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Title: Research priorities for sustainable branch line revitalisation in South Africa

Theme: Beyond today's infrastructure

ABSTRACT

In June 2010 the holding company of South Africa's national railroad announced its intent to concession its 7300 km of branch lines in an attempt to focus on its core business while unlocking potential value for smaller operators. The research presented in this paper demonstrates the importance, when taking decisions on the concessioning or closure of branch lines, of understanding potential current and future flows, as well as considering the impact on sustainability by analysing freight transport externalities and road usage costs. The research results reveal considerable volume opportunities for branch lines which, if captured, will significantly reduce both the direct transport costs for this traffic as well as externality charges for the economy. This will therefore not only render rural economies more competitive but also enable the provision of more sustainable freight transport to these communities. The research approach will be of value to researchers in both developed and developing economies to inform the continuous debate regarding the role of rail in sustainable transport provision.

1. INTRODUCTION

In June 2010 the holding company of South Africa's national railroad announced its intent to concession some 7000 km of branch lines in an attempt to focus on its core business while unlocking potential value for smaller operators (Ash, 2010). The appropriate management of this process is critical to facilitate the development of South Africa's "second" economy, specifically the drive to develop a considerable number of South Africa's 3 million subsistence farmers, who are often within geographic reach of a branch line, to commercial farmers. In addition, some of the lines are currently not utilised and recommissioning of some, if not all, of the lines will lead to job creation.

The debate surrounding branch lines is not unique to South Africa. As a case in point, the New South Wales Grain Freight Review (Australian Government, 2009) recommended in 2009 that the majority of the region's grain branch lines should be retained, and also highlighted the important funding roles of both government and industry. The study highlighted that the cost of road provision and maintenance will be well above the capital injection and maintenance expenditure to keep branch lines operational. In addition, it is between one-and-a half to two times more expensive to transport grain to a consolidation centre by road compared to rail. The revitalisation of branch lines as a means of providing sustainable local freight transport solutions is also a continuous endeavour in the United

Kingdom (see for example Merseyside Transport Partnership, 2009; Devon County Council, 2002) and the United States (see for example Wisconsin & Southern Railroad Co, 2004; Connecticut Department of Transport, 2010).

This proposed shift to rail transport is aligned with the global renaissance in rail (Friends of the earth, 2000: 5), mainly driven by the desire to increase the sustainability of freight transport by reducing associated intrinsic and extrinsic costs. In the United Kingdom, a modal shift from road to rail transport is regarded as one of the government's core policy goals to promote environmentally sustainable development (Haywoood, 2007). The differences between road and rail transport costs are significant. According to Ballou (2004: 168) in the United States the total cost of road transport is as much as 12 times more than that of rail transport. Kwan & Knutsen (2006) established that with one gallon of fuel one ton of goods can be carried only 96 km by truck compared to 325 km by rail. In addition, road transport costs are mostly variable and exposed to volatile exogenous core cost drivers for example the price of fuel (Pietrantonio and Pelkmans, 2004; Havenga et al., 2009.)

The research presented in this paper reveals the significant potential volumes available for transport on identified branch lines and suggest that both from a logistics cost savings and development perspective, identified branch lines can be a viable business in the future if higher densities can be achieved on rail. The externality challenge has prompted reaction from South Africa's Department of Transport (DoT) when it considered the condition of rural roads. The DoT announced intentions to reduce axle limits on rural roads in a bid to relieve the burden on the country's secondary road infrastructure (Fleetwatch, 2009). The impacts of externalities as well as proposed legislative changes in axle limits are presented. From a development perspective, stakeholders need to reconsider branch line divestment if these lines give rural traffic access to main lines (Bechtel SAIC Company LLC, 2006: 8). This link between branch line and corridor traffic for South Africa is also discussed.

2. RESEARCH APPROACH

In order to analyse branch line potential, current and potential rail and road freight transport volumes and costs had to be determined. Rail data is available from the national railroad, but road data is not measured officially in South Africa. In order to develop road data an extensive freight flow model was developed for South Africa. This was done through the gravity modelling of total freight flows in the economy based on supply and demand data for 62 commodity groups and 356 magisterial districts, and subtracting rail, coastal, pipeline and conveyer belt flows. The remaining flows are road flows of commodities between specific origin-destination pairs which were then translated into costs. This granularity was critical to enable detailed analysis of South Africa's freight transport demand. The model also contains a 30-year forecast. (Refer Havenga, 2007, for a detailed description of the model).

To determine potential traffic for the branch lines, road flows in the vicinity of branch lines were also analysed. As mentioned, traffic flows in South Africa is determined as flows between magisterial districts (MD's). For each magisterial district a centre point is determined. In order to analyse potential branch line flows these centre points are related to the rail network. This relationship is illustrated in Figure 1.

The resulting flows are classified into four network groups as summarised in Table 1. In cases where the branch line is very short or where traffic would only need to use a short portion of the branch line before connecting to the core line, the assumption was made that any potential traffic of this nature would rather use road transport to connect to the core line.

Externalities were calculated by using the freight flow information developed by Havenga (2007) and Jorgenson's methodology. Because of a serious lack of freight transport cost information in South Africa that evaluates externalities Jorgenson (2009: 2) investigated external transport costs in a number of countries where localised or general conditions are considered to be similar to South Africa. To achieve a representative cross-section of South African transport a group of rural branch line railways and roads in KwaZulu Natal were examined and conclusions drawn that were used to make comparisons to other important corridors or to rural areas.

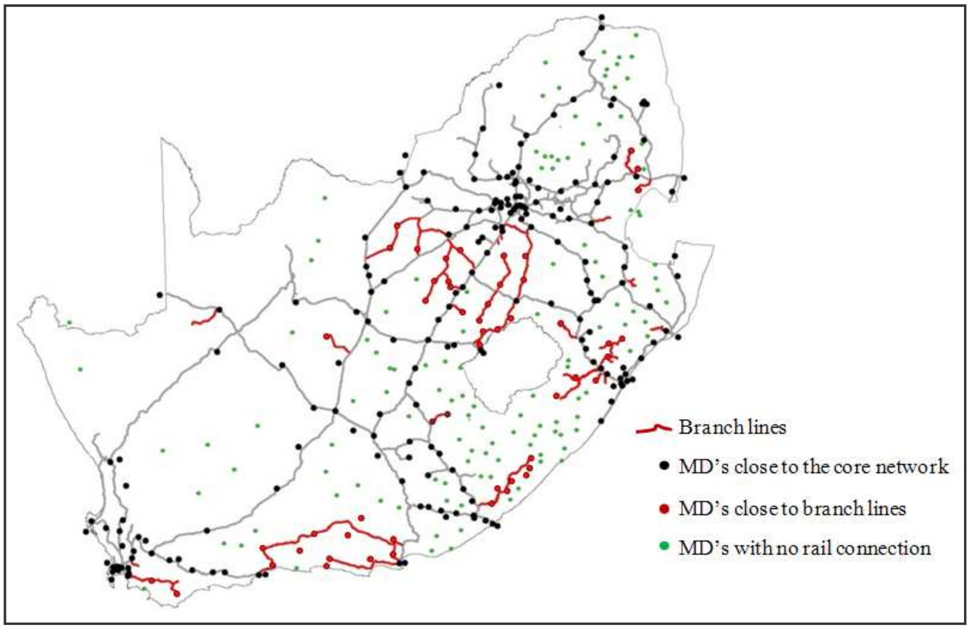
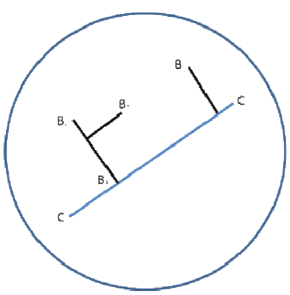


Figure 1: The relationship between magisterial districts and branch lines

Table 1: Classification of total potential branch line related traffic



Code	Description for potential traffic	Flow
B	**B**ranch - Originates and ends on the same branch line	B_1 to B_4
BB	**B**ranch-to-**b**ranch: Utilises two branch lines, but not the core line	B_1 to B_2
BC or CB	**B**ranch-to-**c**ore: Originates on a branch line and terminates on the core line (*or vice versa*)	B_1 to C_1
BCB	**B**ranch-**c**ore-**b**ranch: Originates on a branch line, travels some distance on the core line and then utilises a second branch line	B_1 to B_3

3. RESEARCH RESULTS

Potential branch line traffic

Of South Africa's 935 million tons of total surface freight transported, 66 million tons or 7% travels next to or on branch lines. (This figure is similar in tonkilometre terms, with approximately 8.5% of tonkilometres related to branch lines). The relationship between this traffic and total traffic in South Africa is depicted in Table 2.

Table 2: Relationship between total traffic and potential branch line related traffic

	Tons (million)	Tonkilometres (billion)	Average Transport Distance
Total SA	935	315	337
Total corridor traffic	240	168	701
Potential traffic that would require a proportion of branch line use:	**66**	**27**	**398**
BB	7	1	75
BC	23	11	506
CB	34	15	460
BCB	2	1	490

This means that if branch lines were closed 66 million tons of traffic that could be transported by rail will be captured by road. Of this traffic, 57 million tons (BC+CB) are potential core line traffic and can contribute to the densification (and cost savings) of the core lines. Of the 66 million tons only 9.1 million tons are currently on rail, as summarised in Table 3.

Table 3: Rail market share of potential branch line traffic

	Total Tons (millions)	Rail Tons (millions)	Total Tonkilometres (billions)	Rail Tonkilometres (billions)	Road ATD	Rail ATD
BB	7.3	1.8	0.5	Neg	69.1	21.8
BC	23.4	4.1	10.5	1.3	449.1	324.5
CB	33.7	3.2	14.5	1.0	431.1	302.9
BCB	2.0	0.1	1.0	Neg	466.9	469.9
All B inclusive	**66.4**	**9.1**	**26.5**	**2.4**		

Only 11% of potential tons shipped encompass a single branch line system (BB). As average transport distances are low for traffic that originates and terminates on the same branch line, only 1.9% of potential tonkilometres are enclosed within a single branch line system. The 2008 cost to transport branch line related traffic amounted to R19 billion (or 11% of South Africa's 2008 transport bill of R171 billion). The branch line transport bill for rail is less than R1 billion (0.5%) of this total.

Rail's role in branch line related transport is therefore currently negligible with 14% of tons, 9% of tonkilometres and 0.5% of costs on rail (

Figure 2). It however also implies that there is significant opportunity available.

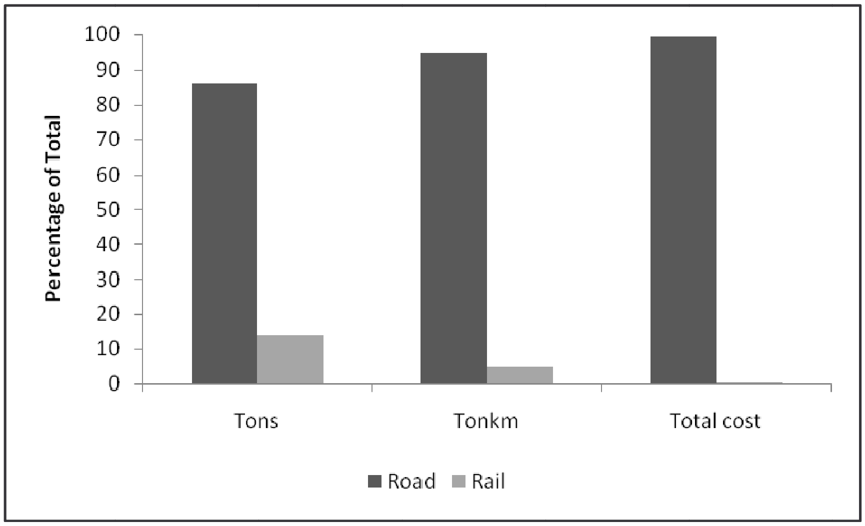


Figure 2: Rail's negligible role in branch line related traffic

This potential could be realised by improving rail's service offering (which is a relatively small cost compared to the fact that the infrastructure already exists) but more importantly through measuring and costing for externalities (*inter alia* through legislation) to ensure sustainable service provision to this traffic.

Switching scenarios – shifting rural freight to rail

Two scenarios for the switching of road traffic next to branch lines were conducted (Table 4), considering variable market share percentages per cargo type. These two scenarios considered the most optimistic achievement of rail (scenario 1, being able to target short distance freight and high market shares), as well as a realistic target (scenario 2, being longer distance freight, with current market shares increased slightly to round numbers).

Table 4: Market share scenarios for switching traffic to branch lines

Scenario 1 = High switching scenario with ATD>100km			**Scenario 2 = Low switching scenario with ATD>500km**	
Automotive	0%		Automotive	0%
Break Bulk	50%		Break Bulk	10%
Dry Bulk	75%		Dry Bulk	25%
Liquid Bulk	25%		Liquid Bulk	0%
Perishables	0%		Perishables	0%

Of the 57 million tons of potential traffic next to branch lines a maximum of 29.3 million tons could move to rail. Of this, only 4 million tons will be enclosed within the same branch line system. The rest of the traffic will require the core network. If this traffic switches, total branch line related traffic will be 38.4 million tons (rail market share of 58%) of which 85% (32.6 million tons) will require the core network (Table 5).

Table 5: Scenarios for switching traffic (million tons)

	Total tons	Total rail tons	Switchable rail tons scenario 1	Switchable rail tons scenario 2	Total rail tons after scenario 1	Total rail tons after scenario 2
BB	7.3	1.8	4.0	1.3	5.8	3.1
BC	23.4	4.1	9.5	2.6	13.6	6.8
CB	33.7	3.2	14.7	3.4	17.9	6.6
BCB	2.0	0.1	1.0	0.3	1.1	0.4
All B	**66.4**	**9.1**	**29.3**	**7.6**	**38.4**	**16.8**

There is therefore significant opportunity available to rail through improved service provision. Appropriate regulation could, however, further improve this position. One option currently being considered is the reduction of the axle mass limit on rural roads to decrease the wear and tear on roads.

Cost impact of proposed axle limit change

The road transport axle limit reduction from 9 tons to 8 tons per axle will have a considerable effect on transport costs. This would require a consignment of 18 tons, which can currently be transported on a double axle truck, to be transported either by two trucks or a 3 axle truck. This will greatly increase the number of vehicles required, number of trips, and running costs. Vehicle types that are now used for specific freight commodities will no longer be optimal, and especially high capacity vehicles, will not be able to reach even close to maximum payload. The road transport costs will be highly affected by such a change. Total road transport costs for traffic in the vicinity of branch lines is expected to increase by R1 billion from R10.3 billion to R11.3 billion if this change is implemented (Figure 3).

If the switch to rail transport presented in the previous section manifests, total transport costs (assuming that commodities can be transported at current rail tariffs), will however be lower. Current branch line related transport costs are R18.8 billion, whilst with the proposed scenarios 1 and 2, it would be R17.6 billion and R18.5 billion respectively (Figure 4).

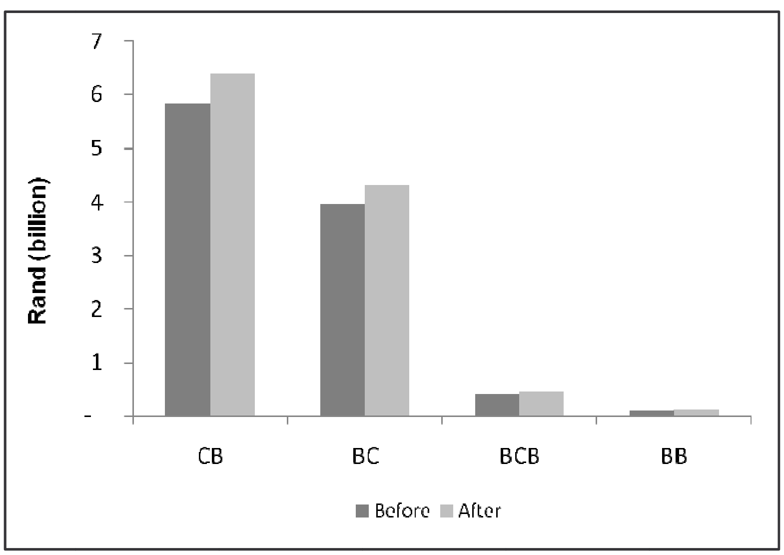


Figure 3: Road transport cost increases per flow type if axle limit change is implemented

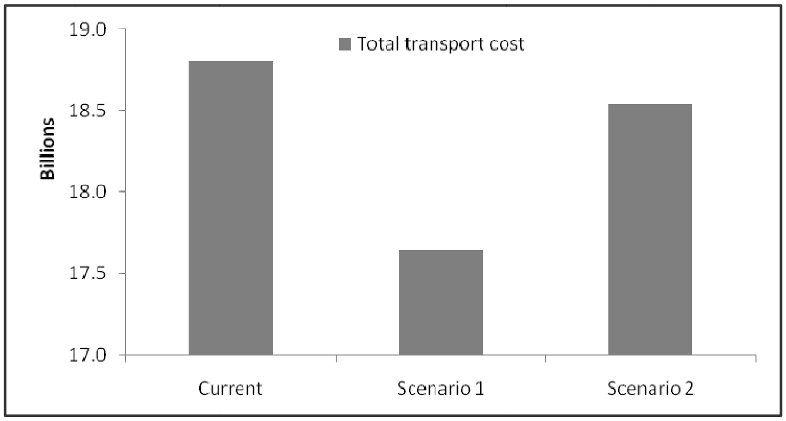


Figure 4: Comparative total transport costs: current vs. scenarios

This means that although road transport costs will increase (a fact that is causing obvious concern for freight owners) improvements in rail service that will make the switch palatable will decrease the total transport bill of the nation.

As discussed in the next section, understanding externalities and costing for these could provide further inducements for a modal shift.

Cost impact of externalities

The branch line related externality costs of R3.8 billion are almost entirely a result of road use (rail's externality costs amount to a mere R38.6 million or 1% of the total). The current externality costs will be reduced by 35% in Scenario 1 (to R2.5 billion) and 8% in Scenario 2 (or R3.5 billion) as illustrated in Figure 5.

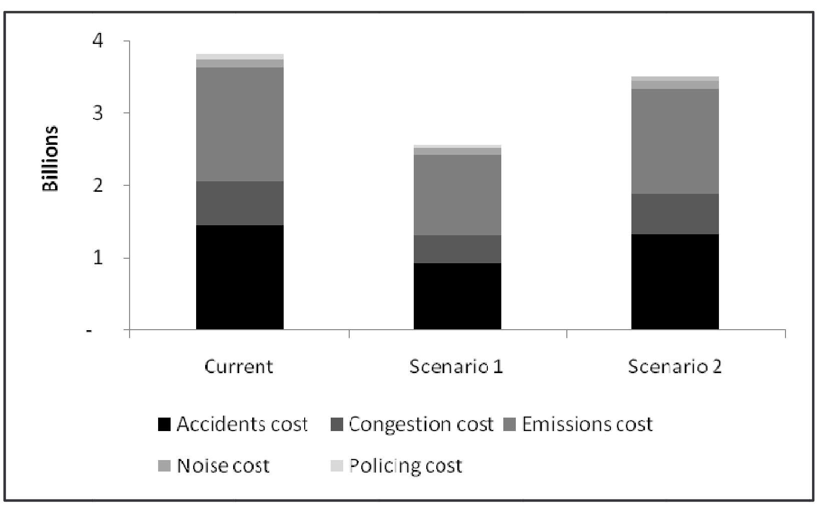


Figure 5: Comparative externality cost components: current vs. switching scenarios

Total transport costs for branch line traffic (with externalities included) will therefore reduce from R22.6 billion to R20.2 billion in Scenario 1 (an 11% reduction) and R22.0 billion in Scenario 2 (a 3% reduction), as depicted in Figure 6.

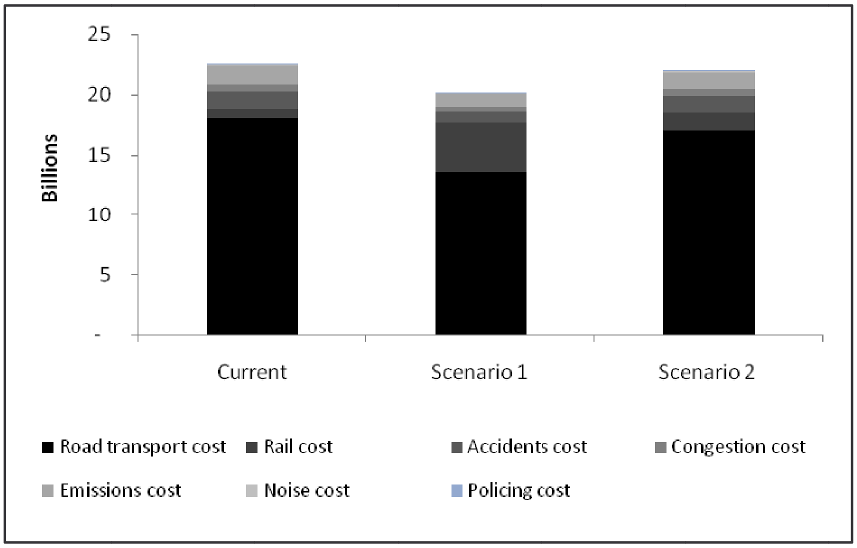


Figure 6: Comparative cost components: current vs. switching scenarios

This means that with an improved service offering, regulation (which is required to protect the pavement surface) and externality accounting, a branch line modal shift will decrease the nation's freight bill substantially.

A view of the future

Future demand (between 5 and 30 years) can be calculated using the model and cost savings determined for the high switch scenario and calculated in today's real monetary value – i.e. the effect of inflation is not considered for both costs and income. The total branch line related tons transported will be 139.9 tons (compared to the current 66.4) and 56.1tonkilometes generated (compared to the current 26.5). The application of the two previously developed scenarios to the higher future volumes point to considerable densification potential for rail, which in turn enables exploitation of rail's significant economies of density (rail's cost savings are exponential with increases in density) (Harris, 1977 and Mercer, 2002). These cost savings are 15% in Scenario 1 and 5% in Scenario 2, as illustrated in Figure 7.

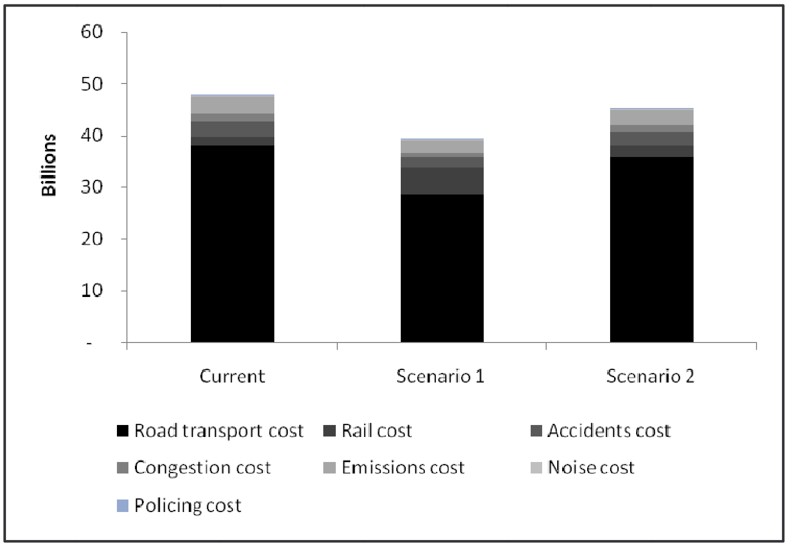


Figure 7: Future comparative cost components: current vs. switching scenarios

These scenarios illustrate the significant cost savings potential if a future view is taken. These savings will only be possible if the branch lines remain in operation because of the prohibitive cost of reviving these lines in future.

4. CONCLUSION

The research illustrated that there are significant volumes available for branch line transport. A switching of these volumes to rail will reduce both transport costs and externality charges, not only rendering this transport more competitive but also more environmentally sustainable due to reduced externalities. The savings (with a shift to rail) become even more considerable if road axle limits are reduced.

It is true that given the current circumstances, i.e. reduced rail capacity due to historic underinvestment, low current rail volumes and the fact that road externality costs are not charged; most branch lines might not be seen as viable. However, supported by government investment and limited subsidies through a concessioning vehicle these lines could, in all probability, become sustainable transport solutions for the future. Short term subsidies to keep branch lines operational might be more cost effective than the investment that would be required for complete rehabilitation in the future.

The research also points to the integrated and "single network" characteristic of South Africa's railway system. Very few branch lines operate in "separate" economic pockets or development areas. Concessioning the lines to different operators is therefore questioned. Finally, a future view of demand and the correct accounting for externalities of road transport illustrate the future viability of branch lines.

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