****	**0.956****	**0.954****	**0.915****	**0.913****	**0.912****	**0.746**	**0.795**	**0.815**
Non-energy commodity	**0.934****	**0.923****	**0.919****	**0.862****	**0.863****	**0.863****	**0.945**	**0.979**	1.032
Interest rate differential	1.001	1.001	1.000	1.011	1.009	1.004	1.029	1.044	1.001
USD multilateral factor	**0.753****	**0.765****	**0.762****	**0.698****	**0.709****	**0.718****	**0.696****	**0.727****	**0.745***

Note: A value lower than 1 indicates that a given model forecasts better than the no-change forecast. These values are shown in boldface. Statistically significant improvements according to the Diebold-Mariano test are marked using ** (5 per cent significance level) and * (10 per cent significance level).

Figure 4. Diebold-Mariano test statistic for equal predictive ability



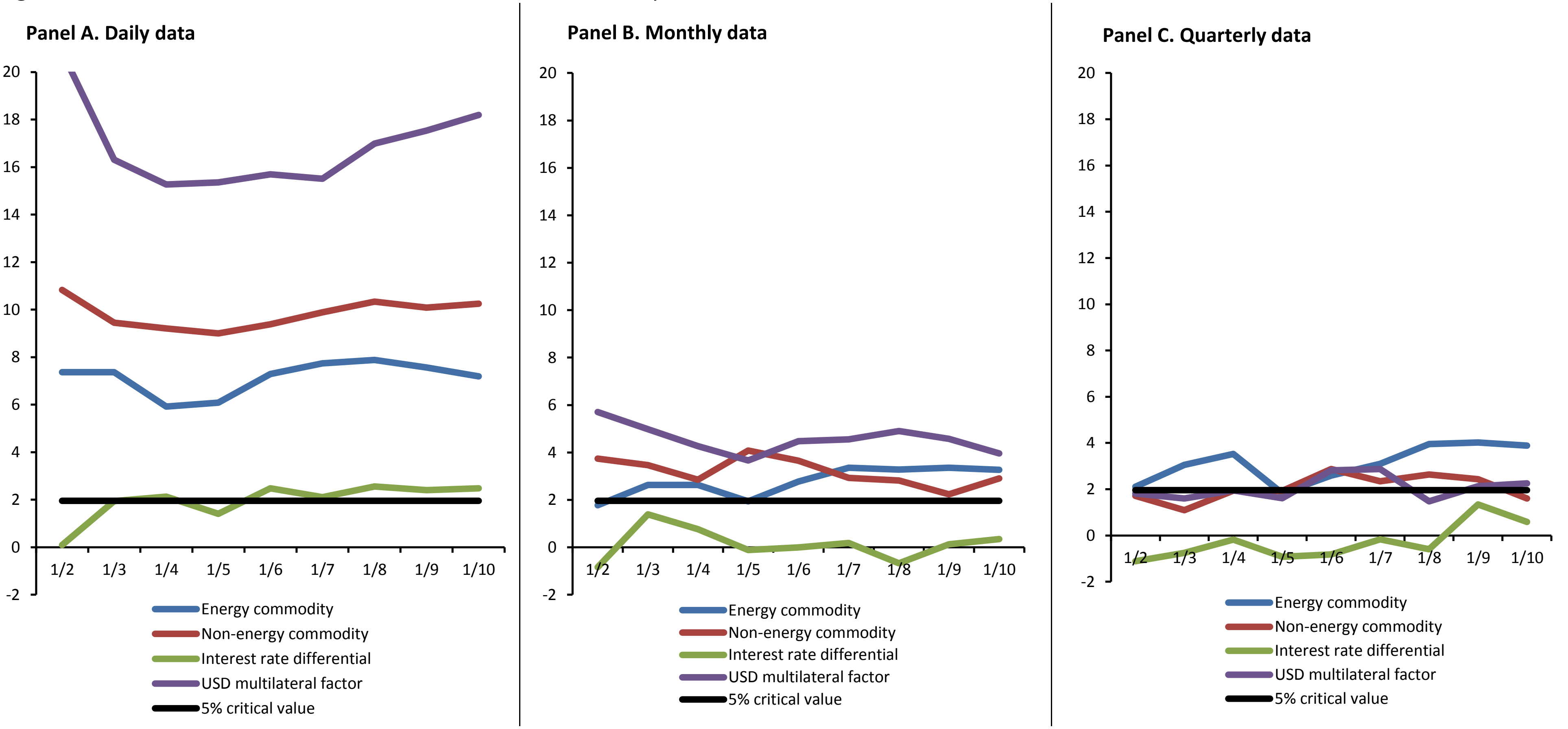
Note: A negative value means a given model forecasts better than the random walk. **A value lower than -1.96** indicates that it does so significantly better at the 5 per cent significance level according to the Diebold and Mariano test. The results are based on different estimation window sizes – represented on the horizontal axis – ranging from using 10 per cent to 50 per cent of the total number of observations for estimating the parameters of the model.

Table 2. Success ratios

	Daily			Monthly			Quarterly		
Window size	1/2	1/3	1/4	1/2	1/3	1/4	1/2	1/3	1/4
Energy commodity	**0.561****	**0.550****	**0.539****	**0.582***	**0.601****	**0.586****	**0.633****	**0.638****	**0.656****
Non-energy commodity	**0.591****	**0.565****	**0.561****	**0.648****	**0.613****	**0.593****	**0.617***	**0.563**	**0.589***
Interest rate differential	0.498	**0.509***	**0.509****	0.484	**0.539**	**0.520**	0.433	0.463	**0.500**
USD multilateral factor	**0.665****	**0.623****	**0.610****	**0.692****	**0.650****	**0.626****	**0.617***	**0.575**	**0.589***

Note: Success ratios indicate the proportion of times that the model under consideration correctly predicts whether the CAD-USD exchange rate rises or falls. Boldface indicates success ratios over 0.5. Statistically significant improvements according to the Pesaran-Timmermann test are marked using ** (5 per cent significance level) and * (10 per cent significance level).

Figure 5. Pesaran-Timmermann test statistic for directional accuracy



Note: These figures report the Pesaran and Timmermann test statistic for the statistical evaluation of gains in directional accuracy. **A value higher than +1.96** indicates that a given model predicts significantly better than a no-change forecast where one would expect a success ratio of 0.5. The results are based on different estimation window sizes – represented on the horizontal axis – ranging from using 10 per cent to 50 per cent of the total number of observations for estimating the parameters of the model.

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