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Forecasting time-varying logistics distribution flows in the One Belt-One Road strategic context

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ABSTRACT

This work presents a multi-methodological approach to address the dynamic and stochastic challenges that underlie the problem of international logistic network reconfiguration induced by the One Belt-One Road initiative. A spatial-temporal logistics interaction model integrated with Markov chain is proposed to forecast time-varying logistic distribution flows for a three-layer supply chain framework. Further, numerical forecasts based on two cases of Chinese oil supply chain is carried out to account for the effectiveness of the proposed model. Analytical results suggest various development strategies for the practitioners and the policy makers in optimizing their logistics and transportation decisions in the OBOR context.

1. Introduction

Globalization and trade liberalization have benefitted China by making it the world's largest manufacturing centre and the country has emerged as an engine of Asian economic growth (McGregor, 2006). However, in recent years, China has faced a slowdown of its domestic economy that has affected global and inter-regional trade (Timmer et al., 2016). To overcome this falloff various foreign trade policies and transnational agreements have been made by the Chinese authorities in recent years. One of them is reviving the ancient silk route (Mark, 2014) into the New Economic Silk Belt that links China overland to Europe, through Central and Western Asia, and the 21st Century Maritime Silk Road that connects China and Southeast Asian countries via the sea to Africa and Europe. The two initiatives are jointly referred to as the "One Belt-One Road" (OBOR) (PRC State Council, 2016), which is presented in Fig. 1. The OBOR initiative features prominently in China's 13th five-year plan (2016–2020) and aims to support a paradigm shift in the inter-regional and foreign trade (Jiao and Zhang, 2013; Lehman Brown, 2016).

With respect to the infrastructure and strategy development for the OBOR initiative, improving and reconfiguring logistics and transportation networks along the OBOR trade corridors and connectivity among them are primary objectives of the initiative (Shahbaz, 2014; Deloitte, 2015; PRC State Council, 2016). But the logistics and transportation related activity has a tendency to change over time (Rodrigue, 2013) on being induced by various political and international trade agreement decisions. Subsequently, the logistics distribution flow adapts to the new spatial structure, resulting in various uncertainties that are difficult to handle instantly leading to financial losses. To handle the stochastic and time-varying challenges of logistics distribution flows in the OBOR strategic context, international logistics networks must be restructured with reconfigured

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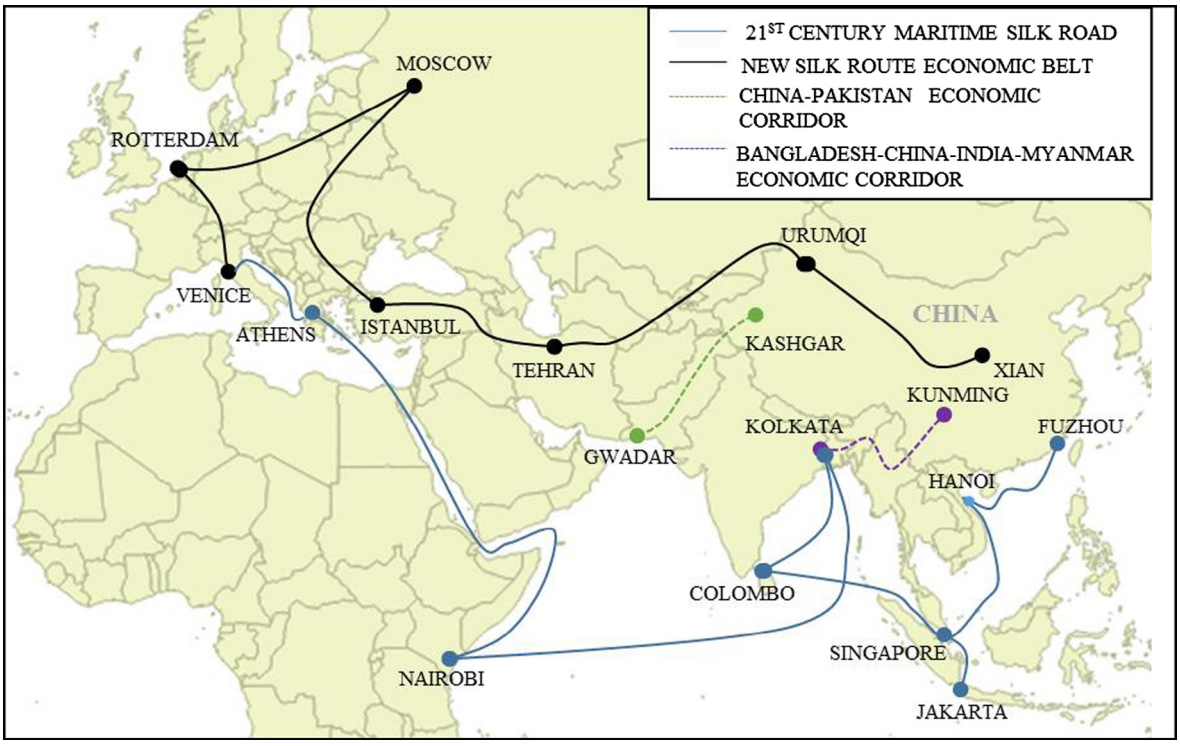

Fig. 1. One Belt-One Road (OBOR) logistics network.

resources from the perspective of space-time interaction technically referred to as spatial-temporal interaction of the logistics distribution flows.

The contributions of this paper are twofold. Firstly, this work presents a multi-methodological approach to forecast the time-varying logistics distribution flow in the international logistics network under OBOR-induced transnational political and trading uncertainties. Specifically, the proposed approach integrates spatial-temporal friction functions with a Markov chain proposed to characterize the dynamic and stochastic features of the aforementioned OBOR-induced uncertainties in a three-layer supply chain framework, followed by the forecast of multi-interval logistics distribution flows moving across different nations in the OBOR context. Secondly, this work investigates two industrial cases of the oil supply chain network of China (oil supplies from the West Africa and the Middle East to China) under the OBOR strategic context. The analytical results of the case study highlight and suggest various development strategies for the practitioners and the policy makers in optimizing their logistics and transportation decisions along the OBOR framework.

The rest of this paper is organized as follows. The second section outlines the relevant literature. The third section develops a time-varying logistics distribution flow assessment model. The fourth section presents an application of the Chinese oil supply chain network (Chinese oil supplies from West Africa and the Middle East). The fifth section presents and discusses results of the simulations. The sixth section offers managerial insights. The final section presents conclusion in support of future development strategies.

2. Related work

Owing to technological advancements and the globalization of business operations, competition between firms has evolved from competition between products to competition between supply chains. Therefore, in the 21st-century network economy, decision-makers must offer better policies and robust logistic network designs that can handle uncertainties and sudden changes in the supply chain to ensure a seamless logistics distribution flow. Logistics network design has been widely studied by academic researchers and practitioners. Generally, studies on logistics network design involve making decisions regarding facility locations, distribution management, warehousing, inventory management, transportation management, coordination and contracts among supply chain members (Hoover, 1948; Losch, 1954; Teo and Shu, 2004; Shen and Daskin, 2005; Simchi-Levi et al., 2001; Melkote and Daskin, 2001; Truong and Azadivar, 2005; Dong et al., 2010; Agarwal and Ergun, 2010; Tardif et al., 2010; Lim et al., 2013; Melnyk et al., 2014). Several researchers have studied logistic network design issues in an international context (Gary and Davies, 1991; Fawcett et al., 1993; Arntzen et al., 1995; Dornier et al., 1998; Sheu, 2004; Meixell and Gargeya, 2005; Sheu and Lin, 2012). With advances in information technology,

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