A decade of national level logistics costs measurement in South Africa: The case for macro logistics

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1. Introduction

South Africa is a large and relatively sparsely populated country with transport demand far in excess of its relative economic size. The country contributes around 0.4% to the world's GDP, but requires 2% of the world's tonne-kilometres (Havenga, 2007). This spatial imbalance means that freight transport infrastructure, specifically, should be managed as a critical macroeconomic production factor to facilitate high levels of logistics efficiencies.

However, freight logistics services in South Africa have either been unreliable (rail) or costly (road) due to backlogs in infrastructure investment and inadequate planning. This gave rise to an untenable modal balance, with 86% of corridor (long-distance) tonne-kilometre (tonne-km) transported on road in 2012. As a result, almost 40% of South Africa's freight transport costs were attributable to diesel costs, a volatile exogenous cost driver (Havenga and Simpson, 2013).

The investment backlog is being redressed through Transnet's (South Africa's state-owned rail, port and pipeline operator) ZAR 312 billion (bn) capital investment program between 2012 and 2019, the largest recapitalisation program in the country's history (Transnet, 2015). In addition, ZAR 60 billion have been spent on national roads in the past 4 years, with another ZAR 77 billion allocated over the next 3-year budget cycle (Treasury, 2015: 651).

On a microeconomic level, such sizeable investments are accompanied by meticulous business and project planning with specific return-on-investment targets to satisfy various stakeholder groups. The same management principles are however sorely lacking where the macroeconomic management of logistics infrastructure investment is concerned. Yet, effective cost reduction in and management of the national logistics system is reliant on measuring and tracking logistics cost components to inform appropriate government policy (United Nations, 2002). As such, national-level logistics performance and costs measurements are becoming increasingly important in national and regional policy-making and competitiveness, and countries with a time series of data have a distinct advantage in this regard (Rantasila and Ojala, 2012).

The key issue here is that one of the pillars of a high-performing system is management information (Fredendall and Hill, 2001: 213) and is especially pertinent for logistics given its role as an integrator of macroeconomic production factors. This implies the elevation of the management of the national logistics system to a macroeconomic management level, on par with other production factors. For this purpose, macro logistics is defined as follows (expanded from the definitions of logistics management as in UNCTAD et al., 2012: 12):

> *that part of the macro supply chain process that enables the efficient and effective forward and reverse flow and storage of all goods, services, and related information in the economy between all points of origin and consumption in order to facilitate trade, lower the cost of doing business and contribute to development state ideals (including socio-economic development and environmental stability). It includes the policy, infrastructure and industry-level collaborative planning required to achieve this goal.*

The purpose of this paper is threefold: (i) to support the case for macro logistics, (ii) to share the applications of South Africa's freight logistics costs model, and its underlying freight flow model, in the macroeconomic freight policy and infrastructure arena, and (iii) to link these applications to the triple bottom line framework in support of a macro logistics framework.

2. Macro logistics

The sustainability concerns of unconstrained global economic growth have been crystallised with the convergence of a number of key factors, pertinently natural resource depletion, ecological instability, and systemic financial and monetary failures (Heinberg, 2011; Guttal, 2012). For the logistics discipline, these limits are primarily evidenced in extreme oil price volatility (Manrodt and Holcomb, 2011 and Engblom et al., 2012) and increasingly formalised efforts to determine logistics-related externality costs to enable total-cost accountability (Piecyk and McKinnon, 2007 and McKinnon, 2009). This, in turn, is increasing pressure for the macroeconomic 'instrumentation' of logistics (Klaus and Müller, 2012), i.e. the calculation of logistics costs and associated externalities, their comparison to output in order to measure logistics' productivity, and the identification of logistics' potential contribution to sustainability.

Efficient freight logistics infrastructure is a key contributor to sustainable economic growth (Rodrigues, Bowersox and Calantone 2005; Limão and Venables, 2001; Serhat and Harun, 2011; Bensassia et al., 2015; Closs and Bolumole, 2015). The World Trade Organisation (2004) reports that "the effective rate of protection provided by transport costs is, in many cases, higher than that provided by tariffs". Ravn and Mazzenga (2004: 657) estimate that a reduction in transport costs from 20% to 15% of GDP is equivalent to a permanent increase in domestic consumption of just above 1.5%.

Yet, even at a company level, strategic attention to logistics as a source of competitive advantage is a relatively new phenomenon. During the 1980s, competitive advantage meant delivering flawless product quality, while in the 1990s, the focus shifted to providing superior customer service. When these avenues were exhausted (mainly due to emulation by competitors), companies became increasingly aware that a well-run logistics system could provide them with a sustainable competitive advantage (Gourdin 2001: 8). It is therefore not surprising that the macroeconomic shift towards strategic logistics management is still in its infancy.

In the literature the element of macroeconomics that does receive some attention relates to investment in logistics infrastructure. In this case, investment in infrastructure is viewed as a direct economic injection and a strengthening of the 'capital' production factor. Lakshmanan and Anderson (2002: 6) describe this better-known field of study in terms of its accepted positive correlation and the regulatory impacts that are therefore required, but they are careful to note the deficiencies in the body of knowledge around the networks created by different modes and the effect of this on production factors. In so doing, they indicate the way towards a more robust understanding of the effect of different modes on network design to benefit an economy as a whole.

Similarly, in South Africa, the infrastructure component is understood in general, but without an understanding of the concomitant network and modal view. Fourie (2008) highlights that the policy and research emphasis in South Africa is still on infrastructural *quantity* as opposed to *quality*.

In a detailed historical analysis spanning 106 years, Fedderke et al. (2006) demonstrate that the impact of infrastructure investment on economic growth is both strong and statistically significant. The paper provides significant *a posteriori* evidence towards substantiating the importance of infrastructure investment, but falls short of providing performance measures of the various infrastructure categories and in providing *a priori* guidelines for the significant transport infrastructure investments mentioned previously.

Lakshmanan and Anderson (2002: 17) emphasise the need for performance-based research to clearly demonstrate the link between logistics infrastructure investment and economic growth. This would enable an understanding of the "effects of logistical transformation, productivity-enhancing location shifts, and value-adding effects" and "ex post assessment of major infrastructure projects and programs". Their appeal is for indicators to inform the development of national logistics strategies and track performance of the macro-logistics system against national strategies.

UNCTAD et al. (2012) expand the components of a macro logistics system to include the interaction between (1) shippers, traders, and consignees; (2) public, private sector logistics and transport service providers; (3) provincial and national institutions, policies, and rules; and (4) transport and communications infrastructure. Performance is determined by cost efficiency, time responsiveness, and reliability – ensuring the *economic* sustainability of the macro logistics system. The SSATP (Africa Transport Policy Program) advocates to its member countries that adequate and reliable data provide the foundation for evidence-based policy decisions, and for planning, monitoring and evaluating the impact of transport investments towards *poverty reduction* and growth (Nogales, 2015). McKinnon et al. (2014) identified external factors that will impact on company-level efforts to cut freight logistics-related carbon emissions, and classified these into 6 categories using the acronym TIMBER - technology, infrastructure, market changes, behaviour, energy and regulation. The purpose of this framework is to help governments and companies find ways of achieving dramatic *carbon reductions* in the transport sector in order to contribute to 2050 global climate greenhouse gas emissions targets. These latter excerpts point to development of a desirable macro logistics framework – one that encompasses the triple bottom line of profit, people and the planet.

The findings from and applications of South Africa's logistics costs and freight flow models demonstrate the beginnings of such a framework, flowing from the availability of appropriate intelligence.

3. South Africa's macro logistics models

3.1 Methodology

The logistics cost model employs a bottom-up approach for calculating logistics costs, which comprise three direct elements, namely, transport; storage and port-handling costs; and management and administration costs; and one indirect element, namely, inventory carrying costs. Total surface freight flow data is modelled for 71 commodity groups between 356 magisterial districts, eight inland border posts, seven ocean ports and one airport – translating the tons produced and imported (that is, total supply) of a specific commodity into total freight flows based on gravity-modelling, and subsequently determining the costs of performing transport, storage and port handling functions with respect to that commodity. Actual disaggregated rail freight flows and costs are obtained from South Africa's single freight rail operator; the balance of the flow and cost data therefore defines the road transport mode. The cost of holding inventory is added by calculating the average turn of each commodity in the economy, researching warehousing cost (storing and handling) and applying the prime rate to the average inventory delay. Finally, management and administration costs are calculated by relating the relationship between the salary bill as a percentage of the costs of the transport industry for reward with the total costs of transport and warehousing to determine salary costs. The remainder of this component is calculated as the average profit margin in the transport industry for reward and other outsourced logistics activities, or, alternatively, as the administration charge for in-house transport or warehousing activities. The modelling approach is detailed in Havenga (2010).

The freight flow model has more than 1 million records of freight flow data between 372 defined origin and destination pairs and for 71 commodity groupings, with 30-year forecasts and three growth scenarios, making it one of the most comprehensive freight segmentation models in the world. The warehousing cost portion of the logistics costs model calculates distinct storage and handling costs per commodity, based on different inventory turns for each commodity. This wealth of data enables aggregation to national-level intelligence to inform policies, large-scale infrastructure investments and industrial positioning. At the same time, it also allows disaggregation to the local level to enable practical application.

The South African logistics cost model was expanded in 2009 to calculate transport externalities (Swarts et al., 2012), but due to a lack of data, still depended on global averages for some cost inputs. The externality cost model has since been refined with South African input data and also been expanded to calculate land-use costs as an externality cost. Externality costs include accidents, congestion, emissions, policing, noise and land-use (Havenga, in press).

3.2 The macro logistics application of the modelling results

The individual and integrated sets of results from these models have created a significant macro logistics body of knowledge in South Africa and are enabling *inter alia* the following:

1. The development of flow categories to guide modal shift and intermodal investments including:

- The development of a domestic intermodal strategy (Havenga, Simpson and De Bod, 2012), which led to a government requirement for the railway to implement intermodal solutions.
- The signing of memorandums of understanding between two of South Africa's largest logistics service providers – Imperial Logistics and Barloworld Logistics – and Transnet (Diza, 2013; Finweek, 2013).
- The signing of agreements between the railway and two local private firms to test swop body technology within this year (Ash, 2015).

2. The segmentation of the freight flow market in South Africa (Havenga, 2012) to redirect the rail policy debate in the country leading to the revision of the 2011 Green Paper on Rail Policy from the Department of Transport (Mahlalela, 2011), released in 2013 to limited stakeholders for comment, resulting in a turnaround 'to change the thrust of rail policy away from one that is focused on institutional reform and clarity' towards one 'that encourages development and investment' (Smith, 2012).
3. Facilitated the upward revision of the multi billion rand rail revival investment program from an initial R90bn to the current R200bn (Dlamini, 2010; Batwell, 2012);
4. Development of macro logistics performance measures. Two initial indicators have been proposed, namely:
   - total logistics costs as a percentage of GDP (measures the overall performance of the system); and
   - road corridor ton-kilometre market share (measures modal optimisation and resulting exposure to external risk).

   (Havenga, 2010)
5. Guiding national resilience through increased visibility of extra-national risk factors (such as fuel price and exchange rate instability due to disproportionate dependence on long-distance road freight transport) – scenario analysis indicates that at R12/US$ and a $150 oil price, logistics costs would have been R50bn more in 2012 (Havenga et al., 2014). Back-of-the-envelope calculations indicate that, investing in either conventional ballasted rail line or tubular modular track in order to transport the

long-distance component of all intermodal-friendly freight on rail on the Johannesburg-Durban corridor, could require an investment of up to R75bn. The national opportunity cost of the exposure to (not unlikely) external shocks is therefore significant and the modelling outputs can be used to inform a pre-feasibility study.

6. The externality cost extension of the logistics cost model is already being applied to further facilitate the rail revival and intermodal business case (Diza, 2013).
7. To develop business cases for the protection of branch lines (Simpson and Havenga, 2010).
8. Guidance in logistics decarbonisation efforts: Input into the global decarbonisation of logistics project of McKinnon, Piecyk and Validi (2014). Their proposed framework classifies external factors that influence companies' internal decarbonisation efforts into 6 categories using the acronym TIMBER - technology, infrastructure, market changes, behaviour, energy and regulation. Their objective is to use actual data as far as possible, and South Africa is one of the target countries of this global study. It is expected that the research presented here will aid in focusing the decarbonisation project's research efforts to high-impact local applications, and contribute data to facilitate the population of the framework. Initial reflections on South Africa's TIMBER framework are presented for the first time at this conference.
9. The author represents South Africa in the global endeavour to create a Logistics Performance International Observatory (LPIO), sponsored by the World Bank. The purpose of the LPIO is to establish on-going conversations between the network of researchers and research institutions dealing with national-level logistics costs and performance measurement (Rantasila and Ojala, 2012), in order to identify common analytical frameworks and enable better alignment between research outputs.

3.3 Future application of the research

1. Policy:
    - The intent is to conduct a detailed cost-benefit analysis to enable rail policy planning as a subset of national transport

policy planning. This should be a joint effort between, at minimum, the DoT, DPE and Transnet and, at best, include major other stakeholder groups. The ultimate goal is to work towards holistic transport planning across all freight modes utilising the 30-year demand forecast to improve supply efficiency.

- Given the limits to growth in the global economy, a critical next step is to model high impact demand reduction points and develop policy incentives to achieve this.
- In the medium term, instruments can be developed to determine and direct the socio-economic impact of the industry, influence job creation and improve working conditions.

2. Collaboration: The concentration of specific industries on long-haul corridors provide distinct guidelines for the collaborative development of intermodal solutions with industry – opening up the discussion for private sector participation in shared and scarce infrastructure. The results of the flow model can also be utilised for collaborative export market development.
3. Development of meso logistics performance measures – using the provincial logistics costs report in the annual State of Logistics Survey (Havenga and Simpson, 2013) as a starting point.
4. Infrastructure – holistic policy development and collaborative planning should facilitate optimal infrastructure development.
5. Humanitarian logistics – modelling of demand concentration can facilitate the optimal location of disaster relief centres.

3.4 Macro logistics in relation to the triple bottom line

The triple bottom line concept has gained exponential traction since the 1990s. The balance between economic growth, social development and environmental protection is considered (United Nations, 1987; Elkington, 2004), with some institutions such as Sustainable Aotearoa New Zealand (2009) even advocating a “strong” model where the environment is seen as more important than the economic or social dimension (Figure 1).

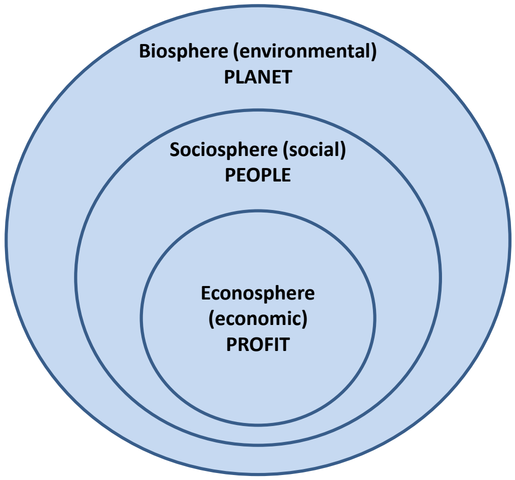

Figure 1: The strong sustainability model

The application of South Africa's logistics costs and freight flow models confirm that – given the availability of appropriate intelligence – macro logistics management based on the 3Ps (profit, people and planet) is innate and attainable (Table 1).

Table 1: South Africa's macro logistics models' outputs – application in relation to the 3Ps

SUSTAINABILITY ELEMENT	APPLICATION IN SOUTH AFRICA (refer Sections 3.2 and 3.3 for numbering)*
Profit	(3.2) 1, 2, 3, 4, 5 (3.3) 1, 2, 3, 4
People	(3.2) 7 (3.3) 1, 5
Planet	(3.2) 1, 6, 8, 9 (3.3) 1, 2

* There will be spillover effects from the applications to all three sustainability elements

4. Concluding remarks

Freight logistics is a critical integrator of macroeconomic production factors. As such, the discipline requires elevation to the macroeconomic realm, both in terms of measurements and strategic national attention, i.e. a formal transition to macro logistics. The concept is well understood in expert circles such as the World Bank's Logistics Performance International Observatory, yet recognition on country-level throughout most of the world is sorely lacking. The annual measurement of logistics costs in South Africa is an ideal case study in this regard. Consistent measurement, reporting and interpretation elevated the country's national logistics challenges to public and private boardrooms, allowing for critical debate and triple bottom line applications. Formal macro logistics measures for *planet, people* and *profit* however have to be agreed on, developed and tracked annually, in line with other macroeconomic indicators.

5. References

Ash, P. 2015 Transnet gears up to recapture freight from road, http://www.railjournal.com/index.php/freight/transnet-gears-up-to-recapture-freight-from-road.html.

Batwell, J. 2012. Transnet Unveils Market Demand Strategy. http://www.railwaysafrica.com/vn/2012/07/16/transnet-unveils-market-demand-strategy/.

Bensassia, S., Márquez-Ramos, L., Martínez-Zarzoso, I. and Suárez-Burguet, C. 2015. Relationship between logistics infrastructure and trade: Evidence from Spanish regional exports. Transportation Research Part A: Policy and Practice 72: 47–61.

Closs, D.J. and Bolumole, Y.A. 2015. Transportation's Role in Economic Development and Regional Supply Chain Hubs. Transportation Journal 54 (1): 33-54; http://www.jstor.org/stable/10.5325/transportationj.54.1.0033

Diza. F. 2013. Transnet and Imperial Logistics break new ground. http://www.leadershiponline.co.za/articles/BREAKING-NEWS-8920.html.

Dlamini, A. 2010. Rail capacity still falling short of country's needs, says survey. http://www.bdlive.co.za/articles/2010/03/17/rail-capacity-still-falling-short-of-country-s-needs-says-survey?service=print

Elkington, J., 2004, Enter the Triple Bottom Line. In Henriques, A. and Richardson, J. (eds) The Triple Bottom Line: does it all add up. Earthscan: London.

Engblom, J., Solakivi, T., Töyli, J., and Ojala, L. 2012. "Multiple-method analysis of logistics costs." International Journal of Production Economics, 137: 29-35.

Fedderke, J., Perkins, P. and Luiz, J. 2006. Infrastructural Investment in Long-run Economic Growth: South Africa 1875-2001. World Development, 34(6): 1037-1059.

Finweek. 2013. Transnet and Barloworld collaborate in road to rail migration. 24 October 2013. http://finweek.com/2013/10/24/corporate-news-transnet-and-barloworld-collaborate-in-road-to-rail-migration/.

Fourie, J. 2008. A note on infrastructure quality in South Africa. Development Southern Africa, 25(4), October.

Fredendall, L.D. and Hill, E. 2001. Basics of Supply Chain Management. Florida: The St. Lucie Press, Bocka Raton.

Gourdin, K.N. 2001. Global logistics management: a competitive advantage for the new millennium. Oxford, Blackwell Publishing Limited.

Guttal, S. 2012. The urgent need for a paradigm shift. Forum for Development Studies, 39(1): 125-130.

Havenga, J.H. 2007. The development and application of a freight transport flow model for South Africa. Dissertation presented for the degree of Doctor of Philosophy (Logistics Management), Stellenbosch: University of Stellenbosch.

Havenga, J.H. 2010. Logistics costs in South Africa – The case for macroeconomic measurement, South African Journal of Economics, 78(4): 460-478.

Havenga, J.H. 2012. Rail renaissance based on strategic market segmentation principles. Southern African Business Review 16(1): 1-21.

Havenga, J.H. in press. Macro logistics and externality costs trends in South Africa – underscoring the sustainability imperative. International Journal of Logistics Research and Applications.

Havenga, J.H. and Simpson, Z. 2013. 10th Annual State of Logistics Survey for South Africa: Bold Steps Forward. http://www.csir.co.za/sol/docs/10th_SoL_Bold_Steps_Forward_web.pdf.

Havenga, J.H., Simpson. Z. and De Bod, A. 2012. South Africa's Domestic Intermodal Imperative. Research in Transportation Business and Management, 5:38-47.

Havenga, J.H., Simpson, Z.P., De Bod, A. & Viljoen, N.M., 2014, South Africa's rising logistics costs: An uncertain future. Journal of Transport and Supply Chain Management 8(1), Art. #155, 7 pages. http://dx.doi.org/10.4102/jtscm.v8i1.155

Heinberg, R. 2011. The end of growth: Adapting to our new economic reality. British Columbia: New Society Publishers.

Klaus, P and Müller, S (eds.). 2012. The roots of Logistics. A reader of classical contributions to the history and conceptual foundations of the science of logistics. Berlin Heidelberg: Springer-Verlag.

Lakshmanan, T.R. and Anderson, W.P. 2002. Transportation infrastructure, Freight Services and Economic Growth: A Synopsis of a White Paper. The US Department of transportation, Federal Highway Administration, Washington.

Limão, N. and Venables, A.J. 2001. Infrastructure, Geographical Disadvantage, Transport Costs and Trade. In The World Bank Economic Review, 15(3), Oxford University Press.

Mahlalela, G. 2011. Statement by George Mahlalela, Director-General of the Department of Transport, on plans to split Transnet to boost the ailing rail sector. 25 August. http://www.polity.org.za/article/sa-statement-by-george-mahlalela-director-general-of-the-department-of-transport-on-plans-to-split-transnet-to-boost-the-ailing-rail-sector-25082011-2011-08-25.

Manrodt, K., and Holcomb, M. 2011. 20th Annual trends and issues in logistics and transportation study – Operating in the new normal. http://www.manrodt.com/pdf/Normal_2011.

McKinnon, A.C. 2009. The present and future land requirements of logistical activities. Land Use Policy, (26S): S293-S301.

McKinnon, A., Piecyk, M. and Validi, S. 2014. The role of external factors in the decarbonisation of companies' freight transport operations: German and UK perspectives. Paper presented at the LRN Conference, 3-5 Sep, Huddersfield.

Nogales, A. 2015. In search of evidence to define transport policies - Transport sector data management systems: policy note & guidelines. SSATP (Africa Transport Policy Program). Working Paper no. 104. http://www.ssatp.org/sites/ssatp/files/publications/SSATPWP104-TSDMS_0.pdf

Piecyk, M., and McKinnon, A.C. 2007. Internalising the External Costs of Road Freight Transport in the UK. Edinburgh: Heriot-Watt University.

Rantasila, K., and Ojala L. 2012. Measurement of National-Level Logistics Costs and Performance: Discussion Paper 2012-04. Paris: International Transport Forum at the Organisation for Economic Co-operation and Development (OECD).

Ravn, M.O. And Mazzenga, E. 2004. International business cycles: The quantitative role of transportation costs. Journal of International Money and Finance, 23. Elsevier.

Rodrigues, A.M., Bowersox, D.J. and Calantone, R.J. 2005. Estimation of global and national logistics expenditures: 2002 data update. Journal of Business Logistics, 26(2): 1-16.

Serhat, B. and Harun. S. 2011. Analyzing the Dependency Between National Logistics Performance and Competitiveness: Which Logistics Competence is Core for National Strategy? Journal of Competitiveness | Issue 4/2011: 4-22.

Simpson, Z. and Havenga, J. 2010. Revitalisation of branch lines In South Africa: A long-term view for sustainability. Journal of Transport and Supply Chain Management 4(1): 243-254.

Smith, N. 2012. Second thoughts over split of Transnet Freight Rail. 17 September. http://www.bdlive.co.za/business/transport/2012/09/17/second-thoughts-over-split-of-transnet-freight-rail.

Sustainable Aotearoa New Zealand. 2009. Strong sustainability for New Zealand: Principles and Scenarios. New Zealand: Nakedize Limited

Swarts, S., King, D., Simpson, Z., Havenga, J., and Goedhals-Gerber, L. 2012. Calculation of freight externality costs for South Africa. Journal of Transport and Supply Chain Management, 4 (1).

Transnet. 2015. 1064 funding announcement. Esselenpark. 2 March 2015.

http://www.transnet.net/PressOffice/Press%20Office%20Release/Transnet%201064%20Funding%20Announcement.pdf

Treasury. 2015. Estimates of national expenditure 2015 – Abridged version. www.treasury.gov.za/documents/national budget/2015/ene/FullENE.pdf

UNCTAD, UN-ESCAP and UNECA. 2012. Cross-border and transit transport process management – CT-TPM toolkit. Reference material. United Nations.

United Nations. 1987. Report of the World Commission on Environment and Development: Our Common Future. http://www.un-documents.net/our-common-future.pdf

United Nations. 2002. Commercial Development of Regional Ports as Logistics Centres. New York: United Nations Publications.

World Trade Organisation. 2004. World Trade Report 2004: Coherence. www.wto.org/english/res_e/publications_e/wtr04_e.htm