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Exchange rates and commodity prices: Measuring causality at multiple horizons☆

Hui Jun Zhang [a,d,1], Jean-Marie Dufour [b,c,d,*], John W. Galbraith [b,c,d]

[a] Cambridge-INET Institute, Faculty of Economics, University of Cambridge, UK
[b] Centre interuniversitaire de recherche en analyse des organisations (CIRANO), Canada
[c] Centre interuniversitaire de recherche en économie quantitative (CIREQ), Canada
[d] Department of Economics, McGill University, Leacock Building, 855 Sherbrooke Street West, Montréal, Québec H3A 2T7, Canada

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ABSTRACT

Different causal mechanisms have been proposed to link commodity prices and exchange rates, with opposing implications. We examine these causal relationships empirically, using data on three commodities (crude oil, gold, copper) and four countries (Canada, Australia, Norway, Chile), over the period 1986–2015. To go beyond pure significance tests of Granger non-causality and provide a relatively complete picture of the links, measures of the strength of causality for different horizons and directions are estimated and compared. Since low-frequency data may easily fail to capture important features of the relevant causal links, daily and some 5-minute data are exploited. Both unconditional and conditional (given general stock market conditions and short-term interest rates) causality measures are considered, and allowance for "dollar effects" is made by considering non-U.S. dollar exchange rates. We identify clear causal patterns: (1) there is evidence of Granger-causality between commodity prices and exchange rates in both directions across multiple horizons, but the statistical evidence and measured intensity of the effects are much stronger in the direction of commodity prices to exchange rates, especially at horizon one: the ratios of causality measures in two different directions can be quite high; (2) causality is stronger at short horizons, and becomes weaker as the horizon increases; (3) conditioning on equity prices (the S&P500) does not change the patterns of causality measures found in the unconditional cases; (4) the main results are robust to eliminating U.S.-dollar denomination effects and including a short-term interest rate as the conditioning variable. In contrast with earlier results on the non-predictability of exchange rates, we find that the macroeconomic/trade-based mechanism plays a central role in exchange-rate dynamics, despite the financial feature of these markets.

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* Corresponding author at: Department of Economics, McGill University, Leacock Building, Room 519, 855 Sherbrooke Street West, Montréal, Québec H3A 2T7, Canada. Tel.: +1 514 398 4400x09156; fax: +1 514 398 4800.
E-mail addresses: hjz20@cam.ac.uk (H.J. Zhang), jeanmarie.dufour@mcgill.ca (J.-M. Dufour), john.galbraith@mcgill.ca (J.W. Galbraith).*URL's:URL:* http://www.jeanmariedufour.com (J.-M. Dufour), http://johngalbraith-economics.mcgill.ca/ (J.W. Galbraith).
[1] Mailing address: Faculty of Economics, University of Cambridge, Austin Robinson Building, Sidgwick Avenue, Cambridge CB3 9DD, UK.

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1. Introduction

The dynamic relationship between commodity prices and exchange rates has attracted much attention from both researchers and practitioners. Two main explanations have been proposed. The first one suggests that changes in a commodity price lead to changes in the exchange rate of the corresponding commodity currency. This idea commonly appears in both the research literature (see, for example, Chen and Rogoff, 2003; Chen, 2004) and press commentaries.[2] The second explanation stresses the financial and speculative features of foreign exchange markets: exchange rates can help predict economic fundamentals including commodity prices; see, for example, Meese and Rogoff (1983), Engel and West (2005), Cheung et al. (2005), Rogoff and Stavrakeva (2008), Chen et al. (2010), and Rossi (2013). Following the first mechanism, commodity prices should help predict exchange-rate movements. According to the second one, the reverse should happen. Thus, a central difference between these two alternative explanations lies in the direction of causality in the sense of Wiener-Granger.[3]

The first theory relies on macroeconomic and trade-theory arguments. For a small open economy whose exports depend heavily on a particular commodity (for example, gold for Australia, crude oil for Canada and Norway, copper for Chile), an increase in the price of that commodity should produce an upward pressure on the demand for its currency, which leads to an appreciation. For instance, while crude oil is the largest Canadian export, Canada's total crude oil production is a small share of world output. The price of oil is determined by global supply and demand conditions to which Canada contributes only modestly, while a change in the price of oil has a large effect on the value of Canadian exports. This mechanism can be justified in sticky-price open economy models with non-traded goods, a portfolio-balance model, and the terms-of-trade hypothesis; see Chen and Rogoff (2003) and Chen (2004). This type of explanation suggests that exchange-rate movements can be predicted by economic variables. However, statistical evidence shows that it is generally difficult to forecast exchange rates, so economic models of exchange-rate determination do not fare well from the empirical viewpoint.[4]

Instead, according to the second theory, exchange rates are determined – like most asset prices – by the net present value of fundamentals (including commodity prices), which implies that exchange rates should lead and therefore Granger-cause commodity prices; see Obstfeld and Rogoff (1996), Engel and West (2005), Chen et al. (2010) and Alquist et al. (2012). [5]

Here we examine empirically the causal relationship between commodity prices and nominal exchange rates, using data on three commodities (crude oil, gold, copper) and four countries (Canada, Australia, Norway, Chile), over the period 1986–2015. We emphasize five issues which should be taken into account.

First, predictability and dynamic responses may depend on the time horizon, so it is important to assess these links across different horizons. In particular, looking at multiple-horizon causality does allow one to account for indirect causal links – which go through different variables across time – and may help to eliminate spurious findings of causation; see Dufour and Renault (1998).

Second, given that causal links may theoretically exist in all directions, it is of interest to determine which links – in terms of direction and time horizon – matter most. This can be done using measures of the strength of causal links. Significance tests (for non-causality) are inappropriate for that purpose: a large effect (from an economic viewpoint) may not be statistically significant because the data do not allow one to measure it precisely, and an economically negligible effect may be statistically significant because the effect, while small, can be very precisely estimated. It is much more informative to parameterize the relevant effects, compute point estimates for these parameters, and eventually confidence sets; see Dufour and Taamouti (2010) and Dufour et al. (2012). Non-causality tests can provide evidence on the presence forecast improvements from the inclusion of different past variables, but do not indicate the magnitudes of such improvements.

Third, the proposed measures should be intuitive and easy to interpret without a highly restrictive parametric model. In particular, they should allow for a wide spectrum of dynamic structures. To this end, we use here the methodology of Dufour and Taamouti (2010) and Dufour et al. (2012).

Fourth, it is well known that Granger causality is not generally invariant to aggregation: high-frequency data may reveal patterns which are aggregated away in low-frequency data, and causality in low-frequency data can also be spurious; see Tiao and Wei (1976), Wei (1982, 1990), Marcellino (1999), Breitung and Swanson (2002), and Silvestrini and Veredas (2008). Indeed, as stressed in Dufour and Renault (1998), the interpretation of Granger causality depends on the forecast horizon and data frequency. Data on commodity prices and exchange rates are originally generated at very high frequency. Quarterly data typically used in

[2] For example, David Parkinson writes in the Globe and Mail (Report on Business, 10 April 2010, B14): "When analyzing the loonie, always look at oil"; "loonie" is a colloquialism for the Canadian dollar, a reference to the image of a loon on the coin. In Bloomberg Businessweek (April 18, 2013), Sebastian Boyd states: "Chilean Peso declines as principal export copper reaches new low". In the Wall Street Journal (July 5, 2013), Vincent Cignarella writes: "… a rise in the price of the precious metal would do wonders to boost the fortunes of the Australian dollar".

[3] This is the concept of causality that will be used throughout.

[4] For more general discussions of the theory and empirical evidence on exchange rate markets, see e.g. Levich (1985), Baillie and McMahon (1989), Baillie and Bollerslev (1990), Baillie and Bollerslev (1994), Frankel and Rose (1995), Froot and Rogoff (1995), Isard (1995), Obstfeld and Rogoff (1996), Mark (2001), Sarno and Taylor (2002) and Kilian and Taylor (2003).

[5] For work on forecasting commodity prices (especially energy prices), see also Schwartz (1997), Schwartz and Smith (2000), Pindyck (2001), Hamilton (2009), Alquist and Kilian (2010), Reeve and Vigfusson (2011), Bernard et al. (2012), Baumeister and Kilian (2012), Baumeister and Kilian (2013), Baumeister et al. (2013) and the references therein.