Do returns to capital matter for gold prices?

Aguiele Ndoungla, Austin College

In the United States, like in other countries with a variety of investment opportunities, interest rate is the default approach for measuring aggregate return on capital. However, because drivers of return to capital are multifactorial, it is very implausible to gauge the rate of return to capital solely on interest rate. The alternative approach is to use estimates of the return to capital in financial markets to back out the aggregate return to capital. But this too can be misleading since financial markets track expectations and speculative pressures more so than fundamentals of the economy. To account for the fundamentals of the economy, some researchers and investors have resorted to gross capital formation, defined as the additions to fixed assets of the economy plus net changes in the level of inventories, to measure return to capital (Bai et al. 2006; Fung et al. 2008; van der Eng 2009; Chow 2017). Others have proposed estimating the return to capital by regressing output on a measure of the capital stock and using the elasticity of capital stock to output as a proxy of return to capital (Pagano 1993; Henry 2003; Dwenger 2014). While these two latter approaches, i.e., gross capital formation and elasticity of capital stock, provide important insights about the drivers of returns to capital, they are likely to lead to biased estimates of the return to capital because both are affected by omitted variables.

Clearly, all the aforementioned approaches are narrow and lack a broader reach to different aspects of the economy. Hence the need for a multidimensional approach to accurately measure return to capital. Yet few existing studies such as Bai et al (2006) and Gil and Iglesias (2019) emphasize the multidimensional nature of return to capital. For example, Gil and Iglesias (2019) analyze the drivers of the return to capital based on interest rate, capital-to-labor ratio, complementarity with R&D capital, and other monetary variables. Bai et al. (2006) measure rate of return to capital as a function of price of the output good coming from capital, marginal product of capital, price of capital, and depreciation rate of capital. In this paper, we also investigate the return to capital from a multi-dimensional perspective. However, unlike Bai et al. (2006) and Gil and Iglesias (2019), we focus on financial capital (i.e., capital in terms of the dollar amount invested in a company) rather than physical capital (equipment, plant, and machinery).[1] Specifically, we propose a robust measure of the return to financial capital that accounts for the several factors not as independent measures of return to financial capital but as composite measure.

The remainder of the paper proceeds as follows. Section 2 lays out the mathematical derivation of the proposed measure and estimates it respectively for the United States (U.S.) and the United Kingdom (U.K.) from 1999-2019. In Section 3, we examine whether the U.S. return to capital and the U.K. return to capital move together. We then investigate

[1] Generally, there are two concepts of capital: financial capital and physical capital. The financial capital concept is the traditional view. It keeps track of capital in terms of the dollar amount invested in a company. In this way, a return on financial capital means that there is an excess of the dollar amount of capital at the end of the investment period compared with the dollar amount of capital at the beginning, excluding the effect of transaction costs to owners. In other words, there has been an increase in the value of money capital. In contrast, the physical capital concept perceives capital in terms of its physical attributes and then translates the value into dollars. Usually, the physical attributes of capital relate to the firm's production capacity based on its equipment, plant, and machinery. A return on physical capital results only if the physical productive capacity at the end of the period exceeds the physical productive capacity at the beginning of that period, excluding effects of transaction costs to owners.

the predictive power of the returns to capital on spot gold price in Section 4. Section 5 concludes.

II. Return to capital: a multi-dimensional measure

Any measure of return to financial capital (*returns to capital*, for short) should include both the financial side and the real side of the economy because the two reinforce each other positively and negatively. Along this line, the new multi-dimensional measure of return to capital proposed in this paper is based on three main building blocks: the real interest rate differential (a measure of volatility in the real interest rate differences between two countries), share price index (a proxy for share price volatility and measures how the value of the share prices is changing), and gross capital formation (a measure of net increases in the stock of fixed capital). For a given country, the return to capital (RTC) is defined as follows:

$$RTC_t = \frac{\sum(RIRD_{jt}, SPI_t, GCF_t)}{3} \quad [1]$$

where t is the period in months, $RIRD_{jt}$ denotes real interest rate differential between domestic and foreign country, *SPI* is share price index growth rate, and *GCF* is gross capital formation growth rate. We assume that all market risks have been absorbed by the share prices and the real interest rate differential (through exchange rate).

The *RIRD* determines capital flows because capital tend to flow from low return countries to high return ones. Since a low (high) return usually implies a high (low) interest rate, if there is a big difference in real interest between two countries, the probability of an inflow surge in the country with the lowest rate would increase. Following Gosh et al. (2012), we specify the mathematical representation of the real interest rate differential as:

$$RIRDjt = Rjt - (Qj - Qit) - Rit \quad [2]$$

where $RIRD_{jt}$ is the real interest rate differential in the domestic country j at time t; R_{jt} is the real domestic interest rate; Q_j is the current real exchange rate between the domestic country and foreign country; Q_{it} denotes the long-term trend of the current real exchange rate;[2] and R_{it} is the real foreign interest rate. The *RIRD* is most appropriate for estimating RTC because inflation can lead to comparisons bias in periods of high or hyperinflation (Ghosh et al. 2012). Furthermore, the use of the *RIRD* allow us to incorporate interest rate and exchange rate, which have been identified in the literature as important determinants of RTC (see for example, Calvo and Reinhart 1996; Fiess 2003; Elbadaawi and Soto 1994; Sula 2010; among others).

Turning now to the other two drivers of RTC in Eq. [1], *SPI* is the prices of common shares of companies traded on national or foreign stock exchanges. *GCF* is the additions to the fixed assets of the economy plus net changes in the level of inventories share of GDP. Both series are transformed into growth rates.

[2] We use Hodrick Prescott (HP) filter to separate the current real exchange rate series Q_{jt} into trend and cyclical components: $Q_{jt} = \tau_{jt} + c_{jt}$ where τjt is the trend component and c_{jt} is the cyclical component. The trend component τ_{jt} is calculated by the difference $\tau_{jt} = Q_{jt} - c_{jt}$.

We estimate this new multi-dimensional RTC measure in Eq. [1] for the U.S. and the U.K. using monthly data from 1999-2019. All the data definitions and sources are provided in Table 1 in the Appendix. Fig. 1 shows the U.S. and U.K RTCs. The plot indicates that RTC in both countries tend to move together. Fig. 2 and Fig. 3 respectively show the U.S. RTC and U.K. RTC, each with its long run trend. The plots indicate that U.S. RTC ranges between -9% to 3% and U.K. RTC ranges between -5% to 3%. Furthermore, long term U.S. RTC is inversely related to long term U.K. RTC. In particular, whereas the long term RTC in the U.S. has been consistently negative since 1999 until 2017 when there is reversal, U.K. RTC have consistently been in the positive territory until 2017.

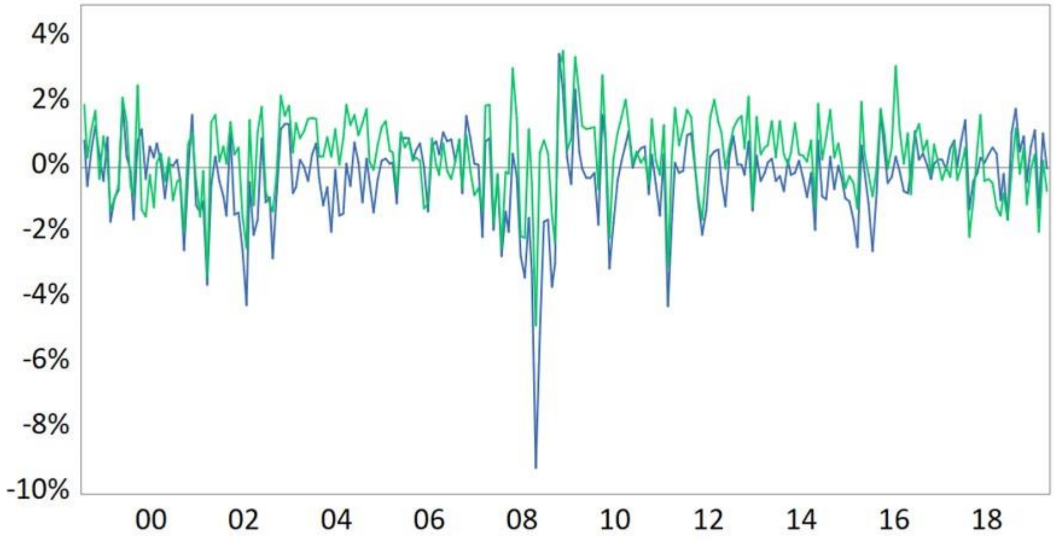

Fig. 1. Return to capital: U.S. and U.K. (Jan 1999-Oct 2019) Note: U.S. = Blue line. U.K. = Green line.

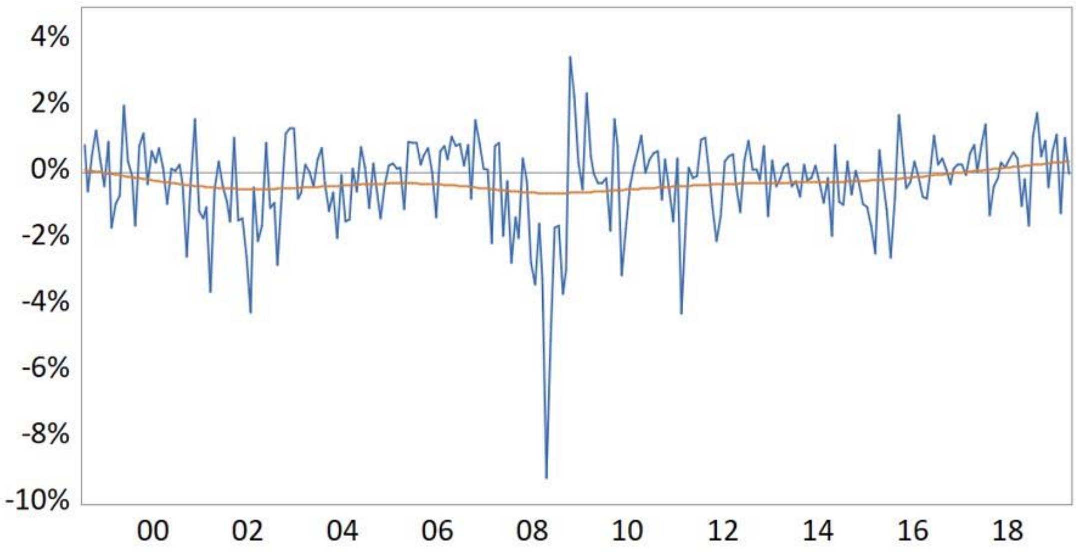

Fig. 2. U.S. Return to capital (Jan 1999-Oct 2019)

Note: Red line represents the long run trend of U.S. return to capital

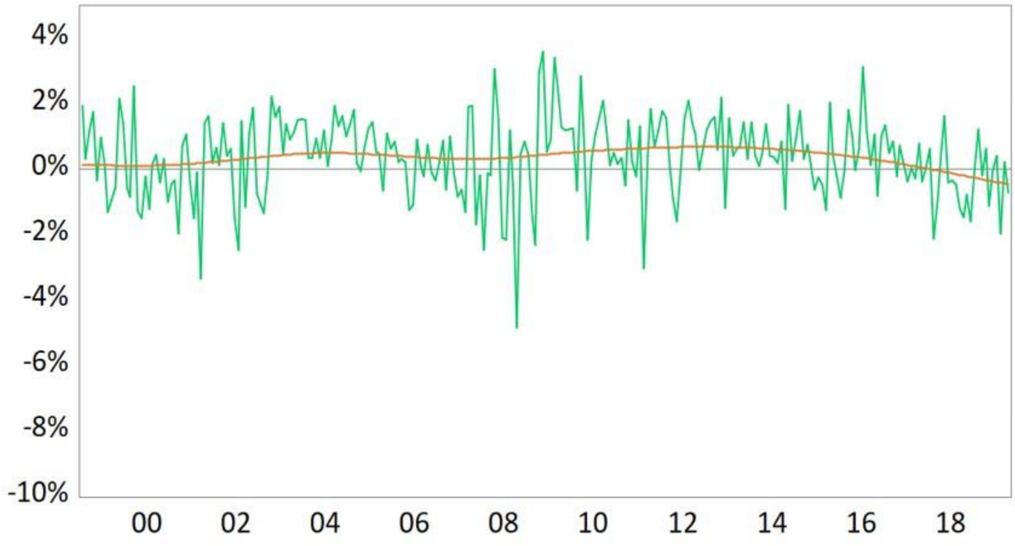

Fig. 3. U.K. Return to capital (Jan 1999-Oct 2019)

Note: Red line represents the long run trend of U.K. return to capital

III. Do U.S. RTC and U.K. RTC move together?

In this section, we examine whether RTCs in the U.S. and U.K. move together. To do so, we estimate the following cross-correlations:

$$r_{xy}(l) = \frac{C_{xy}(l)}{\sqrt{C_{xx}(0)}\sqrt{C_{yy}(0)}} \quad [3]$$

where *x* is either the first difference U.S. RTC or the first difference of U.K. RTC, such that,

$$C_{xy}(l) = \begin{cases} \frac{1}{T}\sum_{t=1}^{t-1}(x_t - \bar{x})(y_{t+1} - \bar{y}) \;\; for \;\; l = 0, 1, 2, 3, ... \\ \frac{1}{T}\sum_{t=1}^{t-1}(x_t - \bar{x})(y_{t+1} - \bar{y}) \;\; for \;\; l = 0, -1, -2, -3, ... \end{cases} \quad [4]$$

and the bar denotes the mean. If the cross-correlation is zero for *l*, it indicates that both series are moving together. But if it is positive for *l*, then it indicates that the U.S. RTC leads the U.K. RTC. The reverse is the case if the cross-correlation is negative. Fig. 4 shows the cross correlograms for -12 ≥ *l* ≤ 12 for the U.S. and the U.K. RTCs, which exhibits a positive and the highest value in the neighborhood of *l* = 1 signifying that the U.S. RTC leads the U.K. RTC by 1 month.

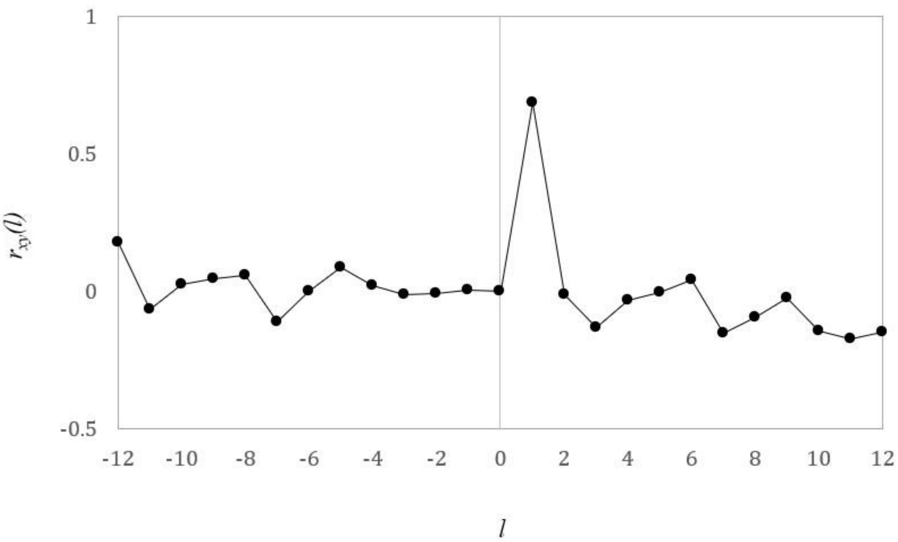

Fig. 4. Cross correlograms

$r_{xy}(l)$ exhibit positive and highest value in the neighborhood of $l = 1$, implying that U.S. RTC leads U.K. RTC by a month.

IV. Do RTC predict spot gold price?

In this section, we evaluate the predictive capacity of the RTC in predicting the spot price of gold. The spot gold price refers to the global gold price per ounce for immediate delivery anywhere in the world (in U.S. dollars). The spot gold market is open nearly 24 hours a day as there is almost always a location somewhere in the world that is actively taking orders for gold transactions (Kitco 2020). Global hotspots for gold trading include New York, London, Sydney, Hong Kong, Tokyo, South Africa, and Zurich. To test the predictive power of RTC on gold price, we use the respective growth rates of U.S. RTC, U.K. RTC, and global spot price. The global spot price data is obtained from goldhub.com. Building on Funashima (2020), we specify the following regression model:

$$g_t = \sum_{i=1}^{q} \beta_i g_{t-1} + \sum_{i=1}^{q} \psi_i rtc_{t-1} + \varepsilon_t$$

where g_t is the growth rate of spot gold price expressed in first logarithmic difference and rtc_{t-1} is either the U.S. RTC or the U.K. RTC. We set q to 3, 6, and 12 months and run F-tests of the null hypotheses $\psi_1 = \psi_2 = \psi_3 = 0$; $\psi_1 = \psi_2 = ... = \psi_6 = 0$; etc.

Table 2 reports the results. We find that U.S. RTC does not predict the gold price at the 5% level of significance for lags 3, 6, and 12 but rather gold price predicts the U.S. RTC at 12 lags. Similarly, gold price predicts the U.K. RTC at 12 lags but at a slightly lower level of confidence, i.e., 10%. As robustness check, we run additional estimations using the first logarithm difference global spot gold price (in U.K. pounds). Results reported in Table 3 show that while the predictive power of gold price on U.K. RTC occurred at 3 and 12 lags, the main finding that gold price has stronger predictive power on the U.S. returns than the U.K. returns is invariant to the use of gold price expressed in U.K. pounds.

Table 2. Pairwise Granger Causality Tests: U.S. RTC, U.K. RTC, and Gold price
Gold price (in U.S. dollars)

Null Hypothesis	F-Statistic sign	Prob.
Lags: 3		
US RTC does not Granger Cause GP	0.3197	0.811
GP does not Granger Cause US RTC	0.6760	0.568
UK RTC does not Granger Cause GP	0.7393	0.529
GP does not Granger Cause UK RTC	1.7676	0.154
Lags: 6		
US RTC does not Granger Cause GP	0.2218	0.969
GP does not Granger Cause US RTC	0.7515	0.608
UK RTC does not Granger Cause GP	0.5698	0.754
GP does not Granger Cause UK RTC	1.4399	0.200
Lags: 12		
US RTC does not Granger Cause GP	0.8584	0.590
GP does not Granger Cause US RTC	2.0975	0.018**
UK RTC does not Granger Cause GP	1.1867	0.294
GP does not Granger Cause UK RTC	1.6977	0.069*

Notes: US RTC = U.S. return to capital; UK RTC = U.K. return to capital GP = Gold price. Prob = p-value with ***, **, and * denote respectively 1%, 5%, and 10% level of significance.

Table 3. Pairwise Granger Causality Tests: U.S. RTC, U.K. RTC, and Gold price Gold price (in U.K. pounds)

Null Hypothesis	F-Statistic sign	Prob.
Lags: 3		
US RTC does not Granger Cause GP	0.4409	0.724
GP does not Granger Cause US RTC	2.8024	0.041**
UK RTC does not Granger Cause GP	0.1689	0.917
GP does not Granger Cause UK RTC	2.5915	0.053*
Lags: 6		
US RTC does not Granger Cause GP	0.4754	0.826
GP does not Granger Cause US RTC	1.6484	0.135
UK RTC does not Granger Cause GP	0.2203	0.754
GP does not Granger Cause UK RTC	1.5246	0.171
Lags: 12		
US RTC does not Granger Cause GP	0.9118	0.536
GP does not Granger Cause US RTC	2.2389	0.011**
UK RTC does not Granger Cause GP	0.7216	0.729
GP does not Granger Cause UK RTC	1.4167	0.159

Notes: US RTC = U.S. return to capital; UK RTC = U.K. return to capital; GP = Gold price. Prob = p-value with ***, **, and * denote respectively 1%, 5%, and 10% level of significance.

V. Conclusion

In this paper, we propose a novel multi-dimensional measure of returns to financial capital. We calculate this new measure of RTC for the U.S. and the U.K. using monthly data from 1999-2019. We find that the U.S. RTC leads the U.K.'s by one month.

Also, we evaluate the predictive capacity of the proposed RTC in predicting the global spot price of gold. Our findings reveal that U.S. RTC does not predict the gold price but rather gold price predicts the U.S. RTC. Similarly, gold price predicts the U.K. RTC. This finding is robust whether gold price is expressed in U.S. dollars or U.K. pounds.
Although the second test was not conclusive, it still supports the idea of a strong relationship between gold spot prices and return to capital. The first test on the other hand, in addition to previous research, suggests the multidimensional measure proposed has grounds for being considered for further research. Taken together, the findings support the usefulness of a multidimensional approach to calculating returns to financial capital. Additionally, the findings suggest that investors and other market stakeholders should take notice of movements in the proposed multi-dimensional returns to financial capital and its relationship with global gold prices.

VI. References

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VII. Appendix

Table 1: Data definitions and sources

Variable	Definition	Source
	Real interest rate differential variables Eq. [2] for U.S.	
US EFFR	U.S. Effective Federal Funds Rate	FRBSL FRED[†] (series: FEDFUNDS)
US GDP DEFL	U.S. Implicit Price Deflators for GDP	US BEA[‡] National Accounts Table 1.1.9
R^*_{jt}	Real U.S. EFFR: FEDFUNDS deflated by U.S. implicit price deflators	authors' calculations
USUK EXCR	U.S./U.K. Foreign Exchange Rate, U.S. Dollars to One British Pound	FRBSL FRED (series: DEXUSUK)
Q^*_j	Real USUK EXCR = USUK EXCR deflated by U.S. implicit price deflators	authors' calculations
Q^*_{it}	Long term Real U.S./U.K. Foreign Exchange Rate	authors' calculation
R^*_{it}	UK EIR deflated by U.K. implicit price deflators	authors' calculation
	Real interest rate differential variables Eq. [2] for U.K.	
UK EIR	U.K. Effective Interest Rate	Bank of England series: CFMHSDA
UK GDP DEFL	U.K. Implicit Price Deflators for GDP	UK National Accounts (series: L8GG)
R^*_{jt}	Real U.K. EFFR: UK EIR deflated by U.K. implicit price deflators	authors' calculation
UKUS EXCR	U.K./U.S. Foreign Exchange Rate = inverse of USUK EXCR	authors' calculation
Q^*_j	Real UKUS EXCR = inverse of USUK EXCR deflated by U.K. implicit price deflators	authors' calculation
Q^*_{it}	Long term trend of REAL UKUS EXCR	authors' calculation
R^*_{it}	Real U.S. EFFR: FEDFUNDS deflated by U.S. implicit price deflators	authors' calculations
	Returns to capital variables Eq. [1] for U.S.	
$RIRD^*_{jt}$	U.S. Real Interest Rate Differential for U.S. based on Eq. [2]	
SPI^*_t	percent change in share prices traded on U.S. stock exchanges	OECD MEI[§] (series: Share Price)
GCF^*_t	additions to fixed assets of U.S. economy + net Δ in inventories share of GDP	FRBSL FRED (series: NAEXKP04USQ652S)
	Returns to capital variables Eq. [1] for U.K.	
$RIRD^*_{jt}$	U.K. Real Interest Rate Differential for U.K. based on Eq. [2]	
SPI^*_t	percent change in share prices traded on U.K. stock exchanges	OECD MEI (series: Share Price)
GCF^*_t	additions to fixed assets of U.K. economy + net Δ in inventories share of GDP	FRB FRED (series: NAEXKP04USQ652S)

Notes: *denotes variables that go directly into the respective equations for each country
[†]FRBSL FRED is the Federal Reserve Bank of St. Louis FRED database
[‡]US BEA is the US Bureau of Economic Analysis
[§]OECD MEI is the OECD Main Economic Indicators database
Full dataset containing all variables is available online at: 10.6084/m9.figshare.12816101.