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Freight logistics' contribution to sustainability: Systemic measurement facilitates behavioural change

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ABSTRACT

The freight logistics discipline can make an important contribution to the sustainability debate through the application of its expertise in systemic measurement and trade-off management to the macrologistics realm. The systemic measurement of a country's freight system allows for the development of decision-making scenarios to, *inter alia*, inform sustainable transport policy, thereby supporting broader national sustainability goals. The purpose of this research is to test the hypothesis that internalisation of externality costs will encourage efficient supply chain behaviour, which will result in a shift to rail of rail-friendly traffic currently on road. Counterintuitively, the results indicate that increased returns to rail density due to such a modal shift could result in a lower total freight bill (inclusive of externality costs). It also underscores the importance of national freight flow and related cost measurement to enable such analysis.

1. Introduction

Freight logistics developed on a company level as an integrative and systemic support function applying trade-offs to determine optimal cost levels in order to address the time and place discrepancy between the supply and demand of goods and services (Stock and Lambert, 2001). It was, in essence, seen as a microeconomic function that supported business growth. Links to economic theory related to specialisation, i.e. the creation of market places and increased supply and demand chains as trade-off costs for returns on specialisation (Stock and Lambert, 2001; Kumar, 2015).

The concept of a value chain was popularised by Porter (1985), who defined value activities as distinct yet interdependent physical and technological activities performed by the firm in order to create the product or service required by the customer. The implications of Porter's work led to increased outsourcing of those activities where the organisation does not have a clear competitive advantage. The linkages between multiple firms' value-creating processes have subsequently more commonly become known as the value chain. This, together with the advent of the information and communication technology revolution, heralded a new era for supply chain management as the management of a network of connected and interdependent organisations mutually and cooperatively working together in preferred alliances to control, manage, and improve the flow of materials and information from suppliers to end users (Christopher, 2005). Gattorna (2010) refers to this as dynamic value networks.

Concurrent with the emergence of supply chain management and value networks, a renewed global focus on sustainability emerged. The triple-bottom-line construct was proposed as a practical approach for firms to measure sustainability (United Nations, 1987; Rogers and Hudson, 2011). The construct determines the contribution of the business to economic

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viability, social equity, and environmental responsibility (Elkington, 1997; Yencken and Wilkinson, 2000; Goel, 2010). Yet, there have been limited successes in truly embracing these principles and, in the final instance, the observable financial bottom line often triumphs. In the latest Fortune 500 ranking, the vast majority (84%) of CEOs who responded to the survey agreed with the statement "It would be easier to manage my company if it were a private company." Frustration with the short-sighted pressures of public markets is on the rise. Surviving the new technological revolution requires long-term thinking and smart investment (Murray, 2015). Yencken and Wilkinson (2000) suggest a reason for this as an omitted fourth dimension of sustainability, in the words of Hawkes (2001), "that a sustainable society depends upon a sustainable culture".

Freight logistics as a discipline can make an important contribution to such a sustainability culture. The *raison d'être* of logistics is to contribute to systemic thinking, with cost/service trade-off thinking as one of its core tenets, and a growing understanding that accurate measurement facilitates systemic behaviour. In cost analysis, the omission of externality costs, however, conflicts with these goals, as it leads to total cost understatement and ultimately market distortion (Pretty et al., 2000). The negative effects of externalities are still being cross-subsidised by society. There is, however, mounting pressure to determine freight-logistics-related externality costs (Piecyk and McKinnon, 2007; McKinnon, 2009), with the goal to enable cost-of-choice visibility throughout the value chain.

Tavasszy et al. (2014) estimate that, although overall impacts on trade and transport are small, such internalisation could lead to positive welfare impacts due to a transition to cleaner energy. Manners-Bell (2015) reports on a study of the World Economic Forum that confirms substantial cost reduction, revenue and brand value improvement, higher labour standards, and lower emissions as outcomes of projects where the three pillars of sustainability (economic, social and environmental) overlap.

This research seeks confirmation that these benefits will also hold true on industry-collaboration and macrologistics levels. The cost impact of full externality cost internalisation is tested through the following hypothesis: that the internalisation of externality costs will lead to changed supply-side behaviour, which will make logistics more efficient; eventually lowering the total freight bill (inclusive of externalities). In order to test this hypothesis, the case of a freight modal shift in South Africa is investigated. A shift from a relatively low capital-intensive road solution to a high capital-intensive intermodal operation is proposed, meaning that returns to density of capital use might be possible (in line with Beuthe et al., 2002, and Janic, 2007). The hypothesis is not at a pre-feasibility stage, but was formulated to eliminate a type-I statistical error, i.e. to ensure that an alternative is not rejected before it moves to the next phase of investigation (Keller and Warrack, 2003). If the hypothesis is therefore proven, further elements should be investigated that could impact on the systemic determinants of such a move.

The methodology is described in the next section. The results are discussed in Section 3, followed by policy implications in Section 4, and concluding remarks and next steps in Section 5.

2. Methodology

Over the last 30 years, following deregulation, railroads in the United States increased their investment levels, enabling a virtuous cycle of productivity improvements, improved freight density, and higher profitability, which led to further investments that included investments in intermodal infrastructure (Furtado, 2013; Havenga et al., 2013). These investments resulted in domestic intermodal freight becoming a cornerstone of railroad traffic growth in the United States, a segment that consistently grew faster than international intermodal for many years and is now larger in absolute terms than its international counterpart (IANA, 2016). European railways did not perform as well, and Tavasszy and Van Meijeren (2011), after a careful study of the potential for modal shift of freight above 300 km, concluded that the European Commission's target of a 30% shift in this segment is too ambitious as only approximately 11% of tonnes travel further than 300 km.

The research hypothesis was informed by the fact that the modal shift opportunity in South Africa is greater than in Europe and the United States due to the current absence of domestic intermodal solutions (Havenga et al., 2013), in a market characterised by unitisable freight, dense pick-up and drop-off areas, dense corridors, and long transport distances; i.e. ideal markets for intermodal services (Yevdokimov, 2000; Case, 2009; Slack, 2016). A detailed flow-segmentation approach, based on the aforementioned variables, has been developed to identify viable market spaces for a modal shift, which is described in the next section.

2.1. Total freight flows

The first step is to estimate total freight flows in South Africa. Total road transport volumes are not measured by any government agency in South Africa and are therefore not available on a national level. Road flows are estimated via the Freight Demand Model (FDM). The FDM is a demand-side model, based on the national input-output model, which estimates supply and demand of commodities in pre-defined geographical areas and translates them into total flows through gravity modelling, currently for 83 commodity groupings in 372 geographical areas, with a 30-year forecast at five-year intervals for three scenarios. Road flows are determined by subtracting the known rail, coastal, pipeline, and conveyor belt flows from total flows. The resulting road freight transport flows are calibrated with industry research and correlated with known freight flows. The freight flow patterns emerging from the model give rise to four distinct typologies (see Table 1), disaggregated into five overarching freight-flow segments, as described in Table 2.

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