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An empirical analysis of Australian freight rail demand

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ABSTRACT

The impact of an unannounced shock in freight rate, international trade and business cycle on the non-bulk freight rail demand in Australia is examined by using a VAR model and an annual data set encompassing four decades (1970–2011). Results based on VAR, impulse response functions and variance decompositions suggest that freight rate and the volatility of the Australian dollar are the most dominant determinants. The availability of an alternative mode, such as road, could be attributed to this considerable response to the freight rate. Macroeconomic conditions favourable to bulk freight demand, such as a depreciated Australian dollar, have a similar impact on non-bulk rail freight.

1. Introduction

The majority of the existing literature on rail freight demand suffers from two major limitations: (i) aggregation data bias, which arises owing to the use of information on total flows by modes at the national or regional level, rather than the use of selected freight modes, commodities or routes; and (ii) endogeneity bias, which is due to the possible feed-in effects between some variables such as the freight rate and the quantity demanded. In this study, we attempt to address these issues by examining the interrelationships between non-bulk rail freight demand and its determinants in an Australian context. As indicated above, previous studies have mainly used aggregated data (e.g., Oum, 1979a; Wilson et al., 1988; Ramanathan, 2001; Kulshreshtha et al., 2001; Mitchell, 2010), a procedure which ignores potential sectoral impacts. A failure to consider sectoral impacts has limited the policy implications of these studies. This is because freight tasks tend to differ markedly between commodities and corridors. For example, where rail has a small market share and is a viable alternative to road (such as on longer-distance corridors), the cross-price elasticity of demand may be quite high. In these cases, a small drop in price would result in a large percentage increase in rail's market share. For other markets, such as those industries using 'just-in-time' inventory management, rail is not likely to be practicable. In these cases, cross-price elasticity would therefore be very low.

Furthermore, some studies have shown that freight rail demand in Australia varies between different categories of goods. For instance, the carriage of manufactured goods responds to drivers that are different to those affecting agricultural products. While the carriage of non-bulk manufactured goods has been sensitive to movements in gross domestic product (GDP), the freight task relating to agricultural products within Australia depends mainly on population growth (ARTC, 2010). Demand for carriage of steel, by way of contrast, is extremely sensitive to industrial production and construction trends. In an attempt to account for sectoral impacts, this study incorporates a lower level of aggregation into the analysis by examining the determinants of non-bulk freight demand in Australia. The main arena of competition between rail and road in Australia,

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and the east coast corridor in particular, is in interstate non-bulk freight (Productivity Commission, 2006; BITRE, 2009). By focusing on the non-bulk freight segment, better policy implications from the response of freight transport demand to changes in policy variables, such as price, can be derived. This is particularly the case given that interstate freight rail access is controlled by the Australian Rail Track Corporation (ARTC), a government-owned infrastructure management entity. These issues have been the principal focus of the debate about road–rail price neutrality in Australia (Productivity Commission, 2006). Moreover, although interstate non-bulk freight is a small part of the total freight task, it is growing rapidly—at about four per cent per year (BTRE, 2006).

The nature of the endogeneity problem is due to the classical identification problem between demand and supply functions. Since both the demand and supply are functions of price and other variables, only the intersections of the freight rail demand and supply curves are observable. Although this is well accepted, endogenous relationships of the variables have not been directly taken into account by most of the existing studies on rail freight demand. The functional forms used to estimate most of the aggregate freight demand models can be classified into four categories: (i) *linear demand model*; (ii) *log-linear demand model*; (iii) *logit model applied to aggregate market share data*; and (iv) *translog demand system based on neoclassical demand theory*. All these models, however, require specifying them in such a way that a clear dependent variable and a set of explanatory variables is provided. This is a major limitation of existing work. If there are feed-in effects between selected variables, the issue becomes even more severe (Kulshreshtha et al., 2001).

In response to shortcomings associated with endogenous regressors, the vector autoregressive (VAR) method has been developed. Compared to traditional models previously used in the literature, which separate endogenous and exogenous variables, the main advantage of the VAR model used herein is that it does not differentiate between them. In structural models, the researcher is bound to classify which variables are explanatory and which variable is dependent. With the VAR method, this issue does not arise because all variables are assumed to be endogenous. This is particularly useful in modelling transport demand because previous rail demand studies often fail to recognize the endogeneity between the quantity demanded and the price (Oum et al., 1990). Researchers often maintain that price is decided by rail authorities and hence should be considered exogenous (e.g., see Wijeweera and Charles, 2013). Yet price and quantity demanded arguably have feed-in effects, so an approach that takes this relationship into account has the potential to produce better results. Although there have been some attempts to recognize the endogenous relationships of freight rail demand in general (e.g., Ramanathan, 2001; Kulshreshtha et al., 2001), the issue has been largely ignored in Australian studies. The VAR model used herein enables us to quantify the impact of an unannounced shock in freight rate, international trade and business cycle on the time path of non-bulk freight rail demand in Australia. Developing and specifying a model that incorporates these shocks should therefore have a broader applicability to a setting where similar shocks could result in changed demand conditions.

This study is divided into four main sections. The following section provides a brief overview of recent literature on freight rail demand. Section 3 discusses variables and the VAR methodology employed in this study. Empirical results and policy implications are presented in Section 4. Some concluding remarks complete the article.

2. Review of literature on freight rail demand

Existing studies on rail freight demand can be categorized into two sub components: (i) time series studies, and (ii) survey-based studies (Winston, 1983). This review focuses on the existing literature dealing with time series studies in the context of rail freight demand. Time series models are usually aggregated in nature and do not explicitly incorporate all theoretically relevant explanatory variables, i.e., the explicit treatment of service quality factors apparently resulting from data unavailability in the estimation (Pendyala et al., 2000; Mitchell, 2010). In this review, we discuss international studies on freight rail demand (Section 2.1) before moving on to Australian studies (Section 2.2).

2.1. International studies on freight rail demand

In one of the earliest studies, Rao (1978) constructed a simultaneous equation system to measure the impact of macroeconomic activity and intermodal competition on rail freight demand in Canada. The model consists of 3 stochastic equations (the volume component, the average length of haul, and the revenue per ton mile) and an identity (equilibrium condition). The volume and average length of haul comprised the rail freight demand. The total number of trucks registered, commodity outputs and commodity exports variables were included as macroeconomic control variables. The model was estimated using annual time series data for the period 1958–1973 by both Ordinary Least Squares (OLS) and Two Stage Least Squares (2SLS) techniques. The study identified that the commodity outputs and the export-share variable were the main determinants of demand and that railway freight demand is price elastic. The model's main drawback is that it does not allow for free variation of the elasticities of substitution between transport modes and the own- and cross-elasticities. These two factors place a significant restriction on the parameters of intermodal competition (Oum, 1979a, 1989).

Oum (1979a) developed a demand model for freight transport as an intermediate input to the production and distribution sectors to estimate price elasticities and elasticities of substitution between three modes: railway, highway, and waterway. Yearly Canadian data (1945–1974) were used, while a maximum likelihood (ML) method was employed to estimate the parameters. Oum found that demand for rail freight is price inelastic, with own-price elasticity increasing in absolute