LONG TERM CONTAINER VOLUME FORECASTING: DECOUPLING GROSS DOMESTIC PRODUCT AND CONTAINER MOVEMENTS

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Abstract

The correlation between container trade and economic growth is currently the most common relation used to forecast international trade container demand volumes. The article argues that there is a ceiling level in the propensity to containerise, as all the suitable volumes of the underlying commodities shift to containers over time. Also, the link between freight transport and gross domestic product (GDP) will decouple as more sustainable approaches to economic development and freight transport are necessitated by economic and environmental realities. A commodity-based model, that takes the underlying drivers of containerisation into account, is proposed as a more realistic forecast of container demand. Applying this model could materially influence large-scale investment decision making.

Keywords: Long Term Container Volume Forecasting, Decoupling Gross Domestic Product, Container Movements

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Introduction

The growth in the containerisation of freight necessitates major capital investments in the container shipping industry and the related sea-land interface at ports. Uncertainty of the pace of this growth dictates the development of an appropriate model to forecast demand for international trade containers in order to inform decision making relating to these capital investments.

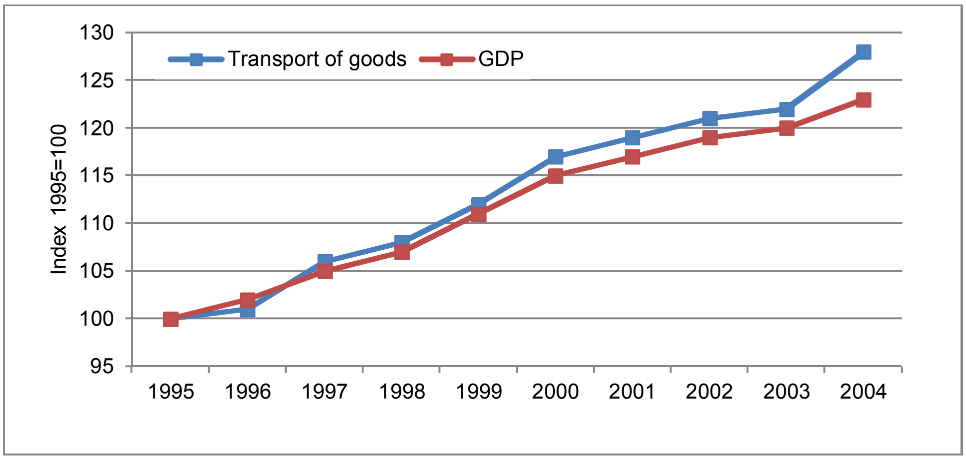
Singh (2005: 15) forecasted that demand for container port capacity will outstrip supply by 2012 and that a doubling of global port capacity will be required between 2005 and 2012. However, in 2010 overcapacity still existed (Neylan, 2010: 50). Container demand is prone to many uncertainties, including weather conditions, seasonality and the condition of the labour force (Bilegan et al., 2007: 2). These determinants are short-term issues that are often considered in forecasting models, whereas long-term approaches, which analyse underlying drivers, are more difficult to find.

The article addresses the shifts in drivers of containerisation and current common approaches to forecasting container demand. A new container demand forecasting technique is proposed using South Africa as a case, as well as how to overcome the related data challenges.

Growth drivers of demand for trade containers

Abonyi and Van Slyke (2010: S2, S3) identify four drivers of production globalisation, namely policy liberalisation; capital mobility; increasing competition; and accelerating technological change in transport, telecommunications and information technology. Pienaar (2012: 1) confirms that "sustained economic growth and development are dependent on productive regional specialisation … and the profitable exchange, or trade, of goods, services and information". Trade is stimulated because specialisation increases productivity and reduces costs (Ballou, 2004: 2). Therefore, specialisation drives production globalisation, and transport ability sustains it. The net result of this state of affairs is that transport growth will outstrip GDP growth. This can be seen for Europe over the period 1995–2004, as illustrated in Figure 1.

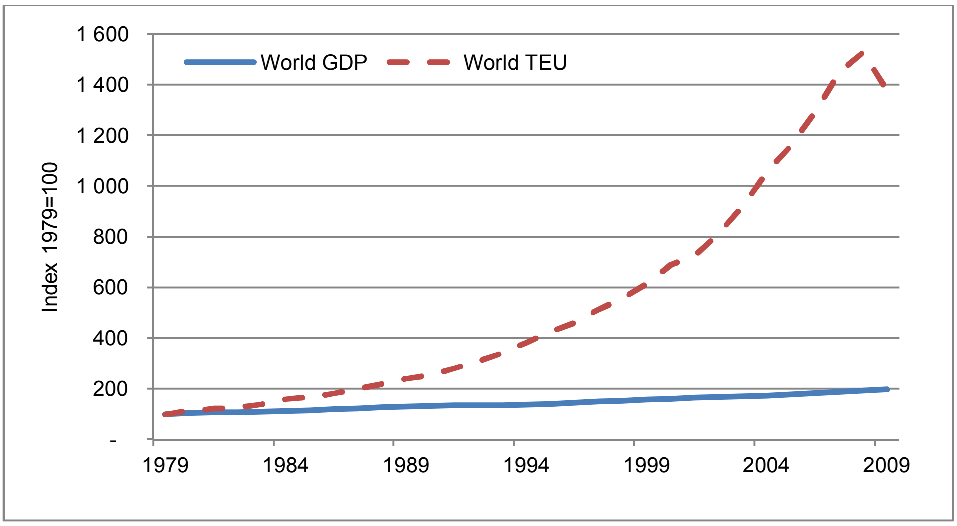
Figure 1. Growth in goods transport outstripping GDP growth in Europe, 1995–2004



Source: Ponthieu, 2008:2

Growth in global container flows significantly outperformed global GDP growth over the last three decades. This trend is illustrated in Figure 2.

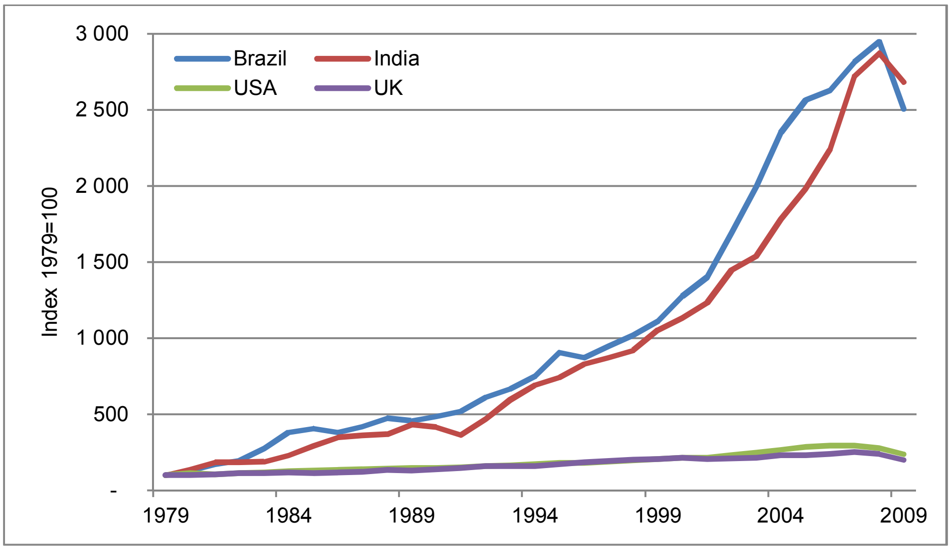
Figure 2. Growth in global container flows outstripping GDP growth over the last three decades Sources: GDP data from IndexMundi, 2011; TEU data from Sooredoo, 2011



Note: TEU = twenty-foot equivalent unit

A review of individual countries reveals that container growth in developing countries has been much higher than in developed countries over the same period. One reason for this is that the containerisation trend started earlier in the developed world, pointing to a natural slowing down of containerisation over time. At some stage, the trend to containerise commodities should, therefore, slow down to the global trade growth pattern. This phenomenon can be seen in Figure 3 for India and Brazil, representing developing economies, against the trend for the UK and the US, representing developed economies

Figure 3. Relationship between GDP and TEU growth for developing and developed countries



Sources: GDP data from IndexMundi, 2011; TEU data from Sooredoo, 2011

Research Problem

It is believed that various factors can influence container volume growth, but that is the link between GDP growth and container volume growth that is most relevant. Therefore, it is important to determine the propensity to containerise different commodities constituting the transportable portion of the GDP. This would decouple the number of containers carrying a specific commodity from the growth expectations of the underlying commodity. In this regard, granularity (i.e. disaggregation to commodity level) is the key driver of reliable forecasts. By understanding reasons why decoupling exist at the finest possible level of granularity, one can enable better container growth forecasts based on GDP growth expectations. Gardiner (2007, 67) uses the term "demand-side modifiers" and mentions four such modifiers, namely; empty movement, transhipment, head-haul/back-haul imbalances and cargo weight. The following list of modifiers defines the research problem of this research:

1. Shifts in consumer demand and industrial output.
   a. This will shift the type of commodities in containers and therefore also container numbers, even though the overall GDP might be the same.
2. Shifts in the underlying structure of the GDP in terms of international trade compared to local trade.
3. Shifts in trading patterns.
   a. This can shift specialisation trends, i.e. the nature of trade is different between different trading partners.
4. Shifts in average TEU weights.
   a. This will decouple container numbers from GDP. If containers are heavier this will result in fewer containers being required to move the same GDP.
5. Improvements or deterioration of logistics optimisation and technology.
   a. The use of better routing and scheduling based on advanced planning will enable the reduction of container empty haulage and number of transhipments, lowering the relative number of container movements to achieve the same level of GDP.

To address the research problems two methodologies were followed. Firstly the significance of some demand-side modifiers are established, based on recent container content mega-sampling. Secondly, a single demand-side modifier, i.e. the propensity to containerise, is used to simulate a long-term forecast model.

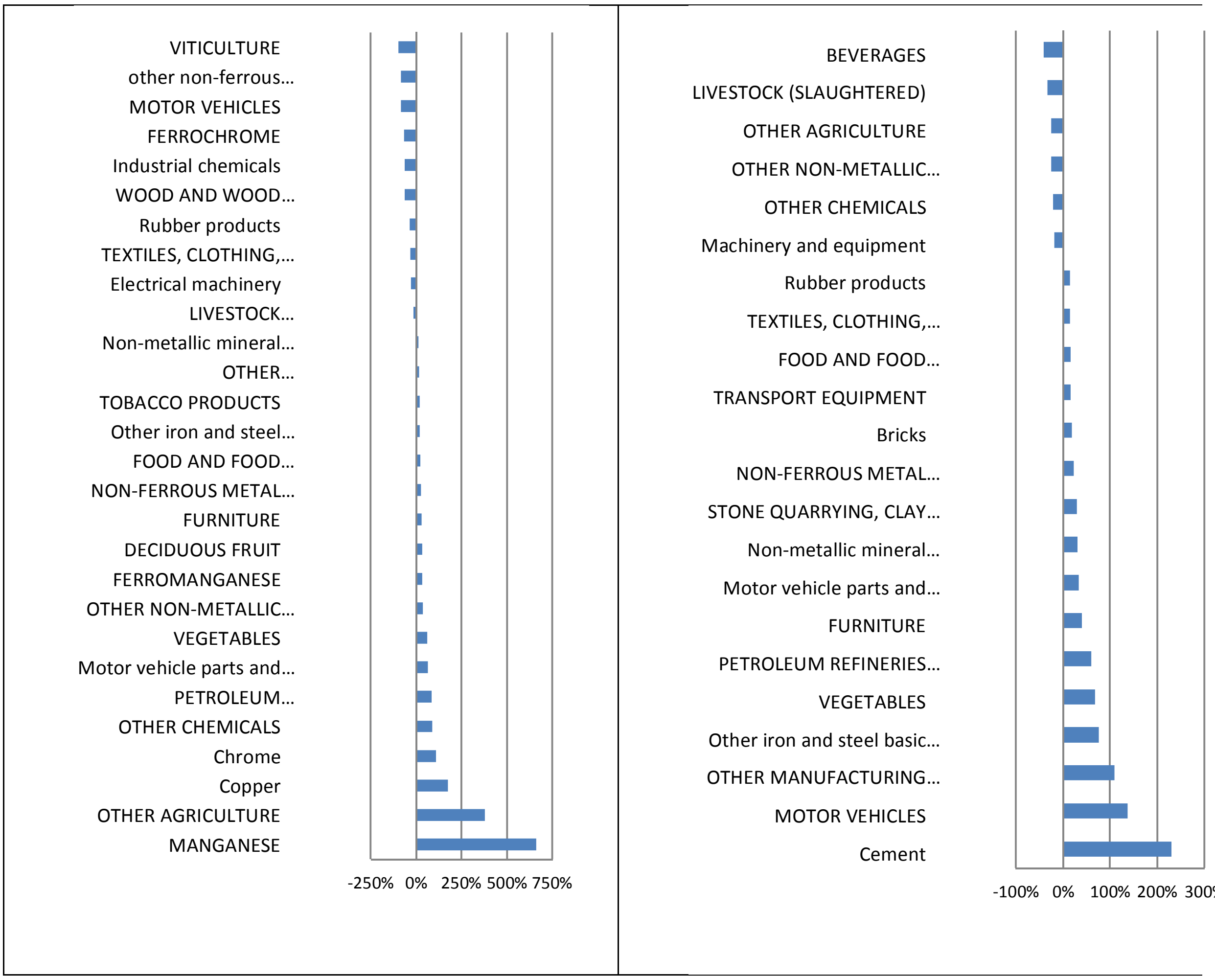
Significance Of Demand-Side Modifiers

To understand the significance of demand-side modifiers, information of container content, flow and weight was necessary. This was acquired through mega-sampling. The mega-sampling process is described in the section on long-term forecast simulation.

Demand-side modifiers 1 and 2: (1) Shifts in consumer demand and industrial output, and (2) shifts in the underlying structure of the GDP

Recent observations based on commodity mega-sampling of South African container movements illustrate how single events can impact container movements. Changes in imports and exports over the period 2009-2010 for South Africa is depicted in Figure 4 as year-on-year percentage growth. Only the significant commodities (more than 2 000 TEUs in 2009) with significant changes (less than -10% and more than +10%) are shown.

Figure 4. Year on year percentage growth of containerised commodities in South Africa, 2009 - 2010



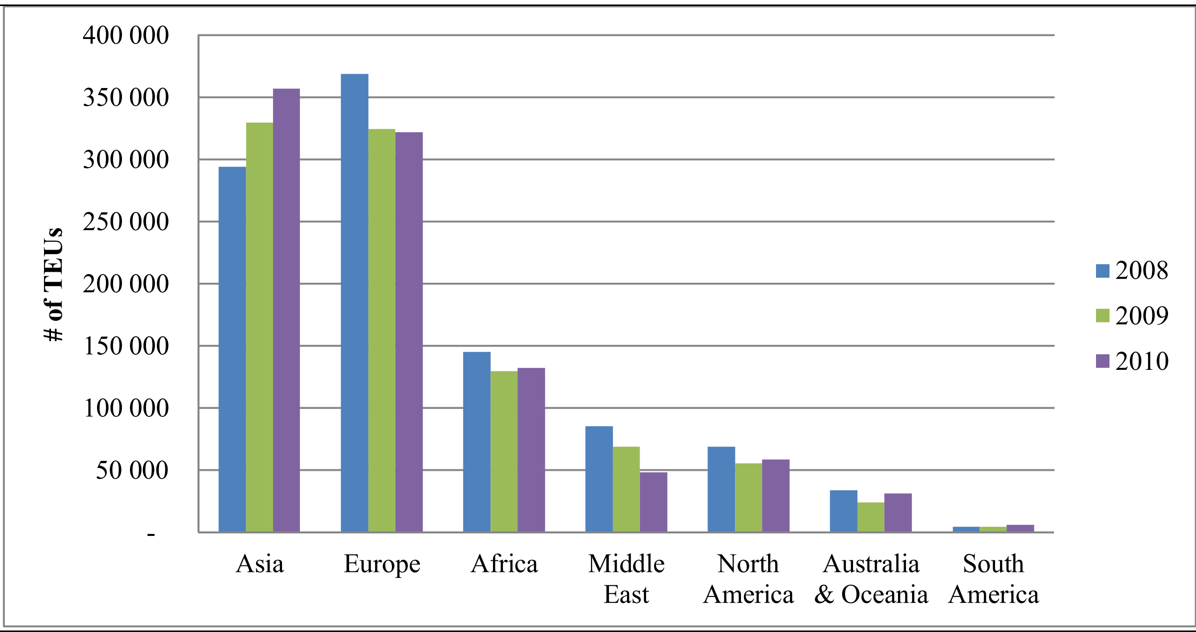
South Africa's railways experienced a period of low capital investment during the late 1990s and early 2000s and insufficient capacity for the export of manganese was created. Given the high price and demand for manganese, the export of minerals overland shifted to road and containers, as a means to meet global demand. Total exports for 2010 showed a 1.97% increase in the number of containers exported. Manganese showed the largest increase in mass (weight) and this contributed to the growth in export container volume. In the absence of this single event, South Africa would not have experienced export container growth, but rather a decline of 0.22%. An intensive programme of capital investment by the railway has already showed significant increases of bulk manganese exports in 2011, which could erode most of the containerised manganese volumes.

Heineken has built a R3.5 billion brewery in Johannesburg, that started production in September 2009. The brewery produces three brands of beer: Amstel, Heineken and Windhoek Lager. This local production caused a significant drop in the import container numbers for beverages. The total impact on South Africa's import containers was a decrease in growth from 17.56%, if the imports of beverages had not decreased, to the 16.17% increase realised in 2010. The consequences of not taking South Africa's drive towards local production and beneficiation into account can result in container demand being hugely overstated. In a macroeconomic context it might be better to invest in more local manufacturing capability than container capacity.

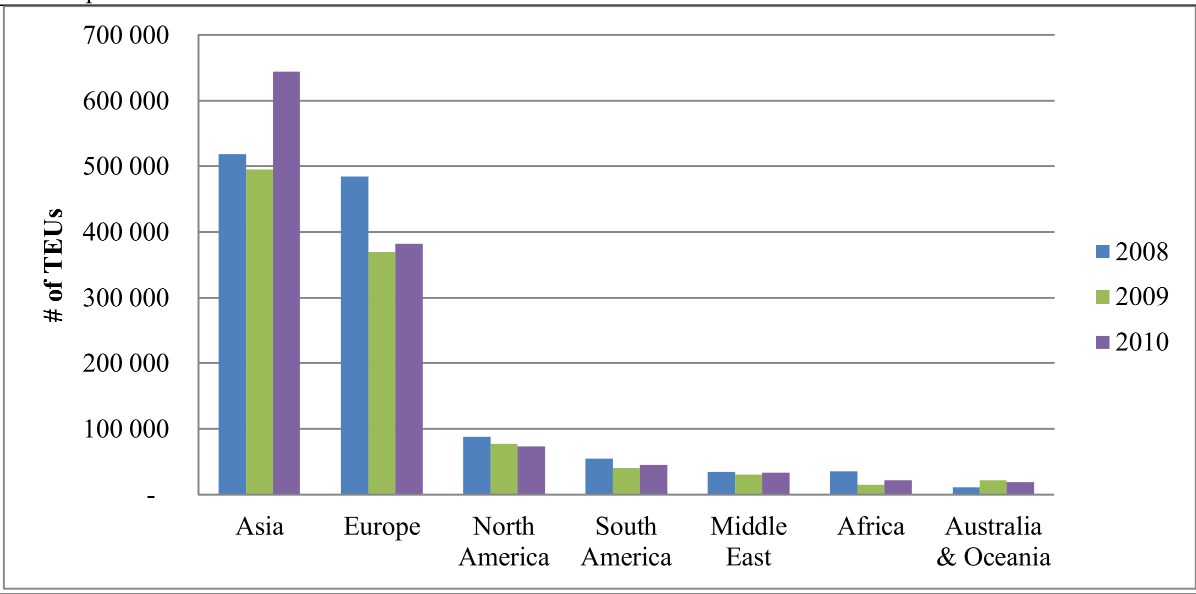
Demand-side modifier 3: Shifts in trading patterns

Shifts in trading patterns can also lead to a decoupling of GDP with container volumes, as the commodities that are traded differ from country to country and from region to region. By understanding the underlying commodities in containers and the trading partners per commodity in question, a finer granularity of demand-side modifier transparency can be achieved. Figure 5 reflects recent changes in South Africa's trading patterns.

Figure 5. Trading pattern shift for South Africa



Imports

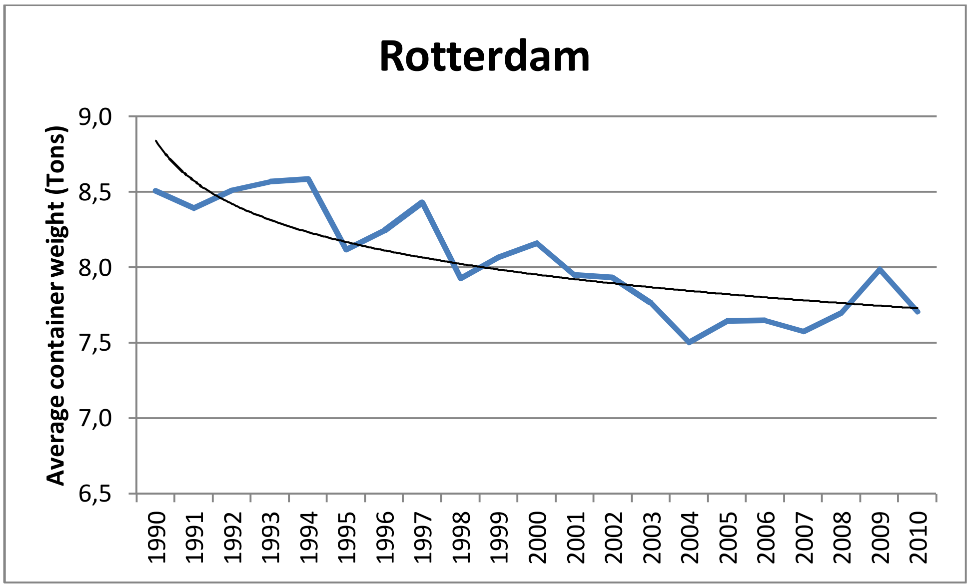


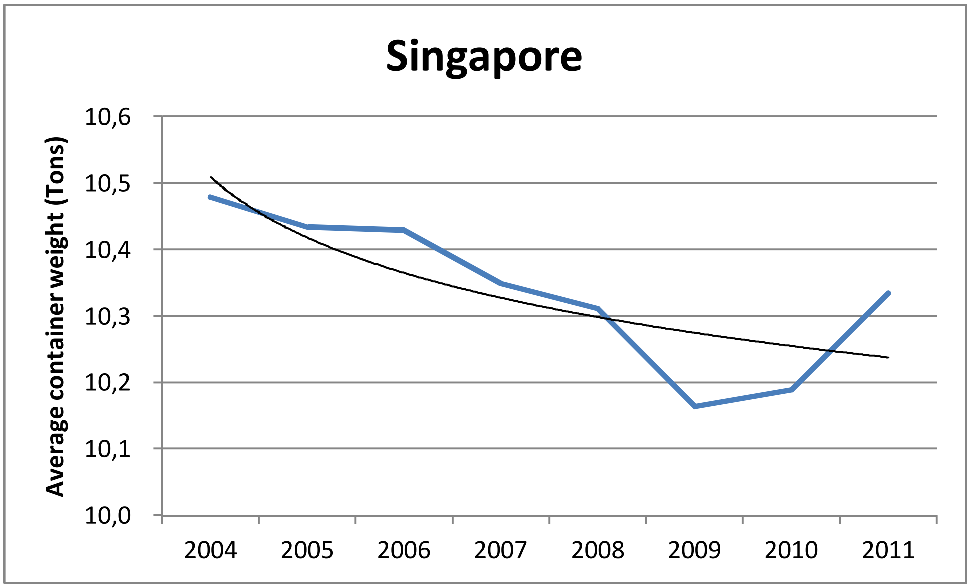
The shift in South Africa's trading patterns to the East is significant. It is often driven by raw materials in containers for heavy manufacturing industries towards oriental countries. The containerisation of the raw materials is caused by a decrease in rail capacity over the last two decades. A change in rail capacity could severely influence this demand-side modifier.

Demand-side modifier 4: Shifts in average TEU weights

Average TEU weights for many ports around the world have been declining due to customer service pressure and a propensity to sub-optimise space. Data for Rotterdam and Singapore is illustrated in Figure 6.

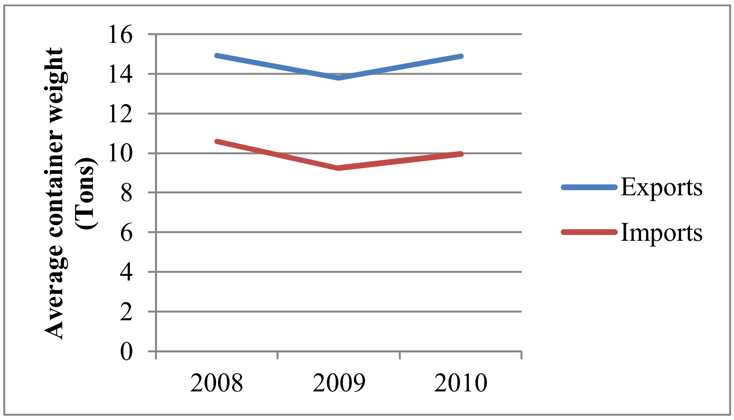
Figure 6. Average container weights for Rotterdam and Singapore





Similar data for South Africa was not available before the mega-sampling approach took place, but assumptions that rapid container growth will continue seems incorrect. (See Figure 7.)

Figure 7. Average container weights for South Africa

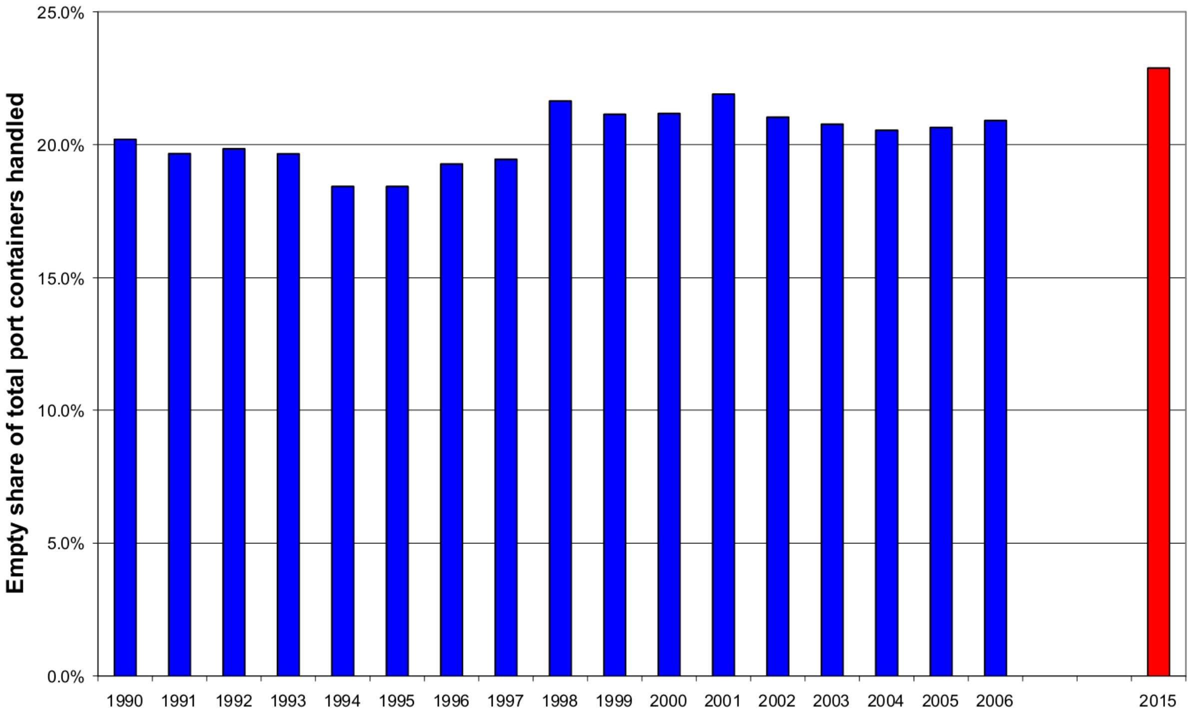


From the charts it seems as if the global trend is flattening, and that South Africa is at the same position in terms of this trend. This serves as another example of how a lack of transparency of the demand-side modifiers could lead to incorrect forecasts.

Demand-side modifier 5: Shifts in improvements or deterioration of logistics optimisation and technology

Figure 8 illustrates how an improvement in logistics optimisation led to a lower ratio of empty container movements to total containers handled internationally.

Figure 8. Illustration of how improvement in logistics optimisation led to a lower ratio of empty container movements to total containers handled.



Source: UNESCAP, 2007: 49

Since 1998 pronounced trade imbalances deteriorated this position severely. South Africa has no forecast model to ascertain this, but globally this trend is forecasted to continue for a few years.

Forecasting techniques for trade container demand

The historical correlation between container traffic growth and GDP growth is indisputable (Garratt, 2006). The most common approach to forecasting trade container demand is the firm belief that it is "ultimately driven by economic growth" (UNESCAP, 2007: 28). The underlying assumption in the UNESCAP forecast for the decade up to 2017 is that "the structural relationships between growth in container trade and economic growth will remain basically unchanged". The Department of State and Regional Development of New South Wales (2011), responsible for container forecasts for five major ports in Australia (Melbourne, Sydney, Brisbane, Fremantle and Adelaide), also bases dramatic intermodal growth on globalisation and world economic growth, which are forecast to remain constant over the next 20 years.

The forecasting approach followed by the United Nations is linked to world output, but some major ports, such as Rotterdam (where commodities are considered) and New York (where the "economic well-being of surrounding hinterland states" as well as foreign trade volumes are considered), have developed more complex forecasting models (Dagenais and Martin, 1987: 1). Gosasang et al. (2010: 1) refer to the Japan International Cooperation Agency's (JICA) forecast reports of 1994, which forecasted volumes of import/export containers at the Port of Bangkok by applying regression analysis, using population and GDP as independent variables. They propose a neural networks method for predicting the container throughput at the Port of Bangkok, but still take into account Thailand's GDP, world product (i.e. global output), the exchange rate (compared with the dollar), population, inflation rate, interest rate and fuel price as underlying variables.

Fung (2001: 15) adopts a forecasting model that considers price sensitivity and service competitiveness between the competing ports of Hong Kong and Singapore, with GDP growth as a given. He concludes that “the demand for container handling services is derived from the demand for imports, as the resultant market shares of container handling services [are] gripped by different regions inevitably becoming a mirror image of the relative competitiveness of their exports. When the markets of the two ports overlap, the market shares will depend on the prices they charge and on how well they meet the needs of the shippers and shipping lines” (Fung, 2001: 18–19). Wilson and De Vuyst (2007: 10) also emphasise inter-port competition in the US and highlight a common mistake entailing a belief that certain forecasts relating to the improvement of efficiency levels will correlate with growth, while port competition is ignored.

Lam et al. (2004: 142), in addressing demand forecasting for the Port of Hong Kong (one of the busiest container ports in the world), proposed that explanatory factors (such as population, trade values of imports/exports and GDP) that affect freight movements should be reviewed since the relationship between these and freight movements was determined as far back as 1997. They point out that changes in the economic environment “might cause their relationship to no longer be valid, and hence a reanalysis is needed”.

In forecasting container throughput for Indonesia to support the case for the building of a new port, Syafi’i, Kuroda and Takebayashi (2005) include container throughput, GDP, population, and exports and imports as model variables, and assume that the statistical structure of the model will not change substantially in the future. Wilson and De Vuyst (2007: 10–11) maintain that “rather than modelling individual or even multiple commodities, we explicitly recognise that the supply and demand for container shipments is a market of its own, regardless of the contents of the containers”. They do list “non-identity of container content” as an outstanding issue and concede that the reason their model excludes commodities is because the content of containers is unknown. They add that “there has been an increase and shift in commodities shipped by containers” and suggest that “somehow this will have to be captured in the model specification” (Wilson and De Vuyst, 2007: 28, 34). Garratt (2006) refers to the slower growth rate of containerisation due to the “maturing of the containerisation of commodities”.

Research Methodology

This paper advances the notion that for each commodity group a different ceiling for propensity to containerise exists, and that this is a more important explanatory factor in forecasting container demand than is usually considered. Therefore, a container demand forecast based on commodity-level export and import-volume forecasts, as well as the propensities of the commodities to be containerised, is proposed. The methodology is driven by information on container content, forecasts of long-term growth in demand for this content, and “fitting” these to maximum propensities to containerise.

Sourcing information on container content through mega-sampling in South Africa

Due to resource constraints, South Africa’s National Ports Authority (NPA) stopped capturing information on container content from shipping line manifests, which is in the authors’ opinion one of the main causes of the poor planning of trade container capacity. Various methods have been attempted since 2006 by the authors to rectify this problem.

The first attempt involved deriving information on container content from the difference between imports and exports (per commodity), as found in customs data, and available NPA data per commodity, which excludes containers. No meaningful results could be obtained from this exercise. For various possible reasons information was recorded incorrectly or coded in different ways. The second attempt involved surveying freight forwarders and logistics service providers, but poor response rates and unreliable data also led to difficulties in solving the container content question. The third attempt involved shipping lines, which were requested by the authors in 2009 to submit their original raw manifest data. After considerable persuasion, data on the content of 66% of all import and export containers was recorded. This sample comprised 1 311 853 fully stuffed TEU containers. It is by far the most reliable source of commodity data that could be secured. The database covers two calendar years (2008 and 2009), and includes total weight of the contents, the number of TEUs and content information, enabling a robust analysis. The detailed commodity data was classified into commodity groups to enable matching with the recorded GDP.

The data will be updated annually for the first four or five years to establish the robustness of the process and the results. The intention is that it should thereafter be updated every three years to determine shifts in the propensity to containerise specific commodities. This, in turn, will enable calibration and validation of the methodology proposed in this paper.

It was established that the commodities most suitable for containerisation fall into two broad categories:

- perishables, including agricultural products, such as fruit, meat and dairy produce; and
- break-bulk, including mainly palletised finished manufactured consumer goods.

Once the content of trade containers was known, the supply and demand for all commodities had to be forecasted (to ensure that all types of future containerisable commodities were incorporated). This was followed by translating supply and demand into flows to determine import and export flows.

Forecasting economic growth and deriving freight flows

To refine domestic freight-flow forecasting in South Africa, disaggregated supply and demand data based on an input-output model (I-O model) of the economy was used. South African ports are primarily hinterland ports, rather than transhipment ports, meaning that freight flows, which are derived from the I-O model, play an important part in import/export demand. The I-O model was used to calculate the output per sector. For the purposes of freight-flow analysis, the I-O model was disaggregated into 356 magisterial districts and 64 commodity groups. Five of South Africa's seven commercial ports handle international container movement (from west to east, the ports of Cape Town, Port Elizabeth, East London, Durban and Richards Bay). Container movement over land to and from neighbouring countries is not considered in this study. In this study these ports, therefore, serve as the points of entry and departure for container flow into and out of South Africa. The exact volume of containers handled annually in these ports is provided by the NPA. For the purpose of this study, a container trip end is represented by a magisterial district. Therefore, in this study, apart from the five container ports, there are 356 container trip origins and 356 container trip destinations.

A combination of forecasting techniques was used to determine future supply and demand for the 64 commodity groups. These include expert consensus for agricultural and mining commodities, correlated with macroeconomic forecasts at the industry level. For validation, results were compared to historical trends. For manufacturing, standard forecasting models from a major industrial bank were used. These forecasts are the results of an elaborate system of quantitative analyses coupled with, and to some extent controlled by, a qualitative evaluation of each sector's unique characteristics. A 30-year forecast is updated annually, with yearly results for the first five years and thereafter a 10-, 15- and 30-year forecast.

Economic forecasts, even at the sub-sector level, are normally expressed in monetary terms. For this reason, most of the modelling is done in monetary terms. However, to facilitate transport analyses, it is more practical to express production magnitudes in volumetric terms. The supply and demand components of the I-O table were converted from monetary to volumetric terms using a monetary/ton ratio. This enables the generation of total supply and demand volumes (in tons) that ultimately need to be transported on South Africa's transport network.

A gravity freight flow model calibrated by Havenga (2007) was applied to determine the distribution of freight flows within the country. Through this step the forecast for all flows, including import and export commodities, was established, leading to the next step of determining the propensity of import and export commodities to be containerised in the future.

Estimating the propensity to containerise

The extent to which containerisable commodities have been containerised had to be determined. Put another way, are there commodities that could be in containers, but are still being transported as bulk or break-bulk freight? The current containerisation per commodity was determined, based on the non-containerised bulk volumes from disaggregate commodity records obtained from the NPA database, and the containerised volumes as received from the shipping lines. Assumptions for the percentage of each commodity that can potentially be containerised in the forecast period were then developed, based on the sampled data to date and through discussions with industry experts. The shifts were captured as a cumulative, gradual change over time. This process was repeated for all 64 commodity groups. The current containerisation of import/export commodities and the containerisation at the end of the forecast period are provided in Table 1.

Table 1. Percentage containerisation per commodity 2009 and 2040 (sorted according to 2009 %)

Break-bulk	2009 (%)	2040 (%)
Cement	21	17
Ferrochrome	25	24
Iron and steel basic industries	28	60
Ferromanganese	30	33
Wood and wood products	32	52
Industrial chemicals	38	54
Food and food processing	52	95
Other chemicals	59	94
Non-ferrous metal basic industries	63	63
Machinery and equipment	90	97
Transport equipment	93	99
Paper and paper products	94	96
Other manufacturing industries	96	99
Non-metallic mineral products	97	100
Motor vehicle parts and accessories	97	100
Rubber products	99	100
Metal products excl. machinery	100	100
Electrical machinery	100	100
Bricks	100	100
Furniture	100	100
Textiles and clothing	100	100
Tobacco products	100	100
Pharmaceuticals and toiletries	100	100
Cotton	100	100
Printing and publishing	100	100

Perishables	2009 (%)	2040 (%)
Citrus fruit	69	100
Vegetables	91	100
Deciduous fruit	94	100
Dairy	100	100
Livestock (slaughtered)	100	100
Subtropical fruit	100	100
Viticulture	100	100

Source: Havenga and Simpson, 2009

Based on the proposed forecasting methodology, the differential between GDP and container forecasts will diminish over time as the propensity to containerise reaches saturation. The benefit of this methodology is that although container growth will outperform GDP growth and/or trade growth in the medium term, once commodities reach their respective ceiling values for containerisation, the growth of containerisation will have to be limited to GDP growth and/or trade growth.

Research results

Findings on the propensity to containerise

The combined percentage of containerisation for the industry groups most likely to be containerised – i.e. break-bulk and perishable industry groups – in 2009, was 48% for exports and 69% for imports, respectively

On analysing the remaining 52% of export commodities not yet containerised, 76% belongs to four commodity groups that were considerably containerised already, and could be containerised further in the future. Some of these commodity groups might reach a ceiling of less than 100% due to weight complexities, such as iron and steel products, and wood. Table 2 shows these commodity groups, their current containerised percentages, and the remaining non-containerised bulk tons.

Table 2. Commodity groups, percentage containerised and bulk tons for exports (2009)

Commodity	% containerised	Sum of bulk tons
Iron and steel basic industries	28	2 749 901
Wood and wood products	28	2 428 099
Ferrochrome	24	1 766 885
Industrial chemicals	31	1 237 578

Source: Havenga and Simpson, 2009

Performing the same analysis for the remaining 31% of import commodities not yet containerised, 84% belongs to four commodity groups that were already considerably containerised, as shown in Table 3. Processed foods and chemicals are expected to approach 100% containerisation in the short to medium term.

Table 3. Commodity groups, percentage containerised and bulk tons for imports (2009)

Commodity	% Containerised	Sum of bulk tons
Food and food processing	42	1 922 850
Iron and steel basic industries	39	499 809
Other chemicals	66	393 182
Industrial chemicals	53	374 232

Source: Havenga and Simpson, 2009

The number of future containers is calculated by multiplying the total import and export volumes (tons) by the percentage containerisation predicted, and then dividing the tons containerised by the average weight per TEU for imports and exports, respectively. The resultant container growth rate versus the GDP growth rate over the forecast interval is shown in **Ошибка! Источник ссылки не найден.**, indicating that the differential is diminishing over time.

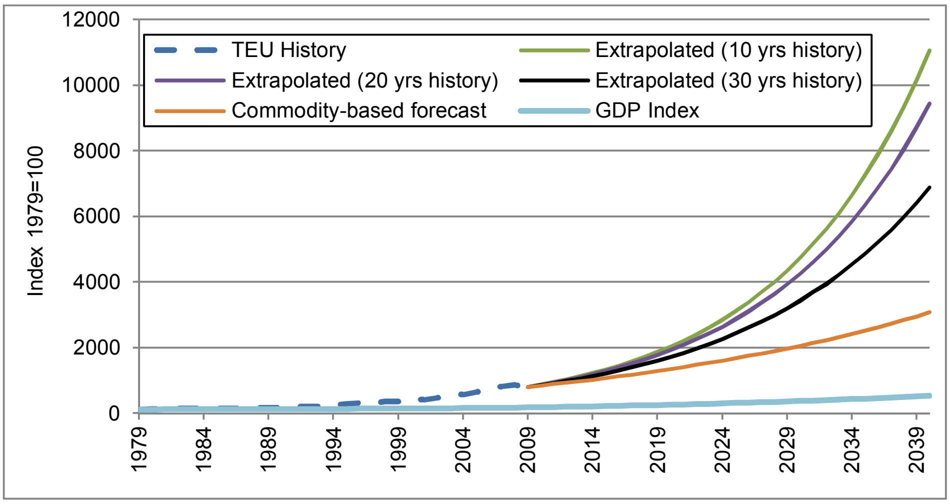
Table 4. GDP growth, container forecast and difference per forecast interval

Year	(%) GDP growth	(%) container growth	(%) points difference
2010	2.88	5.70	2.82
2011	3.00	5.44	2.44
2012	4.05	4.62	0.57
2013	4.05	4.49	0.44
2014	4.05	4.80	0.75
2015	4.05	4.74	0.69
2020	3.87	4.79	0.92
2025	3.69	4.42	0.73
2040	3.69	4.12	0.43

Container volume forecast

The results of the proposed commodity-based causal approach (discussed here) and the results of three statistically extrapolated forecasts from the same data are illustrated in Figure 9. The extrapolation was done by using container growth rates for the past 10, 20 and 30 years. The forecast container volumes, based on the approach described in the proposed methodology, still outperform GDP growth over the 30-year forecast period.

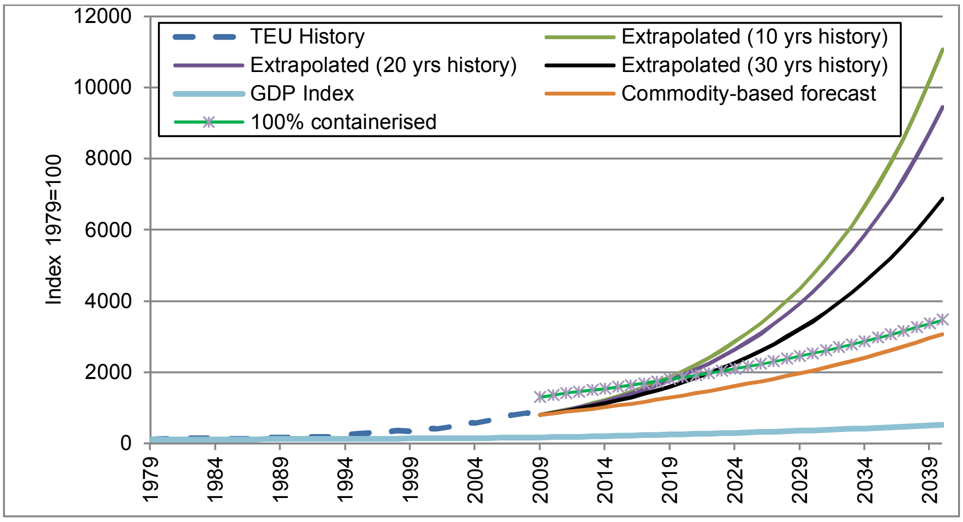
Figure 9. Extrapolated container forecasts versus commodity-based forecast



The extrapolated forecasts would create a potential over-estimation of required port capacity for container handling by 300% for the 20-year extrapolation, compared with the commodity-based forecast. This shows the potential danger of planning and investing in infrastructure on the basis of extrapolating historic trends for containers.

To test the risk that the propensity to containerise could be faster than expected, and that the commodity-based forecast might, therefore, be too conservative, another forecast is added for 100% containerisation of all suitable commodity groups by 2039 (excluding bulk iron ore, coal, and manganese exports, and crude oil and petroleum imports, which can be confidently excluded from containerisation). Although many other commodity groups can also probably not be completely containerised, this assumption indicates the ceiling and also the over-estimation of the extrapolated forecasts. As Figure 10 shows, the ceiling of the commodity-based forecast is still significantly lower than the level of the extrapolated forecasts.

Figure 10. Extrapolated container forecasts versus commodity-based forecast with ceiling container volumes



Conclusions

Container demand forecasting attempts based on aggregate trend extrapolation have shown significant deviations from actual demand. When analysing container contents and current containerisation trends on a disaggregate basis, it is observed that containerisation is already maturing, which curbs the continued further growth of containerisation. A disaggregate container forecasting methodology based on each commodity's expected propensity towards containerisation is proposed. This potentially more realistic forecast yields, at its ceiling value, a forecast below the most conservative aggregate-trend extrapolation. The results of the proposed disaggregate commodity model can be applied to inform investment decision making relating to port container facilities and bulk-handling terminals. Informed decisions are critical since they will have long-term repercussions for the development of other logistics infrastructure, industry location decisions and hinterland development.

Additional research is suggested in the following areas: (1) The propensity to increase containerisation for each commodity group; and (2) applicable ceiling values of those commodity groups that have a less than 100% containerisation propensity.

References

1. Abonyi, G. and Van Slyke, D.M. 2010. Governing on the Edges: Globalisation of Production and the Challenge to Public Administration in the Twenty-First Century. Syracuse: Maxwell School of Syracuse University.
2. Ballou, R.H. 2004. *Business Logistics/Supply Chain Management.* New Jersey: Pearson Prentice Hall.
3. Bilegan, I.C., Craininc, T.G. and Gendreau, M. 2007. Forecasting freight demand at intermodal terminals using neural networks. *Sixth Triennial Symposium on Transportation Analysis* (TRISTAN). Phuket, Thailand, 10–15 June 2007.
4. Dagenais, M.G. and Martin, F. 1987. Forecasting containerised traffic for the Port of Montreal (1981–1995). Transportation Research Part A: General, Policy and Practice, 21(1): 1–16.
5. Department of State and Regional Development of New South Wales. 2011. The Southern Highlands Intermodal – Demand Forecasts. Available from: http: //www.southernhighlandsbusiness.com/forcast.html (Accessed 6 June 2011).
6. Fung, K. 2001. Competition between the ports of Hong Kong and Singapore: A structural vector error correction model to forecast the demand for container handling services. Maritime Policy Management, 28(1): 3–22.
7. Gardiner, N. 2007. Annual Container Market Review and Forecast 2007/8: - Incorporating the Container Forecaster – 3Q07. London: Drewry Publications.
8. Garratt, M. 2006. Forecasting for Long-Term Investment in the Container Shipping Industry – A Holistic Approach. MDS Transmodal. Available from: http://www.mdst.co.uk/attachments/downloads/Hamburg_Dec06.pdf (Accessed 18 July 2011).
9. Gosasang, V., Chandraprakaikul, W. and Kiattisin, S. 2010. An application of neural networks for forecasting container throughput at Bangkok Port. World Congress on Engineering. Imperial College London, 30 June–2 July 2010.
10. Havenga, J.H. 2007. The Development and Application of a Freight Transport Flow Model for South Africa. Doctoral thesis. Stellenbosch: University of Stellenbosch.
11. Havenga, J.H. and Simpson, Z. 2009. Transnet Freight Demand Model. (Working document 2009/1.) Stellenbosch: Centre for Supply Chain Management, Department of Logistics, University of Stellenbosch.
12. IndexMundi. 2011. GDP (purchasing power parity). Available from http://www.indexmundi .com/g/g.aspx?c=xx&v=65 (Accessed 14 July 2011).
13. Lam, W.H.K., Pan, L.P.N., Seabrooke, W. and Hui, E.C.M. 2004. Forecasts and reliability analysis of port cargo throughput in Hong Kong. Journal of Urban Planning and Development, September.
14. Neylan, P. 2010. Container Forecaster: 4Q10, Quarterly Forecasts of the Container Market. London: Drewry.
15. Pienaar, W.J. 2012. Introduction to business logistics. In: Pienaar, W.J. and Vogt, J.J. Business Logistics Management: A Value Chain Perspective, 4th edition. Cape Town: Oxford University Press.
16. Ponthieu, E. 2008. Towards an Integrated and Coordinated Sustainable Logistics and Transport Policy for Europe. Rome: European Economic and Social Committee, 19 June 2008.
17. Singh, A. 2005. Future Trends in Global Ports – Managing Growth in an Era of Mergers and Acquisitions. Thailand: LCB Container Terminal 1 Ltd.
18. Sooredoo, N. 2011. Historical TEU throughput (information kindly provided on request directly by Drewry). London: Drewry.
19. Syafi'i, Kuroda, K. and Takebayashi, M. 2005. Forecasting the demand of container throughput in Indonesia. Memoirs of Construction Engineering Research Institute, 47, November.
20. UNESCAP (UN Economic and Social Commission for Asia and the Pacific). 2007. Regional Shipping and Port Development – Container Traffic Forecast 2007 Update. New York: United Nations.
21. Wilson, W.W. and De Vuyst, E. 2007. Optimization Models of Container Shipments in North America: Spatial Competition and Projections (Methodology). Fargo: North Dakota State University.