

基于金融因素的国际石油 价格波动研究

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摘 要

近年来,国际石油价格波动频繁而剧烈,作为现代社会基础能源产品和重要的工业原料,石油牵动着经济领域的方方面面,石油价格波动给石油生产和消费带来收益的不确定性,这种不确定性通过国际贸易被放大之后,对世界经济稳定和经济增长会产生一系列不利影响,甚至可能诱发全球性通货膨胀或经济衰退。在这种背景下,探索油价波动背后的深层次原因具有重要的现实意义。

石油稀缺性、重要战略性、供求在空间上分离、需求价格弹性小等特性决定了石油价格极易呈现波动态势,石油储采比变化、石油库存波动、石油需求增长强劲、供求平衡脆弱、欧佩克减产等商品因素,以及地缘政治局势和突发政治事件等战略因素对油价波动具有一定推动作用,但这些因素的影响与频繁而剧烈的油价波动相比显得微不足道,众多资料表明美元汇率变化、投机基金过度参与等金融因素才是近年来影响油价波动的主导因素。随着国际石油期货、期权、互换等衍生工具的发展,以及石油期货交易市场、石油现货交易市场、石油衍生品市场、石油美元市场之间的互动,石油经济系统已经变成了一个高度复杂、精密的金融市场,石油安全已从“生产—供应”型的“供给安全”模式转变成“贸易—金融”型的“价格安全”模式。

为了揭开国际油价波动之谜,本书首先构建国际油价波动基本理论,然后提出“内在机理—模型分析—计量检验”分析框架,从金融视角展开研究。

早期石油现货市场交易给石油生产行业带来了较大的价格风险,供求双方都需要某种市场规则或交易方式来锁定成本或利润,达到石油产

品保值之目的,在这种背景下,期货合约应运而生,石油期货的引入使石油产品从此具有了金融属性。石油期货市场的参与者可以根据自身对市场价格的预期进行买、卖合约的相继操作,来赚取价差利润。因此,石油金融市场吸引了大量石油相关企业、对冲基金、投资银行、机构投资者、私人股权基金及其他金融资本纷纷参与其中。近年来美元贬值造成以美元为主的各国外汇储备也随之发生贬值,国际油价持续上涨,为了保障外汇安全,避免外汇资源浪费,稳定本国石油生产和供应,世界各国纷纷将国家外汇用于石油储备,因此国家外汇也走入了石油金融市场。另外,石油进口国的石油企业为了实现“走出去”战略,参与国际石油市场竞争,需要有石油基金、石油银行为其提供资金与保险等服务,共同实现石油净进口国的石油战略目标,石油基金、石油银行的参与,加深了石油市场的金融属性。现阶段,石油金融衍生产品几乎涵盖了所有金融衍生品的种类,无论是从时空布局、交易规模、交易方式、产品种类、市场参与者结构还是从市场功能来看,石油衍生产品市场已成为联结国际石油市场、金融市场和资本市场的重要纽带,石油与金融紧密交织在一起,石油市场日趋金融化。

通过考察金融因素对油价波动的影响机理,我们发现:浮动汇率制度下,“特里芬难题”注定了美元汇率的不稳定;石油以美元计价,导致大量石油美元的出现,一方面加剧了美元汇率的变化,另一方面助长了石油投机;美元汇率波动对油价波动产生系统性影响,不仅直接作用于油价波动,而且还通过影响石油供求、石油投机间接影响油价波动;投机基金是油价剧烈波动的直接原因;丰富的金融衍生工具为油价推波助澜。正是“特里芬难题”、石油“计价货币”之争、石油美元、石油金融衍生工具、投机基金、美元汇率等多种金融因素之间的相互影响、协同作用,才促使近年来国际油价基本脱离供求规律制约呈现出频繁而剧烈的波动态势。

通过构建包括石油消费者和石油生产者两部门的简单 DSGE 模型和复杂 DSGE 模型,分别将生产率冲击、石油消费需求冲击和石油投机需求冲击引入其中,给出一阶最优条件,然后对约束方程和一阶最优条件进行对数线性化,最后在参数校准的基础上,使用 Dynare 和 Matlab 软

件编程得出模型变量对各种随机冲击的脉冲响应结果。结果表明：短期内石油投机需求外生冲击对石油价格影响作用最大，首期偏离稳态 1.2%，回到稳态的时期最短，只需要 5 期；生产率外生冲击对石油价格影响较小，首期只有 0.17%，偏离稳态以后需要 40 期以上的时间重新回复稳态；而石油消费需求外生冲击对石油价格的首期影响为 0.3%，最高时达到 0.4%，回复稳态时间较长，40 期只回复到偏离稳态 0.2% 的程度。通过 DSGE 模型分析和模拟，可以很好地印证理论分析的结论：与石油供求因素相比，石油金融因素对近年来国际油价波动具有更为直接的决定作用。

通过使用包括 ADF 单位根检验、EG 两步法、约翰森协整检验、格兰杰因果检验、VEC 模型、脉冲响应、方差分解、GS 模型、双变量 EC-EGARCH 模型等在内的多种计量方法对国际石油期货市场价格发现功能、波动溢出效应、投机因素与油价波动、汇率因素与油价波动、金融因素及供求因素与油价波动进行了综合实证研究，结论表明：（1）油价的大起大落并没有影响到国际石油期货市场的有效性，期货市场运行仍然有效，在价格发现过程中起主导作用，石油期货市场良好的价格发现功能一方面为石油套期保值、规避风险提供了条件，另一方面也为期货市场的波动溢出奠定了基础；期货价格收益率和现货价格收益率均为平稳序列，具有“尖峰厚尾”和集聚性特征；期货市场和现货市场均具有“杠杆效应”，期货市场与现货市场之间的波动溢出具有非对称性，溢出方向为期货市场到现货市场，因而期货价格波动带动了现货价格呈现出相同的波动态势和规律。（2）用总持仓和非商业交易头寸占比代表的投机因素短期中对石油期货价格有显著影响；石油期货价格、非商业交易头寸占比、美国商业石油库存、美国石油消费对数序列之间的协整方程说明短期中反映投机力量的非商业交易头寸占比对国际油价的影响远远大于反映供求因素的美国商业石油库存和美国石油消费对油价的影响，换句话说，与供求因素相比，短期中石油投机对国际油价波动具有主导作用。（3）广义美元指数对石油期货价格影响显著；石油期货价格、广义美元指数、非商业交易头寸占比、美国原油供给、美国原油消费对数序列之间的协整方程说明金融因素（包括广义美元指数、

非商业交易头寸占比)对石油期货价格有较大影响,供求因素(包括美国原油供给、美国原油消费)对石油期货价格影响较小,其中美国原油供给对石油期货价格的影响不显著。(4)与短期分析结果相比,长期中石油消费对油价波动的影响有所增强,投机力量对油价波动的影响有所减弱,汇率变化对油价波动有长期反向作用效果。

金融因素主导了近年来的国际油价波动态势,国际油价波动对全球经济稳定和经济增长构成了重大威胁,世界各国亟待加强沟通,采取措施就金融因素对油价波动的影响进行共同应对,主要包括:推进国际货币体系改革;加强国际投机基金监管,防止过度投机行为。随着金融因素与石油产品的日益融合,石油金融属性不断得到增强,石油金融化趋势已是必然。就我国而言,应该顺应石油金融化这一历史趋势,及时跟进国际石油金融化步伐,借鉴国外成熟经验,尽快构建自己的石油金融战略体系,主要包括:建立多层次的石油交易市场;营造石油银行;设立石油基金;建立石油外汇储备;推进石油交易人民币结算业务;完善石油战略储备体系;加强石油金融立法;建立石油金融风险监管机制。

本书从金融视角构建“内在机理—模型分析—计量检验”框架,从理论、模型和实证三个层面对国际油价波动态势给出了合理解释。将DSGE模型用于分析金融因素对国际油价波动的影响,这是一个全新的尝试。研究视角具有一定创新性,主要表现为:供求因素是影响价格的基本因素,分析金融因素对油价波动影响的同时,总是将供求因素考虑其中;检验金融因素对油价波动影响之前首先针对石油期货市场功能进行分析,得出期货市场运行有效的结论,从而为后续分析奠定检验基础;从短期视角和长期视角分别检验金融因素对国际油价波动的影响,结论更为客观、准确。

Abstract

In recent years, the crude oil price in international market has been moving up and down constantly and abruptly. Being one of the most important industrial raw materials and energy products, oil is tied up to almost all economic sectors, the volatility of crude oil price brings huge uncertainty to the production and consumption of oil; the volatility and uncertainty, magnified through international trade, has negative effects on world economic stability and growth, such as world wide inflation and economy depression. Therefore, it is critical to study and explore the underlying reasons behind the oil price volatility.

The fact that oil has characteristics like rarity, strategical importance, disparity of supply and demand, low price elasticity of demand, means oil price is very likely to be volatile. The change of oil reserve-production ratio, the fluctuation of stockpile, the strong demand of oil consumption, the weak balance between supply and demand, the production reduction from OPEC countries, as well as regional political affairs, are all reasons behind oil price volatility; however these factors pale against the way oil price changes. Multiple facts have pointed to financial factors like USD exchange rate changes, overly play of investment funds as the main reason that drives up oil price change in recent years. With the rapid development of financial derivatives like international oil option, futures and swap, the interaction of these oil related financial markets, the oil economy system has become a highly sophisticated financial system. The oil production security system has become a

“trade-finance” type of price security system, from the “production-supply” type of supply security system in the old days.

To uncover the mystery behind the international oil price volatility mechanism, this book is structured around the following analysis framework, “inherent mechanism-mathematical model-econometric testing”, mostly from a financial perspective.

The early stage of oil spot market brought large risk for the oil production industry; both the supply and demand need some sort of market regulations or trade rules to secure the cost and profit of oil products. Under such circumstances, oil futures market is born, from then on, oil products began to have its financial characteristics. The participants of oil futures market take part in determining the oil price through their own expectation of oil market price, because there is price disparity, these market participants can make profits through constantly buying and selling oil futures contracts. Therefore, a large number of oil companies, hedge funds, investment banks, institutional investors, private equity funds and other financial capital were involved in financial oil markets. In recent years, the depreciation of USD has caused the foreign reserves of these countries that mainly hold USD valued assets to depreciate. In order to preserve the foreign reserve value, avoid the loss of foreign asset buying power, stabilize domestic oil production and consumption, countries throughout the world begin to move some of their foreign assets to oil reserves, that is, assets that are held by foreign sovereign countries start to participate in oil financial market. On the other hand, in order to compete in the international energy market, enterprises of these oil consumption countries need oil bank, oil fund to provide insurance and fund to help realize these countries' oil supply security strategic target, which further strengthens the financial characteristic of oil market. As of now, the oil financial derivatives almost cover all aspects of financial derivative market. From the scale of trade, the complexity of trade, the diversity of tools, the width of market participants, oil financial derivatives is closely tied with interna-

tional crude oil market, capital market, financial market.

Through studying the impact of financial factors on oil price volatility, we find that: under the floating exchange rate system, “Triffin Dilemma” means the uncertainty of USD exchange rate; given that oil is currently priced by USD, there is a large amount of “oil dollar” around the world, which on one hand, further strengthens USD exchange rate volatility, and on the other hand, makes oil price speculation even worse. The USD exchange rate volatility has systematic effects on oil price; it not only affects the oil price directly, but also indirectly through affecting oil supply and demand, speculation. Oil speculation fund is one of the main reasons behind the oil price volatility; the richness of financial derivatives makes the situation even more dynamic. The interplays of factors like, “Triffin Dilemma”, the fight over what currency oil should be priced on, oil dollar, oil financial derivatives, oil speculation fund, USD exchange rate, have made the oil price trajectory in recent years derailed from the traditional supply and demand balance rule, displaying constant and volatile change.

Through constructing a simple DSGE model and a complex DSGE model including oil consumers department and oil producers department, this paper introduces productivity shock, oil consumption demand shock and oil speculation demand shock. Firstly, this paper puts forward the first order conditions and the logarithmic linearization, then gives the parameter calibration, lastly obtains impulse response results of the model variables including the international oil futures price from various random shocks using the DYNARE and MATLAB program. Analysis results indicate: Oil speculation demand exogenous shock plays a biggest role to oil price in the short term; there is deviation of 1.2% from the steady state in the first period, and oil price will return to the steady quickly in the fifth period. Productivity exogenous shock plays a smallest role to oil price in the short term; there is deviation of 0.17% from the steady state in the first period, and oil price will restore the steady after 40 periods. Oil consumption demand shock plays a moderate role

to oil price in the short term; there is deviation of 0.3% from the steady state in the first period, and most deviation will get 0.4% in later period; oil price can not restore the steady in the fortieth periods, and there is still deviation of 0.2% then. Through the DSGE model analysis and simulation, we can confirm the conclusion of theoretical analysis that oil financial factors in recent years have a more decisive effect on international oil futures price volatility in contrast to oil supply and demand factors.

By using many kinds of econometric methods such as ADF unit root testing, two stage EG, Johansen cointegration testing, Granger causality testing, VEC model, impulse response, variance decomposition, GS model, EC-EGARCH model with double variables etc, this paper analyzes price discovery function of international oil futures market, volatility spillover effect, relationship between speculation and oil futures price, relationship between USD exchange rate and oil futures price, relationship among financial factors, the supply-demand factors and oil futures price. The results indicate: (1) International oil futures market runs effectively and plays the dominant role in the process of price discovery; price discovery function of oil futures market provides favorable conditions for oil hedging, risk aversion, and volatility spillover. The returns in futures market and in spot market are both steady sequences and have “higher peak and fat tail” features, “clustering” features, and “lever effect”; volatility spillover is asymmetrical and overflow direction is from the futures market to the spot market so that futures price volatility has led the spot price to the same trend and law. (2) The speculative factors represented with the total positions and the proportion of non commercial trading positions have a significant influence on international oil futures price in the short term; There is a cointegration relationship among oil futures price, the proportion of non commercial trading positions, American commercial oil stock, and American oil consumption; the cointegration equation indicates that the proportion of non commercial trading positions has a far greater influence on oil price than American commercial oil stock and

American oil consumption. In other words, oil speculation dominates oil futures price volatility trend compared with supply-demand factors. (3) Generalized dollar index have a significant influence on international oil futures price. There is a cointegration relationship among oil futures price, generalized dollar index, the proportion of non commercial trading positions, American crude oil supply, and American crude oil consumption; the cointegration equation indicates that generalized dollar index and the proportion of non commercial trading positions have a bigger influence on futures oil price, and American crude oil consumption has a smaller influence, and American crude oil supply has no significant influence. (4) In contrast to the analysis results in the short term, oil consumption has an enhanced influence on oil futures price and oil speculation has a weakened influence in the long term; USD exchange rate has a long-term reverse effect on oil futures price.

In order to cope with negative effect of the international oil price volatility on world economy caused by the financial factors, we need take measures to regulate the overly active speculation by oil investment funds, revamp international currency system. For China, we should build a multi-layer oil trade market, set up oil bank and investment funds, build oil foreign currency reserve, continue to push RMB valued oil trade, improve the oil strategic reserve system, strengthen oil financial legislation, establish risk supervision mechanism of the oil finance.

This book is structured around the following analysis framework, “inherent mechanism-mathematical model-econometric testing”, and explains the movement of international oil price from three aspects including theoretical, modeling and empirical analysis. DSGE model is first ever used in explaining the impact of financial factors on the oil price volatility, which is a new try. In addition, research perspective has certain innovation: Supply and demand factors are the fundamental reasons behind the price movement, therefore we always put them into consideration when analyzing the effect of financial factors; before analyzing financial factors impact, we study the functions

of international oil future market first and come to the conclusion that future market is indeed effective; this creates foundation for the subsequent positive analysis; analyzing the financial effect both short term and long term could also make the conclusion more convincing and objective.

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