Tariff and Tariff Rate Quota Liberalization in the South African Livestock Industry: Approaches to Welfare Measurement

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Abstract

The liberalization of the agricultural sector and phasing out of past protection mechanisms in South Africa saw the introduction of a process of tariff reform. Furthermore, a system of tariff rate quotas was introduced in compliance with WTO regulations. This study uses a partial equilibrium comparative static model to measure the welfare effects of further liberalization in the livestock industry of South Africa, particularly in meat products using four policy scenarios. The traditional method of welfare analyses using the CS and PS was applied, while the EV was used to integrate a well-behaved objective function. Although the CS and PS could have over-estimated welfare due to the fact that the demand system used in this study is non-linear, they still gave useful information sufficient to compare the impact of trade liberalization on consumers and producers of livestock products. Furthermore, the EV explains the income change necessary to attain the welfare level resulting from trade liberalization given the current prices. When expressed as a percentage of the real gross national income and real disposable income, the values are quite marginal. The results from both methods of welfare measurement suggest that it is worth considering the effects on producers if further trade liberalization is envisaged in the South African livestock industry.

1. Introduction

The concept of trade has two diverging viewpoints. One involves recognition of the benefits of international exchange, while the other relates to concerns that certain domestic industries could be harmed by foreign competition (Ohlin, 1933; Samuelson, 1962; Porter, 1990). Although notable authors have proven the advantages of free trade theoretically with such arguments as comparative advantage and competitiveness, the world of the late twentieth century, up to the present day, has not been ready to acknowledge and implement a full free market regime. Instead, countries have opted for trade

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blocs (which include Free Trade Areas, Customs Unions, Common Markets and Economic Unions) and trade-restricting instruments (tariffs, quotas and tariff rate quotas).

More importantly, the increasing interdependence of world trade has led to the emergence of policies that affect agricultural trade, albeit in lesser or greater magnitude. Following the progress made at the Uruguay Round Agreements of the General Agreement on Tariffs and Trade (GATT), the World Trade Organization (WTO) has continued to attempt to liberalize agricultural trade further. The ongoing Doha Round, which was planned to conclude in Hong Kong in December 2005, provides another opportunity for trade liberalization, as trading countries are prepared to negotiate at a multilateral level. Measuring the performance of trade liberalization has been difficult, given the existence of the various mechanisms involved. In this regard economic models have been useful, both for the implementation and assessment of trade policies.

In this study the main focus is on the policies used for managing livestock and meat trade in South Africa. The objective is to demonstrate two different techniques used for measuring welfare. However, in order to put the study into proper perspective, it is necessary to describe the tariff regime in the South African livestock industry, as well as give theoretical information on tariff rate quotas.

2. Meat trade and tariff liberalization in South Africa

South Africa remains a net importer of meat. For example, latest statistics (NDA, 2005a) show beef and sheep meat imports as percentage of local production comprise 10 and close to 50 per cent, respectively. Imports are also highly concentrated, coming mainly from the EU and Mercosur countries in the case of beef, pork and poultry, and Australia in the case of sheep meat. However, a recent study by Pustovit and Schmitz (2003) observed that assuming complete liberalization of agricultural policies in all OECD countries, South Africa would be a net exporter of all the major meat products, including beef, pork and poultry. Presently, however, South Africa remains a net importer of most of these products. This observation supports the notion that tariff liberalization in the South African livestock industry needs to be properly studied, understood and monitored.

The liberalization of the agricultural sector and phasing out of past protection mechanisms in South Africa saw the introduction of a process of tariff reform

in compliance with WTO regulations (e.g. Appendix A. Table A1 shows the tariff regime applicable to imports of livestock meat products into South Africa; excluding SACU and SADC).

Also in line with South Africa's WTO commitments, market access quotas provide a basis to comply with minimum access requirements of the Uruguay Rounds (Table A2 in Appendix A shows South Africa's market access commitments in the livestock industry). The minimum market access quota commitments are implemented by imposing a lower in-quota tariff to imports within the quota while imports above this level attract a higher tariff (thus functioning as a tariff rate quota).

Table 1 supplies information about the importance of TRQs in the South Africa livestock industry in value terms. Oyewumi *et al.* (2006) used two indicators to illustrate the importance of TRQs in the South African livestock industry. Firstly, the potential value of imports on the HS8 tariff lines for which TRQs are applicable and their importance relative to total value of imports (column 2). Secondly, the actual value of TRQ imports is represented in value terms. This is done by multiplying the actual quantity of imports under TRQs by the unit price of each product (as in column 4).

Table 1: Relative importance of TRQs to livestock products and TRQ imports by main meat products (2003)

Product	Total imports	Of which: imports of HS8 products for which TRQs are opened	As per cent of total imports	Actual value of TRQ imports	As per cent of total imports	Ratio of actual to potential TRQ imports i.e. fill rate
	1	2	(3) =(2)/(1)	4	(5) = (4)/(1)	(6) = (4)/(2)
	Rand ('000)	Rand ('000)	%	Rand ('000)	%	%
Meat of bovine animals	280,000	185,878	66	163,180	58	88
Meat of swine	113,066	35,511	31	35,511	31	100
Meat of sheep	64,823	29,350	45	29,350	45	100
Meat and edible offal of poultry	551,105	104,519	19	104,519	19	100
Total	1,008,994	355,258	35	332560	33	94

Oyewumi, *et al.* (2006).

The above analysis shows that of all imports of meat products in South Africa in 2003 (which is worth about R1.01 billion), TRQs were used to administer 35% (worth about R0.36 billion). It should be noted that this is a substantial amount considering the fact that total imports included those from the SACU countries which attract a zero tariff.

At a product-specific level, TRQs opened for bovine meat covered a greater value of trade than those of the other products. The value of TRQ imports of the meat and edible offal of poultry followed while sheep meat carries the lowest value. However, as a percentage of total imports, TRQs applicable to sheep meat followed those of bovine meat, ahead of swine meat and, meat and edible offal of poultry, respectively.

In terms of actual imports under TRQs, all the products except bovine meat carry the same value as the potential value of the TRQ opened for the respective products (as shown by column 4). The implication is that all the products, except bovine meat have a fill rate of 100 per cent (shown by Column 6), reflecting the spirit of the URAA. Also the result shows that meat of bovine animals is the most sensitive of the livestock products traded. Overall, the average quota fill rates expressed in value terms was 94 per cent.

3. Theoretical background

A TRQ is a trade policy instrument which is basically a two-tier tariff on the import of a commodity. Figure 1 shows how a tariff rate quota works and how it can influence the incentive to import. A certain amount of the commodity/product may be imported at a lower tariff, the so-called in-quota tariff (T_{iqt}). Imports exceeding this quantitative import quota are taxed at a higher tariff, the so-called over-quota tariff (T_{oqt}).

Four possible outcomes of increasing levels of import demand can be observed in Figure 1. No trade occurs at M1 because domestic demand (D_1) is insufficient to support imports at world prices (W). At M2, the quota is not binding ($M2<Q_{mac}$), although domestic excess demand (ED_1) is sufficient to result in imports of M2. Moreover, domestic excess demand that results in imports is not high enough to cause the quota to bind at Q_{mac}, therefore the tariff quota functions as an ordinary tariff. If domestic excess demand is represented by ED_2 and imports are equal to M_3, the quota becomes binding and quota rents (equal to area $PABW(1+T_{iqt})$ will be generated. If a tariff quota did not exist and a tariff was merely applied at the in-quota rate imports of M4 would result, whereas in the case of free trade, i.e. a tariff applied at the rate of zero, imports of M5 would result. If domestic exces

demand is represented by ED_3, imports of M6 will be realized and T_{oqt} will be applied to imports in excess of the quota.

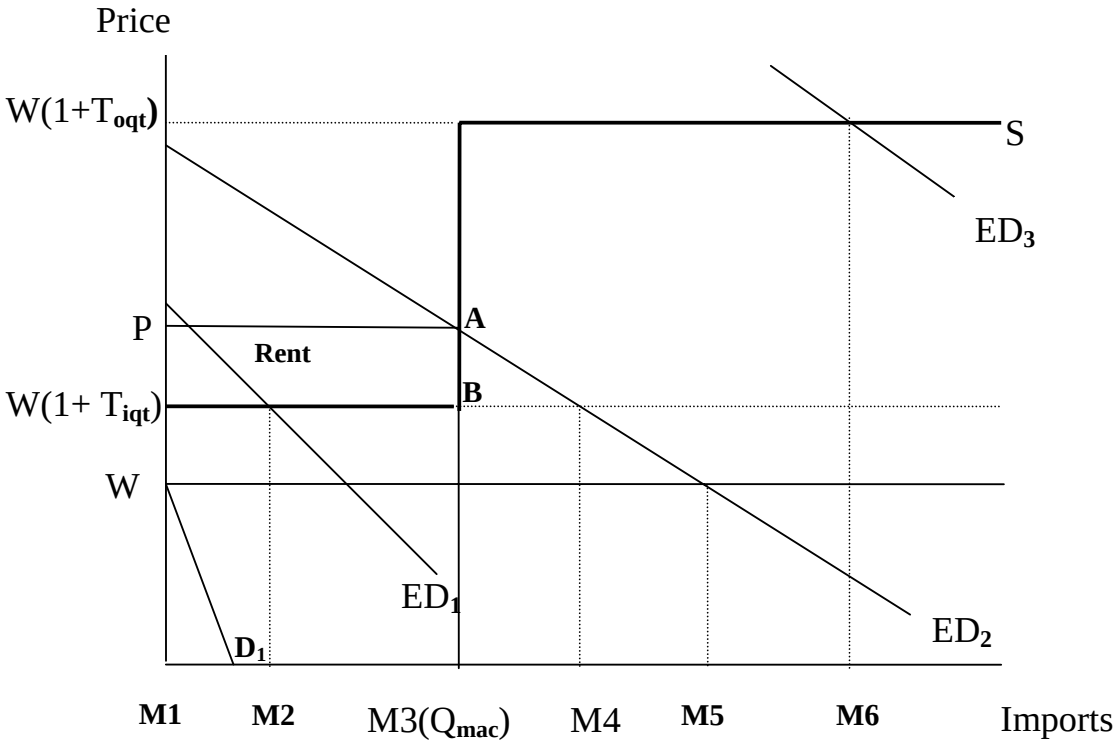
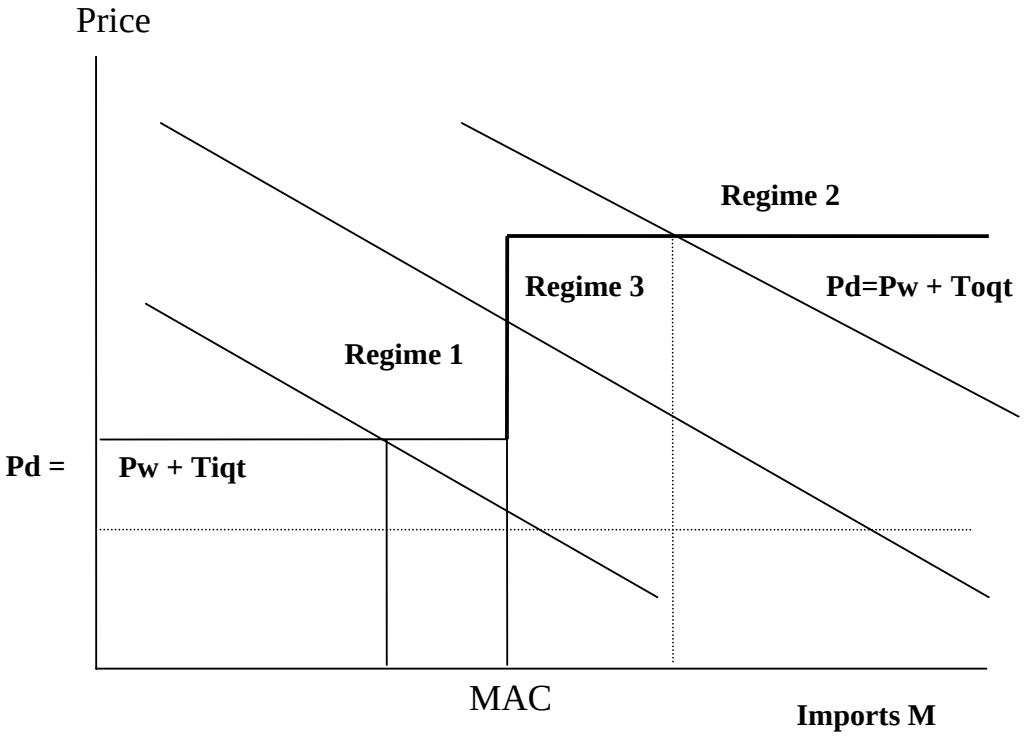


Figure 1: Effect of tariff rate quotas on import demand

Figure 2 shows three possible alternative trade regimes under TRQs (Abbott and Morse, 2000). In the case of the regime 1 weak demand results in net import demand being less than the minimum access commitment (Q_{mac}). Thus, the domestic price is the sum of the world price and the low in-quota tariff (i.e. $Pd=P_w+T_{iqt}$). This therefore functions as a pure tariff. Regime 2 functions as a pure TRQ. Due to strong demand, imports exceed the Q_{mac}. Thus the domestic price is the sum of world price and the MFN tariff, i.e. $P_d=P_w+T_{oqt}$. This was the original intent for introducing TRQs. The third alternative (regime 3) functions as a quota. Due to a "prohibitive" MFN tariff, imports exceed the minimum access requirements at the lower in-quota tariff, but lower than the minimum access requirement at the MFN tariff. Therefore, the domestic price lies in between the world price plus the in-quota tariff and the world price plus the MFN tariff.



Regime 1: Pure tariff **Regime 2: True TRQ** **Regime 3: Quota**

Figure 2: Alternative TRQ regimes

There is a belief that, if market access improvement focuses on successive reductions in MFN tariffs, it has the potential of eliminating TRQs (Matthews and Laroche-Dupraz, 2002). Nevertheless, since its introduction TRQ has continued to generate research interest and debate. Several studies have examined the effectiveness of TRQs in granting market access (Abbort and Paarlberg, 1998; Abbott and Morse, 2000; Boughner, De Gorter and Sheldon, 2000; Skully, 2001; Matthews and Laroche-Dupraz, 2002; Walkenhorst and Dihel, 2003; Khorana, 2004). Noteworthy is that Abbort and Morse (2000) are strongly of the opinion that at the time of introduction of TRQs many did not fully understand the working of the two-tier tariff.

Despite mixed perceptions about TRQ usage for market access it is certain to continue forming part of agricultural trade negotiations, as shown by discussions at the 2002-2003 preparations for "modalities", where the major part of the discussions about market access focused on TRQs and related subjects (WTO, 2004).

4. Methodology

The model takes the year 2000 as its base. Data on prices of domestic products were obtained from the South African Meat Industry Company (SAMIC) and the Annual Report of the South African Poultry Association (SAPA). Elasticities were obtained from Taljaard (2003) and Meyer (2003). Other data were sourced severally from the National Department of Agriculture.

The overarching approach followed in this study is in line with the work of Takayama and Judge (1971). This approach allows for sectoral analyses of allocation of resources among spatially separated market. The model is spatial partial equilibrium in nature and consists of the primary (beef cattle, broilers, pigs, and sheep) and secondary (poultry, beef, pork and sheep meat) sub-sectors. Furthermore the model delineates South Africa into its nine provinces, as well as neighbouring important meat producers – Namibia and Botswana. The model explicitly incorporates the processing level (that is the slaughtering process) within a regionalized framework (see Oyewumi, 2005 for definitions of the behavioural functions and parameters).

4.1 Welfare measurements Methodology and data used

The traditional measurement of welfare uses the consumer and producer surplus concepts. The consumer welfare (CS) measures the difference between what consumers are willing to pay for a good and what he/she actually pays. Moreover, it can be used to measure the effect on the consumer's welfare of a change in price of a good, ceteris paribus. Producer's surplus (PS), on the other hand, measures the effect on the producer's welfare of a change in price of a good, *ceteris paribus*. In order to measure welfare using CS and PS, a quadratic programming approach was involved.

The consumer surplus was represented as follows:

$$\textbf{Equ (1)} \quad CSURP_{is}^{r} = -\tfrac{1}{2}\sum_{is} bd_{is,is}^{r} QD_{is}^{r} QD_{is}^{r}$$

The producer surplus was represented as follows:

$$\textbf{Equ (2)} \quad PSURP_{ip}^{r} = -\tfrac{1}{2}\sum_{ip} bs_{ip,ip}^{r} QS_{ip}^{r} QS_{ip}^{r}$$

where;

QS_{ip}^{r} **=** the endogenous quantity supplied of the primary commodity ip in region r.

QD_r^{is} = the endogenous quantity demanded of the secondary commodity *is* in region *r*.

$bs_{ip,ip}^r$ = the slope coefficient of the supply function of primary commodity *ip* in region *r*.

$bd_{is,is}^r$ = the slope coefficients for the demand function of secondary commodity *is* in region *r*.

$CSURP_{is}^r$ = consumer surplus

$PSURP_{ip}^r$ = producer surplus

An alternative approach to CS and PS is the equivalent variation (see for example Huff and Hertel, 2001; McDougall, 2002; Britz, 2003 and Berrittella, 2004), which can be used to integrate a well-behaved demand system to welfare analysis, as an extension of the Takayama-Judge type spatial equilibrium models. The equivalent variation (EV) measures the income change necessary to reach at simulated prices the same utility level as at original prices. This is presented mathematically from the expressions in Appendix B as:

Equ (3)

$$\begin{aligned} & + \sum_r Pop_r Equ\,\mathrm{var}_r \\ & - \sum_i^r QS_i^r \left(as_i^r + \tfrac{1}{2} \sum_j bs_{i,j}^r - QS_j^r \right) \\ & - \sum_i^r QC_i^r \left(ac_i^r + \tfrac{1}{2} \sum_j bc_{i,j}^r QC_j^r \right) \\ & - \sum_{r,i}^{r'} x_{r,i}^{r'} impprice_{r,i}^{r'} - \sum_{r,i}^{r'} x_{r,i}^{r'} tc_{r,i}^{r'} \end{aligned}$$

The objective function comprises equivalent variation (first line), minus production costs as the integral under the marginal cost function (second line), minus slaughtering costs and profits as the integral under the marginal variable cost function of the slaughter houses (third line), minus imports and transport costs.

where:

Pop_r = population by region

$PerCap_i^r$ = per capita demand per commodity per region

$EquVar_r$ = Equivalent variation in by region

PP_i^r = Producer prices per commodity per region

PD_i^r = Demand prices per commodity per region

$imprice_{r,i}^{r'}$ = Import price per commodity per importing region

$x_{r,i}^{r'}$ = Transport flow of commodity to regions

The objective function is subject to the following constraints:

$$(a)\, QS_i^r + QC_i^r + \sum_{r'} x_{r,i}^{r'} = QD_i^r + \sum_{r'} x_{r,i}^{r'}$$

$$(b)\, PP_{ip}^r = as_{ip}^r + \sum_j bs_{i,j}^r * QS_j^r$$

$$(c)\, PP_{is}^r + PD_{ip}^r = ac_{is}^r + \sum_j bc_{i,j}^r . QS_j^r + \sum_{ip} PD_{ip} / p\_to\_f_{ip}^{is}$$

$$(d)\, QD_i^r = PerCap_i^r Pop_r$$

$$(e)\, PerCap_i^r = d_i^r + \left(\frac{\sum_j B_{i,j}^r \sqrt{\frac{PD_j^r}{PD_i^r}}}{\sum_j \sum_k B_{j,k}^r \sqrt{PD_j^r PD_k^r}} \right) \left(PerCapIncome - \sum_i D_i^r PD_i^r \right)$$

$$f)\, EquVar_r = \left(\frac{\sum_j \sum_k B_{j,k}^r \sqrt{PD^{r,b}{}_j PD^{r,b}{}_k}}{\sum_j \sum_k B_{j,k}^r \sqrt{PD_j^r PP_k^r}} \right) \left(PerCapIncome - \sum_i D_i^r PD_i^r \right) - \left(PerCapIncome - \sum_i D_i^r PD^b{}_{r,i} \right)$$

where:

as_r^{ip} = the intercept coefficient for the supply function of primary commodity ip in region r.

ac_r^{is} = the intercept coefficient for the demand function of secondary commodity is in region r

$p\_to\_f_{ip}^{is}$ = conversion factor from primary to secondary products

$d_i^r, D_i^r, B_{j,k}^r$ = parameters of the marshallian demand system.

Constraint (a) is the market clearing identity, and equations (b) to (d) state that marginal willingness to pay respective marginal costs are equal to prices. Equation (c) states that the prices for meat are equal to the marginal costs to operate the slaughterhouses plus the price of the slaughtered animal per ton of meat produced. It can be easily checked that the derivative of the objective function for the quantity variables (meat demand, supply, and animal slaughter) returns the prices comprised in constraints (b) to (d).

5. Results and discussion

This section reports the result of welfare measurements using the two methods highlighted above. The four scenarios simulated include:

- A 33 per cent expansion of quota.
- A 33 per cent decrease in MFN ad-valorem tariffs.
- A scenario combining the two reforms described above.
- Full liberalization scenario with all tariffs set to zero.

5.1 Consumer and producer surplus measures

Table 2 shows the consumer and producer surpluses for the four liberalization scenarios.

Table 2: Welfare change as a result of the four liberalization scenarios

Region	Consumer surplus				Producer surplus			
	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 1	Scenario 2	Scenario 3	Scenario 4
	Total monetary change (Million rand)							
Western Cape	36.0	92.7	118.0	292.6	-5.8	-16.0	-20.0	-46.9
Northern Cape	5.4	16.4	21.0	52.5	-4.6	-13.3	-16.9	-39.8
Free State	13.9	42.5	54.5	134.6	-13.6	-38.7	-48.9	-115.4
Eastern Cape	24.5	66.4	83.8	204.2	-12.5	-35.6	-45.2	-106.4
KwaZulu-Natal	35.9	98.2	124.3	303.1	-13.8	-39.4	-49.6	-117.6
Mpumalanga	17.2	56.0	72.1	183.7	-9.2	-25.3	-31.9	-75.79
Limpopo	30.9	25.0	29.8	79.4	-6.1	-17.0	-21.4	-50.9
Gauteng	54.9	159.4	204.6	516.3	-3.3	-8.9	-11.3	-26.7
North-West	12.1	35.5	45.5	114.4	-8.7	-25.9	-32.7	-77.4
South Africa	230.8	592.1	753.6	1880.8	-77.6	-220.1	-277.9	-656.89

The results are summarized as follows:

- In terms of scenario 1, consumers will experience welfare gains of R230.8 million. This translates into a 0.04 per cent increase in real gross national income or 0.06 per cent increase in real disposable income. Producers' welfare will drop by a total of R77.6 million. The loss in producers' welfare will be more pronounced in KwaZulu-Natal, Eastern Cape and the Free State – the three provinces that contribute the largest share of South Africa's total livestock production (NDA, 2005a). Relative to the real gross farm income, the total loss in producer

welfare is 0.24 per cent, while it represents 0.96 per cent of real net farm income.

- The welfare implications of a 33 per cent reduction in MFN tariffs amount to an increase in consumer welfare of R592.1 million, while producers' welfare will decline by R220.1 million. The welfare change to consumers amounts to only a 0.10 per cent increase in real gross national income or a 0.16 per cent increase in real disposable income. As a percentage of the real gross farm income, the total loss in producer welfare is 0.69 per cent, while it represents 2.7 per cent of real net farm income.

- A combination of the policies in scenarios 1 and 2 (i.e. Scenario 3) will result in a welfare gain to consumers amounting to R753.6 million, while the total loss to producers' will be R277.9 million. The total welfare gain to consumers' amounts to a 0.13 per cent increase in real gross national income or 0.20 per cent increase in real disposable income. Welfare loss to producers translates into a drop of 0.87 per cent in real gross farm income or 3.4 per cent in real net farm income.

- A complete removal of tariffs on consumers will result in a welfare increase of R1 880.8 million. This amounts to only a 0.33 per cent increase in real gross national income or a 0.50 per cent increase in real disposable income. On the producers side welfare will drop by a total of R656.89 million. This represents a drop of 2.05 per cent in real gross farm income or 8.1 per cent in net farm income.

Evidently, the tariff and TRQ liberalization will result in net welfare gains to the society, but the impact on the agricultural sector would be much more substantial in relative terms.

5.2 Equivalent variation

Equivalent variation is a measure of how much more money a consumer would need before a price decrease to be just as well off after the price decrease. Moreover, in the context of this paper the EV, at current prices, shows by how much the consumer would benefit if a policy change results in change in prices.

Table 3 shows the equivalent variation due to potential policy changes expressed by the four scenarios. In respect of scenario 1, at current prices consumers would have to be given R60.6 million to make them benefit from

the price fall. Consumers in the Western Cape, Gauteng, Northern Cape and Mpumalanga require the largest change in income. Expressed as a percentage of real gross national income it translates into 0.01 per cent change or 0.02 per cent change in real disposable income under this scenario.

Table 3: Equivalent variation as a result of the four trade liberalization scenarios

Region	Scenario 1	Scenario 2	Scenario 3	Scenario 4
	Total monetary change (Million rand)			
Western Cape	9.4	25.0	35.5	73.2
Northern Cape	8.5	22.5	28.2	65.4
Free State	7.1	18.8	23.6	54.9
Eastern Cape	5.1	13.4	16.8	39.0
Kwazulu-Natal	5.5	14.5	18.2	42.3
Mpumalanga	8.4	22.3	28.0	65.2
Limpopo	2.5	6.6	8.3	19.4
Gauteng	8.8	23.3	29.3	68.0
North West	5.3	14.0	17.6	40.8
South Africa	60.6	160.4	205.5	468.2

In terms of scenario 2, at current prices consumers would have to be given R160.4 million to make them benefit from the price fall. In relative terms, the equivalent variation represents a change of 0.03 per cent in the real gross national income or 0.04 per cent in real disposable income.

The equivalent variation due to the combined effect of quota expansion and the reduction of ad valorem MFN tariff (scenario 3) amounts to R205.5 million. Consumers in the Western Cape will require the most increase in income while consumers in Limpopo will require the least increase in income. In relative terms, the equivalent variation represents a change of 0.04 per cent in the real gross national income, or 0.05 per cent in real disposable income under this scenario.

In a scenario of full liberalisation, at current prices income would have to rise by R462.8 million to make consumers benefit from the price fall. In relative terms, the equivalent variation represents a change of 0.08 per cent in the real gross national income, or 0.12 per cent in real disposable income. It should be noted that although trade liberalization in this sector has potential for consumer welfare gains, the effects of such policies on production, profitability and livelihood should be taken into account.

6. Conclusions

The study employed two distinct approaches to measure welfare. Both results confirm that tariff and TRQ liberalization will lead to welfare gains to the society. However, cognisance should be taken that CS and PS estimations assume quasi-linearity of the demand and supply curves, whereas the model used in this study accounts for the non-linearity of demand and supply curves. Hence, the CS and PS estimates could be an over-estimation of the welfare impacts. Nevertheless, this method provides a useful indication of the relative impact of tariff and TRQ liberalization on producers as well as consumers of meat products.

The second approach (using equivalent variation) is more appropriate given the functional forms specified for the parameters used in this model. It should be noted that the income change necessary to bring consumers to the same level of utility as in the simulated liberalization scenarios are quite small in all cases. This is even more evident if one measures the impact on a per capita basis. This is not to downplay the importance of trade liberalization in maintaining competitiveness in the industry. Equally important is that economic theory supports the notion that unilateral liberalization is more advantageous than no liberalization.

In order to make well-informed policy decisions that balance the interests of both consumers as well as producers, it was necessary to investigate the relative effects of these scenarios on consumers and producers. Taking this into consideration, the gains to consumers were related to the real gross national income and the real disposable income while producers' losses were related changes in the real gross farm income and real net farm income. In the case of further liberalization of the South African livestock industry, policy makers should first consider expanding the existing quotas rather than reducing tariffs. This is even more so if one considers the fact that the rural economy of South Africa (e.g. the livestock sector) has a GDP multiplier of 1.53 (Mullins, 2004). In effect, a one rand drop in the production of livestock will result in a R1.53 drop in the GDP of South Africa.

The results obtained for scenarios 1 and 2 have quite important policy implications, especially over the short to medium run if one considers the positive impact on consumer welfare compared with the relatively large impact on producer welfare combined with the status and potential welfare creation capabilities of this industry. On the one hand, consumers could benefit from cheaper meat, but one also has to take cognizance of the

potential impact on the livestock industry since this sub-sector is important to the rural economy of South Africa, and hence the economy as a whole.

One could relax the assumption of comparative static analysis (that producers react to a price drop by cutting down on production) used in this study and argue that a reduction in prices due to further liberalization would induce increased productivity, i.e. a move of the supply curve outward. This would mean an increase in the producer surplus for those producers that remain in the industry (i.e. those who have been able to increase productivity) rather than exit due to lower prices. However, the question that arises is that how much productivity can be increased, given the available natural resources, volatility in input prices (especially maize) and the dependency and interaction of the livestock sector with related agricultural sub-sectors. In many areas in South Africa, at least as far as the commercial sector is concerned, only a marginal level of productivity increase would be possible (for instance, the calving percentage in this sector is between 80 and 90 per cent while off-take rate is approximately 25 per cent). In addition, in many areas livestock farming is the only viable agricultural enterprise, whilst it also provides some form of security (reduces overall risk of mixed farming enterprises).

In terms of the emerging commercial sector, large productivity improvements can be made and should be made. Currently off-take rates are between 5 and 10 per cent while calving percentage is approximately 30 per cent. Should this sector be able to achieve the productivity level of the commercial sector, one could expect significant increases in supply. However, significant changes to the extent mentioned are not likely over the short to medium run due to impediments inherent in this sub-sector. Therefore it will take considerable time to effect an appreciable level of change in productivity due to issues such as training, infrastructure impediments, the current composition of the emerging commercial sector herds, etc. In addition and as earlier alluded to, not all producers will be able to make the necessary changes, causing some to exit the industry to be replaced by other/new producers. The extent and the ability of the producers to act will also be determined by the value of the marginal product in relation to input prices, i.e. trends in input prices are upward and volatile, whilst end product prices will be further forced down. This raises the question of what gap producers have left to absorb lower prices even if productivity increases.

This issue however falls beyond the scope of this study and needs to be further researched. Given the absence of concrete evidence on the ability of producers to absorb lower prices through increased productivity, policy

makers need to adopt the second best option. Incorrect decisions in terms of trade policy could seriously damage the livestock industry with marginal benefits to consumers. In addition, it will impede on presidential imperatives on lowering poverty and establishing a vibrant rural economy.

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APPENDIX A

Table A1: Current RSA tariff regime on imports of livestock meat products*

HS8 Tariff line	Description of product	Base Rate %	Bound Rate %	Applied Tariff % or R/kg
02.01	**Meat of Bovine Carcasses, Fresh or Chilled:**			
0202.10	-Carcasses and half carcasses	115	69	40 /2.4
0202.20	-Other cuts with bone in	115	69	40 /2.4
0202.30	-Boneless	400	160	40 /2.4
02.02	**Meat of Bovine Animals, Frozen:**			
0202.10	-Carcasses and half carcasses	115	69	40 /2.4
0202.20	-Other cuts with bone in	115	69	40 /2.4
0202.30	-Boneless	400	160	40 /2.4
02.03	**Meat of swine, Fresh, Chilled or Frozen**			
0203.1	-Fresh or chilled:			
0203.11	=Carcasses and half carcasses	50	37	15 /1.3
0203.12	=Hams, shoulders and cuts thereof, with bone in	50	37	15 /1.3
0203.19	=Other:			
0203.19.10	-Rib	50	37	15 /1.3
0203.19.90	-Other	50	37	free
0203.2	-Frozen:			
0203.21	=Carcasses and half carcasses	50	37	15 /1.3
0203.22	=Hams, shoulders and cuts thereof, with bone in	50	37	15 /1.3
0203.29	=Other:			
0203.29.10	-Rib	50	37	free
0203.29.90	-Other	50	37	15 /1.3
02.04	**Meat of Sheep or Goats, Fresh, Chilled or Frozen:**			
02.04.10	-Carcasses and half-carcasses of lamb, fresh or chilled	190	95	40 /2.0
02.02.2	-Other meat of sheep, fresh or chilled:			
0204.21	=Carcasses and half carcasses	190	95	40 /2.0
0204.22	=Other cuts with bone in	110	66	40 /2.0
0204.23	=Boneless	110	66	40 /2.0
0204.30	-Carcasses and half-carcasses of lamb, frozen	190	95	40 /2.0
0204.4	-Other meat of sheep, frozen:			
0204.41	=Carcasses and half carcasses	190	95	40 /2.0
0204.42	=Other cuts with bone in	110	66	40 /2.0
0204.43	=Boneless	110	66	40 /2.0
0204.50	-Meat of goats	150	82	40 /2.0
02.07	**Meat and Edible Offal of the Poultry of Heading No. 01.05, Fresh, Chilled or Frozen :**			
02.07.1	-Of fowls of the species Gullus domesticus:		82	free
02.07.11	=Not cut in pieces, fresh or chilled		82	27 /2.2
02.07.12	=Not cut in pieces frozen		82	free
02.07.13	=Cut and offal fresh or chilled		82	free
02.07.14	=Cut and offal frozen			
02.07.14.05	-Boneless (excluding cuts)		82	free
02.07.14.10	-Boneless cuts		82	5 /2.0
02.07.14.20	-Offal		82	27 /2.0
02.07.14.90	-Other		82	0 /2.2

*In terms of the Marrakech Agreement, the actual rate of duty should be phased down from a level that does not exceed the base rate to a level that does not exceed the bound rate within the specified period.

Source: NDA, 2005b

Table A2: Minimum market access quotas for livestock meat products

Tariff Heading	Description of product	In-quota tariff (20% of Bound Rate)	Annual Quota Tonnage
02.01	**Meat of Bovine Carcasses, Fresh or Chilled:**		26254
0202.10	-Carcasses and half carcasses	Full duty less 13.8%	
0202.20	-Other cuts with bone in	Full duty less 13.8%	
0202.30	-Boneless	Full duty less 13.8%	
02.02	**Meat of Bovine Animals, Frozen:**		
0202.10	-Carcasses and half carcasses	Full duty less 13.8%	
0202.20	-Other cuts with bone in	Full duty less 13.8%	
0202.30	-Boneless	Full duty less 32%	
02.03	**Meat of swine, Fresh, Chilled or Frozen**		4691
0203.1	-Fresh or chilled:		
0203.11	=Carcasses and half carcasses	Full duty less 7.4%*	
0203.12	=Hams, shoulders and cuts thereof, with bone in	Full duty less 7.4%*	
0203.19	=Other:		
0203.19.10	-Rib	Full duty less 7.4%*	
0203.19.90	-Other	Full duty less 7.4%*	
0203.2	-Frozen:		
0203.21	=Carcasses and half carcasses	Full duty less 7.4%*	
0203.22	=Hams, shoulders and cuts thereof, with bone in	Full duty less 7.4%*	
0203.29	=Other:		
0203.29.10	-Rib	Full duty less 7.4%*	
0203.29.90	-Other	Full duty less 7.4%*	
02.04	**Meat of Sheep or Goats, Fresh, Chilled or Frozen:**		6002
02.04.10	-Carcasses and half-carcasses of lamb, fresh or chilled	Full duty less 19%	
02.02.2	-Other meat of sheep, fresh or chilled:		
0204.21	=Carcasses and half carcasses	Full duty less 19%	
0204.22	=Other cuts with bone in	Full duty less 13.2%	
0204.23	=Boneless	Full duty less 13.2%	
0204.30	-Carcasses and half-carcasses of lamb, frozen	Full duty less 19%	
0204.4	-Other meat of sheep, frozen:		
0204.41	=Carcasses and half carcasses	Full duty less 19%	
0204.42	=Other cuts with bone in	Full duty less 13.2%	
0204.43	=Boneless	Full duty less 13.2%	
0204.50	-Meat of goats	Full duty less 16.4%	
02.07	**Meat and Edible Offal of the Poultry of Heading No. 01.05, Fresh, Chilled or Frozen :**		29033
02.07.1	-Of fowls of the species Gullus domesticus:		
02.07.11	=Not cut in pieces, fresh or chilled	Full duty less 16.4%	
02.07.12	=Not cut in pieces frozen	Full duty less 16.4%	
02.07.13	=Cut and offal fresh or chilled	Full duty less 16.4%	
02.07.14	=Cut and offal frozen		
02.07.14.05	-Boneless (excluding cuts)	Full duty less 16.4%	
02.07.14.10	-Boneless cuts	Full duty less 16.4%	
02.07.14.20	-Offal	Full duty less 16.4%	
02.07.14.90	-Other	Full duty less 16.4%	

*Calculated based on the agreement that in-quota tariff must not exceed 20% of the bound rate.
Source: NDA, 2003

Appendix B

B1: Behavioral functions

Commodity supply function

The supply functions are represented as follows:

$$PP_r^{ip} = \alpha_r^{ip} + \sum_{ii} \beta_{ii,r}^{ip}.QS_r^{ip}$$

where:

PP_r^{ip} denote the endogenous producer price of primary commodity ip in region r.

α_r^{ip} and $\beta_{ii,r}^{ip}$ denote the intercept and slope coefficients respectively for the supply function of primary commodity ip in region r.

QS_r^{ip} denote the endogenous quantity supplied of the primary commodity ip in region r.

The underlying assumption of the above specification is that the actual supply quantity QS_r^{ip} is to be greater than or equal to the effective supply from region r to all other regions. Mathematically this is expressed as $QS_r^{ip} \geq \sum_{r1}^{n} QS_{r,r1}^{ip}$.

Commodity conversion function

$$PP_r^{ip} = \theta_r^{ip} + \sum_{ii} \upsilon_{ii,r}^{ip}.QC_r^{ip}$$

$$PD_r^{is} = \theta_r^{is} + \sum_{ii} \upsilon_{ii,r}^{is}.QP_r^{is}$$

where:

PP_r^{ip} denote the endogenous producer price of primary commodity ip in region r.

PD_r^{is} denote the endogenous consumer price of secondary commodity is in region r.

θ_r^{ip} *and* θ_r^{is} denote the intercepts respectively for the demand and supply functions of the primary and secondary commodities in the processing sector in region r.

υ_r^{ip} *and* υ_r^{is} denote the slope coefficients respectively for the demand and supply functions of the primary and secondary commodities in the processing sector r.

QC_r^{ip} denote the endogenous quantity demanded of the primary product for conversion into secondary commodities in region r.

QP_r^{is} denote the endogenous quantity supplied of the secondary commodity in region r.

B2: The demand system (Marshallian demand)

Following Ryan and Wales (1996), the demand system is based on the following family of indirect utility functions depending on consumer prices PD and per capita income *Valuesum*[3].

Equ (4) $$U(PD, Valuesum) = \frac{-G}{(Valuesum - F)}$$

where *G* and *F* are functions of degree zero in prices. The budget-share of meat consumption in total per capita income (value-sum) is defined as:

Equ (5) $$Budgetshare = (PD_i^r * QD_i^r) / Valuesum$$

Using Roy's identity, the following Marshallian demands *QD* are derived:

Equ (6) $$QD_i^r = F_i^r + \frac{G_i^r}{G}\left(Valuesum - F_i^r\right) \qquad [X_i\_]$$

where the F_i and G_i are the first derivatives of F and G versus own prices. The function *F* is defined as follows:

Equ (7) $$F_r = \sum_i D_i^r \; PD_i^r \qquad [FGl\_]$$

where D_i^r represents the constant terms of the Marshallian demand functions. The function *G*, based on the Generalised Leontief formulation is defined as:

Equ (8) $$G = \sum_r \sum_i \sum_j (B_{ij}^r + B_{ji}^r)\sqrt{PD_i^r * PD_j^i} \qquad [GGl\_]$$

[3] *Note: Per capita income and total expenditure are separated. Total expenditure on meat was calculated from per capita income and represented as budget-share; since expenditure on meat does not exhaust available income.*

The derivative of *G* with respect to the product price is labelled G*i* and defined as:

Equ (9) $$Gi_i^r = \sum_j (B_{ij}^r + B_{ji}^r)\sqrt{PD_j^r / PD_i^r} \qquad [GiGl\_]$$

Symmetry is guaranteed by a symmetric *B* matrix describing the price-dependent terms, correct curvature by non-negative off-diagonal elements of *B*, adding up is automatically given as Euler's Law for a homogenous function of degree one:

Equ (10) $$\sum_r \sum_i X_i^r PD_i^r = \frac{\sum_r \sum_i G_i^r PD_i^r}{G\_gl}(Valuesum - F) + \sum_r \sum_i D_i^r PD_i^r ,$$

$$X_i^r = \frac{Gi_i^r}{G\_gl}(Valuesum - F) + D_i^r$$

and homogeneity is also guaranteed by the functional forms.

The calibration of the demand system involves derivatives of the Marshallian demands versus prices and income from the expenditure system above and is determined as follows:

Equ (11)
$$\frac{\partial QD_i^r}{\partial Valuesum} = \frac{Gi_i^r}{G}$$

$$\frac{\partial QD_i^r}{\partial PD_j^r} = \left(\frac{Gij_{ij}^r}{G} - \frac{Gi_i^r Gi_j^r}{G_r^{\,2}}\right)(Valuesum - F) \wedge i \neq j$$

where:

$$Gij_{ij}^r = \frac{\partial Gi_i^r}{\partial PD_j^r} = \tfrac{1}{2} B_{i,j}^r \, B_{j,i}^r \Big/ \sqrt{PD_i PD_j} \quad \wedge i \neq j$$

A non-linear optimization program then defines a set of parameters for each province, which lead to point elasticities minimizing squared differences between the raw elasticities and these calibrated elasticities, i.e.

Equ (12) $$\min \sum_{i,j} \left(\frac{\varepsilon_{i,j}^{trim}}{\varepsilon_{i,j}^{orig}}\right)^2$$

subject to all the conditions earlier defined.