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Assessing efficiency and investment opportunities in commodities: A time series and portfolio simulations approach☆,☆☆

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ABSTRACT

This paper investigates the informational efficiency hypothesis in the short and long term for four major commodity markets (oil, gas, electricity, and coal) from January 1997 to January 2016. Unlike previous studies, we provide a more concise comparative analysis by focusing on different classes of commodities for a large sample, including 5 developed and 3 emerging regions and covering 46 countries. We apply different parametric and non-parametric econometric tests. Our study provides two interesting findings. First, we show that commodity markets are informationally inefficient in the short term. Our portfolio simulations highlight that commodities might provide "good" investment opportunities, but those opportunities vary according to commodity class and regions. Second, we show that most commodity markets become informationally efficient in the long term, thereby reducing investors' interest for the duration. Thus, commodity markets might be used to hedge investor's portfolios, particularly for speculators and chartists in the short term, while these investments might not be appealing in these markets in the long term.

1. Introduction

Market efficiency refers to the close evolution of the observed price of an asset around its true or fundamental value (Samuelson, 1965). Efficiency constitutes a cornerstone of modern financial theory, and it has been considered a joint benchmark hypothesis for asset pricing models since most financial asset models are built on this hypothesis.

The notion of efficiency was first mentioned by Kendall (1953) and Working (1934). However, Fama (1965, 1970) is considered the true "father" of the efficiency hypothesis because he developed the theory and offered the first economic explanation and formalization[1]. In his first formulation, Fama (1965, 1970) defines an informationally efficient market as one in which prices instantaneously and fully reflect the complete and pertinent information available on the market. He also identifies three main forms of efficiency according to this information type: weak (the information includes past prices and returns), semi-strong (only public information is a concern), and strong (both public and private information should be reflected in the price).

While many different statistical and econometric tests are developed to check these three forms of efficiency using mainly financial data[2], the definition by Fama was considered at least a source of an important paradox by Grossman and Stiglitz (1980). The authors suggest that if the market is efficient, there is no reason to continue to seek information on financial assets. This paradox results in several criticisms of the work of Fama. Additionally, two different analyses can be identified considering the studies on efficiency and rationality. While two of the three 2013 Nobel laureates in economics, Eugene Fama and Lars Hansen, postulate the classical economic rationality of agents when explaining price forecasting, the third 2013 Nobel laureate, Robert Shiller, considers that investors' rationality does not obey the rules of rationality as stated in classical economic models, and Shiller often criticized the efficiency hypothesis.

This challenge concerning informational efficiency is not new, and the related empirical literature has identified at least two research groups. In the 1970s, most empirical research is concluded in terms of efficiency and the absence of price forecasting given that a random walk model fitted the data well. However, since the 1980s and the seminal study by Shiller (1981)

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[1] While it is possible to distinguish between different types of efficiencies (productive, allocative, and informational), informational efficiency is the most well-known and well-studied in the financial literature. Informational efficiency will also be the focus of the current study because it is not sufficiently developed for commodities. For more discussion on the other types of efficiencies, see Jawadi and Prat (2012).

[2] Note that weak-form efficiency has received substantial attention from economists and has been extensively empirically tested in practice.

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Table 1
Composition of developed and emerging indexes.

Developed indexes					Emerging indexes		
NA	**G7**	**EUR**	**EAFE**	**AP**	**LA**	**BRICS**	**EM**
1. US	1. US	1. Austria	1. Austria	1. Australia	1. Brazil	1. Brazil	1. Brazil
2. Canada	2. Canada	2. Belgium	2. Belgium	2. Hong Kong	2. Chile	2. Russia	2. Chile
	3. Japan	3. Denmark	3. Denmark	3. Japan	3. Colombia	3. India	3. Colombia
	4. Germany	4. Finland	4. Finland	4. New Zealand	4. Mexico	4. China	4. Mexico
	5. France	5. France	5. France	5. Singapore	5. Peru	5. South Africa	5. Peru
	6. UK	6. Germany	6. Germany				6. Czech Republic
	7. Italy	7. Ireland	7. Ireland				7. Egypt
		8. Italy	8. Italy				8. Greece
		9. the Netherlands	9. the Netherlands				9. Hungary
		10. Norway	10. Norway				10. Poland
		11. Portugal	11. Portugal				11. Qatar
		12. Spain	12. Spain				12. Russia
		13. Sweden	13. Sweden				13. South Africa
		14. Switzerland	14. Switzerland				14. Turkey
		15. UK	15. UK				15. United Arab Emirates
			16. Australia				16. China
			17. Japan				17. India
			18. Hong Kong				18. Indonesia
			19. New Zealand				19. Korea
			20. Singapore				20. Malaysia
							21. Philippines
							22. Taiwan

Note: North America (NA); the G7 (G7); Europe, Australia, and the Far East (EAFE); Developed Europe (EUR); Developed Asia and Pacific (AP); Brazil, Russia, India, China, and South Africa (BRICS); Emerging Markets (EM); Latin America (LA).

on the volatility puzzle, several empirical studies show that market inefficiency and price forecasting in the medium and long terms have become the new rules. In addition, the rapid development of databases and new econometric tools is helpful for more empirical verifications of efficiency, which often do not support efficiency. Interestingly, the current robust debate on efficiency has led to the emergence of two promising ongoing and future research routes. The first is pursued by Eugene Fama and Lars Hansen among others and develops new sophisticated models for efficiency and price formation under the hypothesis of rational expectations. The second research route is mainly initiated and developed by Robert Shiller, whose research vision rejects the classical model and intends to develop an alternative behavioral finance approach to better explain the

Table 2
Main descriptive statistics.

Oil sector								Gas sector						
Indices	**Mean**	**SD**	**Sk**	**Kur**	**JB**	**ARCH**	**Obs**	**Mean**	**SD**	**Sk**	**Kur**	**JB**	**ARCH**	**Obs**
Developed indexes														
NA	1.03	0.66	-0.15	12.16	17414.2	28.96	4970	1.51	0.55	-0.45	12.26	17870.6	26.82	4970
G7	0.15	0.68	-0.00	11.04	13408.0	25.33	4970	13.29	0.55	1.87	13.54	25828.4	20.22	4970
EAFE	0.83	0.68	0.02	11.81	16110.0	33.50	4970	1.74	0.64	-0.47	27.75	126438.5	17.36	4970
EUR	0.12	0.69	-0.00	9.82	9646.2	24.14	4970	2.26	0.80	-0.53	14.563	27794.1	18.37	4970
AP	0.53	0.67	-0.30	9.69	9366.7	16.57	4970	3.15	0.93	-0.86	25.48	104808.9	18.37	4970
Emerging indexes														
BRICS	0.44	0.89	-0.196	13.45	22653.6	23.99	4970	0.67	1.11	-0.60	13.419	22673.8	28.80	4970
EM	0.67	0.79	-0.462	9.272	8324.8	14.55	4970	3.11	1.17	1.873	13.549	25828.4	17.03	4970
LA	-0.42	0.98	-0.02	6.77	2954.4	14.55	4970	-0.57	2.14	0.21	8.70	6769.1	19.70	4970
Electricity sector								**Coal sector**						
Indices	**Mean**	**SD**	**Sk**	**Kur**	**JB**	**ARCH**	**Obs**	**Mean**	**SD**	**Sk**	**Kur**	**JB**	**ARCH**	**Obs**
Developed indexes														
NA	0.56	0.51	0.02	13.49	22822.0	29.67	4970	-2.37	1.33	0.97	34.93	211673.5	4.81	4970
G7	-0.46	0.64	-0.61	21.18	68801.1	42.31	4970	-0.40	1.19	-0.53	10.85	12993.8	24.87	4970
EAFE	0.25	0.52	-0.17	11.84	16235.1	24.81	4970	0.48	1.11	-0.55	14.50	27638.0	23.92	4970
EUR	0.29	0.56	-0.10	12.40	18342.6	27.23	4970	-3.40	1.16	-0.88	31.16	164730.6	09.15	4970
AP	-0.17	0.49	-0.20	8.634	6610.9	29.10	4970	0.20	0.80	-0.18	9.835	9689.7	24.33	4970
Emerging indexes														
BRICS	-0.97	1.11	-0.124	8.912	7252.5	22.08	4970	2.56	1.26	-0.231	10.84	12765.5	21.01	4970
EM	0.87	0.40	-0.63	11.31	14659.28	27.59	4970	-0.15	0.97	-0.113	9.16	7877.49	24.69	4970
LA	-0.50	1.04	-0.13	9.76	9483.9	27.44	4970	-0.33	0.96	0.21	8.70	6769.1	19.51	4970

Notes: North America (NA); The G7 Group 7 (G7); Europe, Australia, and the Far East (EAFE); Developed Europe (EUR); Developed Asia and Pacific (AP); Brazil, Russia, India, China, and South Africa (BRICS); Emergent Markets (EM); and Latin America (LA). Mean, SD, Sk, Kur, JB, and Obs denote the mean, the standard deviation, skewness, kurtosis, the Jarque-Bera statistic, and the number of observations, respectively. The ARCH refers to the statistics of the ARCH (autoregressive conditional heteroscedasticity) test of Engle (1982).