The optimal shipment size and truck size choice- explanation and implications of the allocation of trucks across hauls

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Abstract

The demand for freight transport service has been growing rapidly, and is predicted to grow in the future. There has also been a proliferation of just-in-time inventory practices, resulting in increased overall freight transport activity. From the side of policy makers, this growth has brought attention to the issues of allowing higher capacity vehicles on the roads, and the impact these vehicles have on safety, the environment, and efficiency (OECD, 2010). As freight volume increases, it is expected that transport services will be provided by higher-capacity vehicles. Inventory practices, however, suggest that part of the growth in volume will have to be met by increasing service frequency.

These trends in freight transportation raise interesting research questions. At a basic level, we can ask how freight operators choose a vehicle for a haul. It is also important to know how the pattern of vehicle use or vehicle size choice changes with policy interventions (such as a change in the permissible payload or road-pricing) or external shocks (such as an increase in fuel price). Answers to these questions help to clarify the implications of vehicle use patterns on traffic congestion, pavement deterioration, pollution and safety. This clarification becomes all the more important when we consider that different vehicles have different impacts on these externalities.

The objective of this study is to investigate how variations in route/haul, carrier and vehicle characteristics affect the optimal vehicle size choice in trucking. Previous studies have mainly focused on mode choice as opposed to the process by which firms make vehicle choices (the main topic here). This study addresses two important issues in the economics of freight demand analysis. First, it outlines a conceptual framework based on shipment size optimization theory to identify the main determinants of firms' choice of vehicle and shipment size. Second, it provides a framework for modeling the interdependence between quantity shipped and vehicle choice using a discrete-continuous econometric model developed by Dubin and McFadden (1984).

For model estimation, a unique dataset from the Danish heavy trucks trip diary was used. The dataset has detailed one-week operational information on a trip-by-trip basis for about 2500

trucks in 2006 and 2007. The results show that the main determinants of vehicle size choice are vehicle operating cost, vehicle age and carrier type. As operating cost increases, the probability of heavier vehicles being chosen also increases, while higher total cost leads to a gradual shift towards smaller vehicles. These seemingly contradictory effects of cost have important policy implications. For instance, in the face of policies (or exogenous shocks) which raise the variable cost of trucking operations (e.g. road pricing or rises in fuel price) firms prefer to use heavier vehicles. On the other hand, policies or other changes which increase fixed costs, and therefore total cost (e.g. registration tax, permits, licenses, etc.) force firms to use smaller vehicles.

In conformity with the predictions of shipment size optimization theory, trip distance and total freight demand were shown to have significant positive effects on shipment size choice. These findings suggest that firms realize economies of distance by using heavier vehicles for longer trips and economies of scale by hauling larger quantities. Commodity-type fixed effects and the density of a cargo were also shown to affect shipment size decisions. In general, the results imply that increases in freight volume and today's widespread business practice of sourcing products from faraway places will lead to more demand for higher capacity vehicles. The desire to have flexible and frequent services, however, may dampen this tendency to some extent.

References

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