Box dynamics: A sectoral approach to analyse containerized port throughput interdependencies

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ABSTRACT

Port throughput is the aggregation of products handled in a port and depends on the performance of relevant interdependent industries. In depth understanding of the fluctuations of a port's activities at the aggregate level requires a granular analysis at the disaggregate level. This becomes more critical in the case of containers since in general limited information for a container's content is available.

In the present study Sydney's container port throughput is decomposed in its main industrial sectors and focus on their interrelations. Quarterly data are used covering the 2014:Q3 – 1995:Q2 period and 15 sectors in line with United Nations classification. For the identification of spillover shocks across container sectors over time we develop a "spillover index" on the basis of a Vector Autoregressive (VAR) model. The interpretation of the results is enhanced with the use of network theory.

The results document that fluctuations on the aggregate level are the output of co-movement across container sectors for both imports and exports, while at the same time they respond differently to shocks revealing "leadership" and "followship" behavior. Finally, the main macroeconomic determinants affecting the co-movement of sectors demonstrate different sign and significance for exports and imports.

1. Introduction

Business cycles are a macroeconomic phenomenon used to describe fluctuations in a wide range of economic activities (Burns and Mitchell, 1946; Lucas, 1981; Kydland and Prescott, 1990). The characterization of a cycle as a sum of cycles of different economic activities or industries/sectors is a striking feature of market economies and forms the basis of modern business cycle models (Zarnowitz and Boschan, 1975; Moore, 1982). An inter-sectoral study can analyze and interpret an economy beyond the aggregate level and leads to a more detailed and in depth analysis. It eventually enables understanding in detail the dynamics and interrelations between the various sectors of the economy, their co-movement and in turn how they shape up the aggregate output.

The cyclicality of ports activity has been studied at both theoretical (Rodrigue et al., 1997; De Monie et al., 2010) and more recently empirical level (Geurrero and Rodrigue, 2014; Paflioti et al., 2015; Angelopoulos and Chlomoudis, 2015). Yet, the sum of the

aforementioned studies examine port throughput at the aggregate country or port level and do not account for the diversification of cargo and commodities carried through a port (Ducruet et al., 2010). Understanding a port's activities in depth requires a more granular analysis focusing on how specific sectors interrelate and eventually drive the aggregate sector. This becomes more critical in the case of containers since in general terms limited information of what's "inside the box" is available (Pelletier and Alix, 2014).

This study conceptualizes the container port throughput as a function of different evolutions of the various sectors that make up the aggregate container output. Rephrasing Burn and Mitchell's (1946) business cycle definition, *the container cycle may be better detected by understanding the path of its sectoral components*. We address the following questions: Is there sufficient variance across different sectors or correlation across them to explain substantial aggregate fluctuations in container port throughput? If so, which sectors represent the 'leaders', and which sectors are the general 'followers', in the transmission of shocks?[2] Which are the main factors driving the cyclical interdependence?

Drawing on business cycle synchronization theory and sectoral analysis, we investigate the dynamics of fifteen containerized sectors in Sydney port. Our analysis is based on the methodology of Diebold and Yilmaz (2015) and uses a flexible empirical model to examine the propagation of shocks within different sectors by combining Vector Autoregressive models (VARs) and the concepts of network theory. The study reveals the relationships of short-run fluctuations among port container sectors (i.e. leaders and followers). Through the examination of macroeconomic factors we also study the determinants of cyclical shocks and their associated repercussions.

2. Intra-port container interconnections: A sectoral approach

2.1. Industrial and commodity waves: A brief analysis on business cycle co-movement

An economy (or an industry) cannot be explained fully at the aggregate level. An inter-sectoral analysis is considered crucial since it provides evidence for aggregate fluctuations. Despite the importance of sectoral business cycles and the increasing role of sectoral shocks, the relevant literature remains quite narrow (for a review, see Foerster et al., 2011). In any case, explaining the behaviour of different sectors is extremely challenging since they are numerous, they usually overlap, may compete indirectly and interact differently to various shocks.

One of the salient features of business cycles is that output moves in the same direction across most industries/sectors (Burns and Mitchell, 1946). The observed co-movement at a sectoral level however is found inconsistent with independent industry specific shocks (Lucas, 1981). Instead, many works agree that increased synchronized relation of sectors is attributed to the presence of common aggregate shocks (demand, supply, monetary, etc.), to which most sectors respond in a similar way. With sectoral output being more correlated than sectoral productivity,[3] researchers turned focus to production complementarities[4] (Long and Plosser, 1983, 1987; Horvath, 2000; Shea, 2002) to explain sectoral shocks with aggregate consequences.

Whether such input-output linkages constitute a quantitatively important source of sectoral co-movement (Dupor, 1999; Rebelo, 2005) has not yet been addressed in the literature. The limited empirical analysis on industrial/sectoral cycles concentrates mainly in the US economy and provides strong evidence of co-movement in employment (Carlino and De Fina, 2004; Goodman and Mance, 2011) or manufacturing sectors (for a review, see Acemoglu et al., 2012). The literature review on business cycle co-movement has also been extended at a global level by examining the relationship between the macroeconomic environment and the co-movement of commodity markets (for a review, see Pradhananga, 2015). Commodity prices may move together because of a) common macroeconomic factors, b) causes related to complementary/substitution goods in the production or consumption or c) due to specific shocks (i.e. droughts).

2.2. The necessity for an intra-port cargo analysis

The cyclicality of ports throughput has been for long taken for granted due to the derived nature of the demand for port activity (Rodrigue et al., 1997; De Monie et al., 2010). On the empirical part, cyclical patterns of port activity have been identified only recently (Paflioti et al., 2015) while the cyclical co-movement as a concept has generally gained limited attention (Geurrero and Rodrigue, 2014; Angelopoulos and Chlomoudis, 2015) in the literature.

Notwithstanding, the interrelation of port throughput between different ports has been approached from an alternative perspective; that of clustering analysis. The latter is considered a useful tool to assess and manage port competition and possible co-operation between seaports (Gianfranco et al., 2014; Cabral-Rios and Ramos-De Souza, 2014). The identified interconnections between seaports can influence common managerial decisions regarding their integration and competitive position in the transport network. However, clustering analysis does not identify leading and lagging relations, and concentrates on the consequences and not the causes behind the formation of specific clusters. Finally, the aforementioned studies largely focus on aggregate flows, specialization effects and other structural attributes across a range of ports and provide limited evidence about ports' throughput at a disaggregate level.

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[2] In the present paper as a shock is defined any event that is likely to affect the demand of a sector and in turn triggers changes in the demand of other sectors. It can be a financial shock, an oil shock, a trade shock, a weather shock, etc. As "leaders" are defined the sectors that transmit a great proportion of shocks to other sectors, whilst as "followers" are defined the sectors that receive a great proportion of shocks from other sectors.

[3] Productivity is an economic measure of output per unit of input.

[4] i.e. the product of one industry is used as an input in the production of another industry.