The Quarterly Review of Economics and Finance 54 (2014) 292–305

Contents lists available at ScienceDirect

The Quarterly Review of Economics and Finance

journal homepage: www.elsevier.com/locate/qref

The international business cycle and gold-price fluctuations

Christian Pierdzioch*, Marian Risse, Sebastian Rohloff

Department of Economics, Helmut Schmidt University, Holstenhofweg 85, P.O. Box 700822, 22008 Hamburg, Germany

ARTICLE INFO

Article history:
Received 27 September 2013
Accepted 30 January 2014
Available online 20 February 2014

JEL classification:
C53
E44
G11

Keywords:
Gold price
Real-time forecasting
International business cycle
Behavioral-finance approach

ABSTRACT

Drawing on recent empirical research, we study whether the international business cycle, as measured in terms of the output gaps of the G7 countries, has out-of-sample predictive power for gold-price fluctuations. To this end, we use a real-time forecasting approach that accounts for model uncertainty and model instability. We find some evidence that the international business cycle has predictive power for gold-price fluctuations. After accounting for transaction costs, a simple trading rule that builds on real-time out-of-sample forecasts does not lead to a superior performance relative to a buy-and-hold strategy. We also suggest a behavioral-finance approach to study the quality of out-of-sample forecasts from the perspective of forecasters with potentially asymmetric loss functions.

1. Introduction

Financial crises, market jitters, and the rapid increases in the prices of precious metals during the last couple of years have spurred renewed interest in the economic determinants of the price of gold.[1] Our contribution to this large and rapidly growing literature is that we study the link between gold-price fluctuations and the international business cycle. Studying this link is interesting because empirical evidence is growing that measures of the business cycle help to predict stock returns. For example, Cooper and Priestley (2009) show that the output gap has in-sample and out-of-sample predictive power for stock returns in the U.S. and other G7 countries. In another influential recent publication, Rangvid (2006) argues that the stock price-output ratio is a predictor of expected U.S. stock returns. Vivian and Wohar (2013) further extend the research on the link between stock returns and the output gap by analyzing whether the U.S. output gap predicts returns of portfolios formed on size and value. The links between movements in dividends, stock prices, and output have also been studied extensively in the earlier macroeconomics and asset-pricing literature (Balvers, Cosimano, & McDonald, 1990; Blanchard, 1981; Lucas, 1978, to name just a few).

Because gold is a globally traded asset, we measure international business cycle fluctuations in terms of the output gaps (and output growth rates) of the G7 countries.[2] Moreover, because it is a priori not clear whether a forecasting model should include the output gaps of all countries in our sample as potential predictor variables, we use the real-time forecasting approach developed by Pesaran and Timmermann (1995, 2000) to forecast gold-price fluctuations. In earlier research, several authors have used the real-time forecasting approach to forecast stock returns (Alcock & Gray, 2005; Bohl, Döpke, & Pierdzioch, 2008; Bossaerts & Hillion, 1999; Hartmann, Kempa, & Pierdzioch, 2008), exchange rates (Sarno & Valente, 2009), and commodities (Vrugt, Bauer, Molenaar, & Steenkamp, 2004). The wide interest in the real-time forecasting approach stems from the fact that this approach has several advantages. First, the approach uses only information available to a forecaster in real time. Second, the approach uses a search-and-updating technique to predict gold-price fluctuations. The search part accounts for real-time "model uncertainty" and requires that

* Corresponding author. Tel.: +49 40 6541 2879; fax: +49 681 302 58193.
E-mail address: c.pierdzioch@hsu-hh.de (C. Pierdzioch).

[1] The list of classic determinants being considered in empirical research includes, for example, inflation rates (Blose (2010), Ghosh, Levin, Macmillan, and Wright (2004), Mahdavi and Zhou (1997), Neill Fortune (1987) among others) and exchange rates Capie, Mills, and Wood (2005), Sjaastad (2008), Pukthuanthong and Roll (2011), Reboredo (2013)).

[2] Another reason for why we focus on international data is that Nitschka (2012) shows that the predictive power of the output gap for stock-market returns reported by Cooper and Priestley (2009) reflects the influence of a global, common component.

1062-9769/$ – see front matter
http://dx.doi.org/10.1016/j.qref.2014.01.002

a forecaster searches over a large number of competing forecasting models to select an "optimal" forecasting model. The updating part requires that this model search is restarted whenever new data on the predictor variables become available in real time. Third, the search-and-updating technique implies that the optimal forecasting model can change over time. The real-time forecasting approach, thereby, accounts for the kind of structural breaks and temporal shifts in forecasting equations well-known from the extensive literature on return-prediction models for common stocks (Paye & Timmermann, 2006; Perez-Quiros & Timmermann, 2000; Pesaran & Timmermann, 2002; Rapach & Wohar, 2006; Timmermann, 2001). Fourth, the approach is tailored to study both the statistical and the economic value-added of forecasts. In terms of the latter, the real-time forecasts of gold-price fluctuations can be used to set up a simple trading rule. The simple trading rule, in turn, can be used to determine whether a forecaster benefits from using output gaps as predictor variables of gold-price fluctuations. Finally, it is straightforward to develop variants of the real-time forecasting approach. In our research, we consider the variant originally developed by Pesaran and Timmermann (1995) and a variant that is known as "thick" modeling (Granger & Jeon, 2004). The "thick" modeling approach has been widely studied in recent research because it uses forecast-aggregation techniques to compute forecasts (Aiolfi & Favero, 2005; Rapach, Strauss, & Zhou, 2010 or Guidolin & Timmermann, 2009, among others). Other variants that we consider use an expanding recursive data window and, alternatively, a rolling-data window to forecast gold-price fluctuations.

We find, in terms of market timing, some evidence that the international business cycle has predictive power for gold-price fluctuations, where gold-price movements are expressed in terms of U.S. dollars. We also find that, from the perspective of a risk-neutral and a mean-variance forecaster, a rolling-data window often (but not always) yields, in economic terms, a better forecasting performance than the recursive variant of the real-time forecasting approach. The answer to the question whether the economic value-added of a rolling real-time forecasting approach dominates the economic value-added of a simple buy-and-hold strategy, however, depends on the details of the specification of the forecasting approach and the magnitude of transaction costs. Using a behavioral-finance approach, we also find that the economic value-added of forecasts depends on the shape of a forecaster's loss function. We analyze the role played by the shape of a forecaster's loss function by combining ideas developed in the literature on asymmetric loss functions (see for example, Elliott, Komunjer, & Timmermann, 2005, 2008) with ideas developed in the empirical finance literature on out-of-sample forecasting (Campbell & Thompson, 2008). The result of this combination is an out-of-sample relative loss criterion that can be used to analyze the value-added of forecasts under a symmetric and an asymmetric loss function. We find that in some cases, even if forecasts appear to add no value under a symmetric loss function, forecasts may perform well (relative to the simple historical mean) under an asymmetric loss function. On balance, however, our results show, also against the findings obtained from a bootstrap simulation, that the gold market is informationally efficient with respect to international business-cycle fluctuations. This "efficiency result" confirms results of earlier research on the efficiency of the gold market (Ho, 1985; Solt & Swanson, 1981; Tschoegl, 1980).[3] Our efficiency result, however, is somewhat at odds with results reported by Vrugt et al. (2004). They study the predictability of the Goldman Sachs Commodity Index by using a variant of the real-time forecasting approach. This index is constructed using data on agricultural, energy, industrial metals, livestock and precious metals (gold and silver) commodity futures. Vrugt et al. (2004) report that their forecasting experiment yields returns that dominate the returns on a buy-and-hold strategy, even after accounting for transaction costs. Their results, however, cannot be directly compared with ours because the contribution of precious metals (let alone gold) to the index is rather small (in the order of the magnitude of about 2%). Moreover, they do not answer the question whether measures of the international business cycle help to predict gold-price fluctuations. Furthermore, they do not use simulations to assess the significance of their results. Finally, their sample period ends in 2004, implying that their results do not account for the recent period of rapid increases in the price of gold.

We introduce the real-time forecasting approach in Section 2. We describe our data in Section 3. We lay out our empirical results in Section 4. We conclude in Section 5.

2. The real-time forecasting approach

2.1. Computation of forecasts

We consider the output gaps, $x_{t,j}$, $j = 1, \ldots, k$, of k countries as potential predictor variables of gold-price fluctuations, where we measure gold-price fluctuations in terms of gold returns in excess of a riskless, short-term interest rate. Because it is a priori not clear whether an "optimal" forecasting model features all k output gaps, the real-time forecasting approach requires, in every period of time, t, estimation of a total of 2^k forecasting models that feature alternative combinations of the output gaps. Accordingly, we estimate by the ordinary least squares technique 2^k variants of the following regression model[4]:

$$r_{t+1} = \beta_{0,i} + \beta_{1,i}x_{t,1} + \beta_{2,i}x_{t,2} + \ldots + \beta_{k,i}x_{t,k} + \epsilon_{t+1,i}, \quad (1)$$

where i denotes the forecasting model being estimated, $\epsilon_{t+1,i}$ expresses a model-specific random disturbance term, and $\beta_{l,i}$, with $l = 0, \ldots k$ denote model-specific coefficients. In every period of time, t, we combine the available real-time information on the output gaps along with the estimated coefficients, $\hat{\beta}_{l,i}$, of the 2^k forecasting models to compute forecasts, $\hat{r}_{t+2,i}$, of gold-price fluctuations.

Equipped with the 2^k forecasts, $\hat{r}_{t+2,i}$, we must decide how to form an "optimal" forecast. To this end, two alternative modeling strategies are available. First, we use widely-studied statistical forecast-selection criteria to obtain an optimal forecast. Because the choice of a forecast-selection criterion is somewhat arbitrary, we analyze four criteria that have been applied in earlier literature (Bossaerts & Hillion, 1999; Pesaran & Timmermann, 1995): The Adjusted Coefficient of Determination (ACD) criterion, the Akaike Information Criterion (AIC), the Schwarz Information Criterion (SIC) and the Direction of Change Criterion (DCC). Results for other forecast-selection criteria (for example, the Hannan–Quinn criterion) are similar and, to save journal space, are not reported (but available from the authors upon request.)

Second, we use the "thick" modeling strategy advocated by Granger and Jeon (2004) to aggregate the forecasts from the 2^k alternative forecasting models to a single "optimal" forecast. Various aggregation schemes have been applied in earlier research (Aiolfi & Favero, 2005; Guidolin & Timmermann, 2009; Rapach et al., 2010). We consider four alternative forecast-aggregation

[3] In recent literature, researchers have assessed the efficiency of the gold market by studying technical and tactical market-timing strategies using commodity futures contracts. See Fuertes, Miffre, and Rallis (2010), Marshall, Cahan, and Cahan (2008).

[4] All computations were coded up using the free R programming environment (R Development Core Team, 2012).