Economic impact of the 2017 Highly Pathogenic Avian Influenza outbreak in South Africa

A report by BFAP to the South African Poultry Association

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Executive Summary

The recent outbreak of highly pathogenic avian influenza (HPAI) in South Africa had a notable effect on the poultry industry – one of South Africa's largest agricultural subsectors. To facilitate rigorous response strategies to these outbreaks, quantification of the disease's impact is critical. South Africa's strategy, to date, was to contain the disease through culling at affected sites. While a possible vaccination strategy is being considered, such a strategy has not been formalised. In the international context, a culling strategy has typically been accompanied by compensation to affected producers, which further highlights the importance of quantifying the economic impact of the disease. This report therefore evaluates the economic impact of the 2017 HPAI outbreak in terms of a retrospective, as well as forward looking analysis.

The retrospective analysis considered biological loss, income foregone and direct costs associated with the outbreak. Total cull numbers from the reported AI outbreaks in the broiler and layer industries are estimated at around **5.4 million birds**. The effect on the layer industry has however been much larger than in the broiler industry with around **4.7 million birds** culled in the **laying sector** as opposed to **around 700 000 birds** in the **broiler sector, which was predominantly affected at breeder level**. The total biological loss associated with these numbers amounts to just over R 317 million rand. Of this approximately 75% accrues to the commercial laying industry and its various stages of production. Direct costs associated with the outbreak was around **R40.5 million**, which could be even larger given the poor response rate on issues related to direct costs associated with the outbreak. In terms of income foregone the total value is estimated at just over **R1.5 billion** rand, which includes income lost from egg sales, pullet sales, day old chick sales and broiler meat sales. Of the total loss, 85% accrues to the laying industry. It should be noted that the income foregone is not an instantaneous loss and the impact would be spread over a period of more than 2 years. It also did not account for company specific management strategies to mitigate the impact, such as utilisation of excess capacity to reduce the impact on day old chick volumes. This was specifically the case in the broiler industry. Given what is presented in the report, the total loss could amount to around **R1.87 billion** if biological losses, direct costs and possible income foregone is considered. This represents 18% of the total gross value of egg production in 2016 and 1.6% of the total gross value of animal products in 2016.

The forward-looking analysis was aimed at quantifying the price impact associated with the loss of production, as well as differences in restocking strategies. It is mainly focused on the commercial laying industry due to the substantial effect the disease had on this part of the sector. Using a quarterly partial equilibrium model of the South African layer industry, it evaluated 2 different scenarios. The first is a scenario where restocking rates are driven by (current) high priced incentives associated with eggs. In the second, a vaccination strategy that allows incremental restocking within the confines of the production cycle is considered. The first scenario resulted in an egg-price shock of 22% relative to a baseline simulation, peaking in the first quarter of 2018. The second scenario showed a similar increase of 22% relative to the baseline, but peaking in the fourth quarter of 2017. Simulation results however suggest that a vaccination strategy will support growth in production to mitigate the initial impact with around 12%. Ultimately, this strategy, combined with current price incentives, also supports longer term production growth, with prices reaching an equilibrium below price levels considered as a baseline in the simulation. From a consumer perspective, the price impact of the outbreaks on egg prices is expected to amount to

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an increase of around R4 per dozen which has already been evident in the last quarter of 2017 and the first quarter of 2018.

Although interviewed respondents explicitly indicated their support for a comprehensive vaccination strategy, this course of action would have substantial implications. The first relates to trade. The analysis presented here suggest that vaccinations will have an impact on possible broiler exports. The threat of imports from countries that are already classified as endemic with HPAI seems unlikely since the current export mix from these countries (specifically China) does not match the current South African import mix. The second implication relates to how spent hens are disposed of. Under current circumstances, hens are sold to hawkers to be traded in the informal market. Under a comprehensive vaccination strategy, this option is no longer viable. In order to fully gauge the impact of this would require further in-depth research. The use of a compartmentalised vaccination strategy would mitigate the impact on the live bird market and also protect South Africa from an endemic status.

As with most agricultural sectors, it should be noted that the effect of a disease such as HPAI entailed severe losses in certain areas, while producers that were not affected in fact benefitted from higher prices. Therefore, one should not consider the aggregated national impact, without noting that affected areas suffered severe losses. Compensation of such losses is critical when a culling strategy is followed to contain the disease. Despite the decline in production volumes, the nature of the product implies that trade has a very limited role in the domestic market and therefore, the disease also resulted in substantial price increases, which does entice some producers to take the risk of expanding production, but also results in a much higher cost and reduced consumption levels.

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1 Introduction

Poultry production is an important contributor to the broader agricultural sector in South Africa. Apart from providing an affordable source of protein to South African consumers, chicken production contributed an annual average of 17% to the gross value of agricultural output over the past 5 years, with egg production a further 5%. Both industries are also characterised by long value chains, which provide employment for large numbers of people. This is true not only in production and processing, but also feed grain sectors, where the poultry industry is the largest consumer of animal feed. Broiler production utilises approximately 45% of total animal feed in South Africa, with a further 18% attributed to the layer industry.

The recent outbreak of highly pathogenic H5N8 virus in South Africa had a notable effect on the poultry industry. Given the time required for production to recover to full potential following the outbreak, and the contribution of the sector to South African agriculture, quantification of the disease's impact is critical. South Africa's strategy to contain the disease has been to cull affected sites. While a possible vaccination strategy is being considered, such a strategy has not been formalised to date. In the international context, a culling strategy has typically been accompanied by compensation to affected producers, which further highlights the importance of quantifying the economic impact of the disease. The impact related to broiler and egg production differs significantly, owing to the longer life cycle in layer production, which increases the propensity of an outbreak in the sector. This report aims to quantify the economic impact of the 2017 Highly Pathogenic Avian Influenza (HPAI) outbreak in South Africa. This impact evaluation is conducted in terms of a retrospective, as well as forward looking analysis and is categorised into five broad components:

- Quantification of the number of birds lost / culled and the associated value of such birds
- Quantification of the direct costs associated with the outbreak, including the cost of culling and disposal
- Income foregone as a result of the reported outbreaks in the broiler and layer industry
- Quantification of the impact on prices, the re-population strategy and the resultant impact on the value of production in the broader agricultural sector. This includes the impact on related industries such as feed grain production
- Evaluate the possible impact on trade patterns as a result of HPAI becoming endemic to South Africa

Information from producers was obtained through surveys and interviews with both affected and non-affected producers, as well as veterinarians working in the industry. The information provided was critical both in terms of understanding the current level of culls and the possibilities associated with re-population following the required quarantine period. The study is based on information up to and including 8 December 2017. Any further outbreaks after the 8 December 2017 are not included in the study. These can be included in a later update.

Following this brief introduction, the remainder of the report is structured as follows: Section 2 considers the costs and income foregone as a result of the outbreak based on pre-outbreak price

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levels. Section 3 incorporates a partial equilibrium simulation to evaluate the price impact associated with the loss of production, as well as the broader impact on the value added by the agricultural sector to the South African economy. It also considers the time required to reach pre-outbreak production levels under different scenarios, before conclusions are drawn in Section 4.

2 Retrospective evaluation of economic impact

The retrospective evaluation of the economic impact of the HPAI outbreak on broiler and egg production is considered in three broad categories. Section 2.1 considers the number of birds lost and culled, as well as the value of such birds in the broiler and layer industries separately. Given substantial differences in value of the birds, losses in the breeder flock are distinguished from commercial production. Section 2.2 considers the direct costs associated with the outbreaks and includes factors such as the cost of culling and disposal. Section 2.3 estimates the income foregone as a result of the birds already culled in the reported outbreaks in the broiler and layer industry.

2.1 Cull numbers and associated value

2.1.1 Layers

Total cull numbers from the reported AI outbreaks in the broiler and layer industries are estimated at around **5.4 million birds**. The effect on the layer industry has however been much worse than in the broiler industry with around **4.7 million birds** culled in the **laying sector** as opposed to **around 700 000 birds** in the **broiler sector, which was predominantly affected at breeder level**. This difference in impact is thought to be attributed to the longer lifecycle in layer production, as well as the more frequent use of open sided housing which is more exposed to external factors. The bulk of commercial broiler production occurs in closed, climate controlled housing. Within the layer sector, 86 500 parent breeder birds were culled. The remainder of culled birds in the laying industry were commercial layers either in the rearing or productive stages of production. A breakdown of culled bird numbers per affected province is provided in Table 1.

TABLE 1: COMMERCIAL LAYER CULLS PER AFFECTED PROVINCE

	Number	Estimated % of provincial population culled/dead[1]
Western Cape	3 320 056	70.95
Free State	360 000	10.09
Mpumalanga	394 435	34.75
KZN	111 945	3.61
Gauteng	415 258	7.26

[1] Calculated based on provincial distributions of layers as published in the 2014 SAPA Bird Census and the average size of the laying flock determined in the SAPA Monthly Egg report of October 2017.

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The total number of layer birds lost amounts to an estimated value of **R225 million**. This estimation is a combination of biological loss (in Rands) reported by respondents and an estimated value (in Rands) for respondents that failed to report. The latter estimation is based on an average bird age of 45 weeks. According to the DAFF cull schedule a layer bird of this age is worth R54.97. The value of eggs destroyed as a result of the outbreak is approximately **R15.6 million**. This is based on the assumption that at the time of culling the farm had roughly a three days worth of egg stock. The prices used to calculate the value of eggs lost were R15.30 per dozen, the average price of large eggs for quarter 2 of 2017. Prices are based on quarter 2, since this constitutes a pre-outbreak level that is not inflated by the severe loss in production due to the outbreak.

2.1.2 Broilers Breeders

In terms of broiler breeders, a total of **712 377 birds** were culled. All incidents related to broilers were in the breeding flock, with outbreaks in Mpumalanga, Gauteng, the Western Cape and the Eastern Cape. According SAPA (2017), the broiler breeding flock in July 2017 is estimated at around 6.6 million birds. The aggregate effect of the outbreak is therefore that approximately 10.8% of the domestic breeding flock in South Africa was lost. The reported value of the loss is **R68.3 million**.

2.1.3 Total biological loss

Based on the cull numbers presented above, Table 2 provides a summary of the total biological loss experienced due to the various outbreaks in South Africa, experienced since June 2017.

TABLE 2: TOTAL VALUE OF BIOLOGICAL LOSS

	Value of loss (Rands)
Culled Layer Parent Birds	8.65 million
Culled Commercial Laying Birds	225 million
Culled Broiler Breeding Birds	68.3 million
Destroyed Eggs	15.6 million
Total Biological Loss	317.55 million

2.2 Direct Cost associated with the outbreak

Responses on the direct costs associated with an outbreak were poorly answered and in some cases these figures are still unknown and/or being calculated by producers that experienced an outbreak. These figures therefore need to be refined and updated in 2018. The preliminary total costs reported on was R40.5 million, as of 8 December 2017. The bulk of these costs are made up of euthanasia (approximately 10%) and disposal costs (approximately 20%). Other costs that producers noted as having significant impacts was the cost of retrenchments and the costs of consulting fees. It should be noted that this information is based on only 60% of farms that experienced an outbreak. Within this 60% there is also various levels of reporting, with some farms only reporting an aggregate preliminary figure.

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2.3 Income Foregone

2.3.1 Layers

The composition of the flocks culled as well as the relative sizes and strategies of different producers that experienced outbreaks varies widely and calculation of the income foregone requires strong assumptions around bird age and egg prices. For the purposes of the calculation, it is assumed that the average bird age at the time of culling was 45 weeks, an accepted industry norm for average bird age on a single production unit. This results in an average loss in productive time of 25 weeks per bird. An average laying efficiency per hen of 0.85 eggs per day is assumed and quarter 2 2017 egg prices are used as a benchmark of pre-outbreak levels. Prices for this period were R15.30 per dozen, which translates to R1.28 per egg. This amounts to an income of R189.44 per bird over a 25-week laying period.

Costs are calculated based on the assumption that hens consume an average of 115g of feed per day. This results in the consumption of approximately 20kg of feed over a 25-week period. The value of feed was derived from typical layer inclusion rates and raw material prices during the second quarter of 2017. The average value of feed for this period was R3567.33 per ton, which results in a cost of R71.34 per hen for the 20kg of feed per bird that is required over a 25-week period. Feed however only accounts for approximately 70% of variable production cost. This means that the total cost per bird over a 25-week period is approximately R101.91.

The income and variable cost components presented yields a gross margin per bird of R87.53 over a 25-week period. Therefore, given the total number of commercial layers culled, the estimated value of income foregone is approximately **R408 million** rand.

Within the breeder flock, the impact is multiplicative. Based on the same assumptions regarding bird age and efficiency, the lost breeders would have yielded approximately 148 eggs over a 25-week period. This is multiplied by a hatchability factor for which the industry norm is around 32%. Which results in 47-day old pullets being produced over a 25-week period. The average price for a day-old pullet is around R9.00, which means that the first level of income foregone, over a 25-week period, is around R425 per culled breeder bird. Given the number of breeders culled to date, this amounts to a first level sales loss of R37 million rand.

Accounting for the costs associated with breeder birds over the same period results in income of roughly R28 million. Subsequent to this, value is also lost because of a reduced number of birds that can be reared to ultimately reach commercial laying capacity. This amounts to an estimated loss of income of around R26 in the sale of point of lay hens which will be incurred over the medium term[2]. Ultimately, this will result in a decrease in the number of commercial layers, which would further contribute to the income forgone. At the average egg price in quarter 2 of 2017, the total loss in income from commercial egg production as a result of an outbreak at breeder level will amount to roughly R750 million, spread over an 18 to 24-month period[3]. The total income foregone from the outbreak in the layer breeder flock of R813 million amounts to 8% of the total gross value of egg production in South Africa in 2016. It should be noted that the calculation

[2] In order to calculate this, a point of lay price of R58.10, as determined by DAFF is used and a feed price of R3567 per ton in order to calculate a gross margin.

[3] Here cost were accounted for by taking feed prices of R 3567 per ton and multiplying it by the amount of hens that would have been in production for the period of 52 weeks, assuming they eat 115g of feed per day.

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represented here, pertaining to the breeding stock, represents a worst-case scenario where the parent birds take 25 weeks to be replaced. This implies that there is no parent stock, in the rearing phase, that are at or close to productive capacity. It is also expected that, where possible, companies mitigate the effect of a breeder outbreak by making use of excess capacity. Such management strategies to mitigate the impact are not accounted for.

2.3.2 Broiler Breeders

The loss of income at breeder level for the broiler chain is also based on strong assumptions. For the purposes of this calculation, it is assumed that broiler parent birds are productive between 26 and 60 weeks of age and that the average age of the breeder population is 40 weeks. This implies that the average productive time lost, as a result of an outbreak at breeder level, is 20 weeks. Further assumptions relate to a laying efficiency is 0.8 per day and hatchability of 0.85. In order to calculate gross margins feed costs of R3567 were assumed. It was further assumed that birds consume around 115g of fed per day. The above assumptions implies that 95-day old chicks, per culled bird, are 'lost' over a 20-week period. Given the number of culled broiler breeder birds, this amounts to an estimated total loss of around **R200 million** in income from day old chicks[4]. A subsequent loss in income, due to reduced volumes of broiler meat sold, amounts to around **R87 million**. This was based on a price of a mature broiler of R21.80 and an associated gross margin of R1.29. The total income loss from the outbreak in the broiler breeder flock of R287 million amounts to 0.74% of the total gross value of broiler production in South Africa in 2016.

Consultation with industry experts however revealed that the integrated broiler companies which experienced outbreaks were able to minimise loss of income by relying on excess capacity. The utilisation of this capacity however came at increased costs. The scenario presented above was mitigated based on different company strategies which companies are not able to disclose. Table 3 provides a summary of the loss in potential income due to the experienced outbreaks.

TABLE 3: ESTIMATED INCOME FOREGONE SUMMARY

	Value of income foregone (Rands)	Share in gross value of egg production in 2016 (%)	Share in gross value of broiler production in 2016 (%)
Income lost from commercial egg sales	408 million	4.00%	-
Income lost from layer breeder flock	813 million	7.99%	-
Income lost from day old pullets	37 million	0.36%	-
Income lost from point of lay hens	26 million	0.26%	-
Income lost from commercial egg sales	750 million	7.37%	-
Income lost from broiler breeder flock	287 million	-	0.74%
Income lost from DOC's	200 million	-	0.52%
Income lost from broiler meat sales	87 million	-	0.23%
Total income foregone	**1.508 billion**	**14.83%**	**3.91%**

2.4 Concluding remarks on the retrospective analysis

In order to estimate the economic impact of the Avian Influenza outbreaks that have ravaged South Africa during 2017 three key components are considered in this section of the report. The first is the value of the biological loss from birds that died or were culled. The total value for this was

[4] This was calculated at a DOC price of R3.85.

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just over R317 million and is proportionally split between the laying industry (76%) and the broiler industry (24%). The second is the direct costs associated with an outbreak. The total costs of this is estimated at a minimum of R40.5 million. Finally, a component was estimated to determine the loss of income as a result of the outbreak. This required strong assumptions about the production process and length of the remaining cycle. The economic effect of this component is, by far, the largest with the aggregate income foregone estimated at just over a R1.5 billion. It should however be noted that this is not an instantaneous effect and the aggregate effect will be spread out over a period of between 18 and 24 months. If all these factors are taken into consideration the total effect of the AI outbreaks in 2017 could be as large as R1.87 billion. This amounts to almost 18.35% of the gross value of egg production in 2016 and equates to 1.6% of the total gross production value from animal products in 2016. Again, it should be noted that this effect is spread over multiple months and is not instantaneous.

As a final comment it is worth noting that the income foregone presents a worst-case scenario which does not account for management strategies within companies to mitigate the impact. Such strategies include utilisation of excess capacity to reduce the impact on day old chick volumes, specifically in the broiler sector. In the laying sector, where the bulk of damage occurred, production was severely constrained due to large farms in the Western Cape totally stopping production. These producers have also indicated that they will not repopulate until a workable vaccine is available to protect them from the disease. Within this context, future scenarios related to possible repopulation strategies are explored in Section 4.

3 Forward looking view on economic impact

Forward looking analysis of the impact of HPAI was conducted using a partial equilibrium simulation. The simulation comprises 2 parts: Firstly, using a model of quarterly frequency covering the egg subsector in South Africa and secondly the BFAP Sector model, of annual frequency covering more than 50 agricultural subsectors in South Africa. The use of a quarterly simulation model of the egg industry is based on the impact of the disease being much greater in egg production, as well as a greater expected price impact in the egg market relative to broilers due to the lack of international trade in eggs. The quarterly model allows for a more accurate representation of the restocking process in the egg industry and provides the first part of the analysis.

After the initial simulations of the quarterly egg industry model, the results are aggregated to an annual basis and introduced into the annual BFAP sector model. The BFAP sector model is a dynamic, recursive partial equilibrium model, which links livestock to grains through feed use and therefore enables the simulation of the extended impacts of reduced egg production. During this stage of the simulations, broiler production is also reduced in line with the impact on the breeder flock, to derive a total impact on the value added by the agricultural sector to the South African economy.

The forward-looking analysis provides the added benefit of quantifying the price impact from reduced domestic production levels, which is an important consideration for consumers. Simulations consider the broader protein consumption mix, including substitution effects between different protein sources as relative prices change.

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Given the small share of trade of eggs in the domestic market, the magnitude of the price impact of an induced production shock is largely determined by the responsiveness of consumers to domestic price changes – the own price elasticity of demand. This response is expected to differ greatly between consumers of different income levels, as well as between table eggs consumed as food and liquid egg products used in the baking industry. Likewise, liquid egg products are a lot more tradeable than table eggs and in the event that prices increase, the possibility of substituting domestic products with imported products is a lot higher. Unfortunately, information on egg consumption could only be obtained at aggregate level, hence not allowing for differentiation of the response to price changes. It is noted however that table eggs present the bulk of domestic consumption and hence aggregate elasticities would be a greater reflection of the response to changes in table egg prices amongst consumer relying on eggs as a source of protein.

3.1 Contextualising egg consumption in South Africa

The importance of the consumer response to changing prices in determining the price response warrants a more detailed evaluation of egg demand patterns to contextualise results. Figure 1 reflects prices of different protein sources at retail level, on a per serving basis, based on protein content. It indicates that eggs provide an affordable source of protein, comparable to chicken, but for lower income consumers, who spend the largest share of their total income on food, cheaper alternatives are available if egg prices increase and become unaffordable. Hence these consumers would be expected to respond in a fairly elastic manner compared to other food products. By contrast, higher income consumers that are more likely to consume eggs for breakfast or as part of baked products, rather than a primary source of protein, may be less sensitive to increased prices.

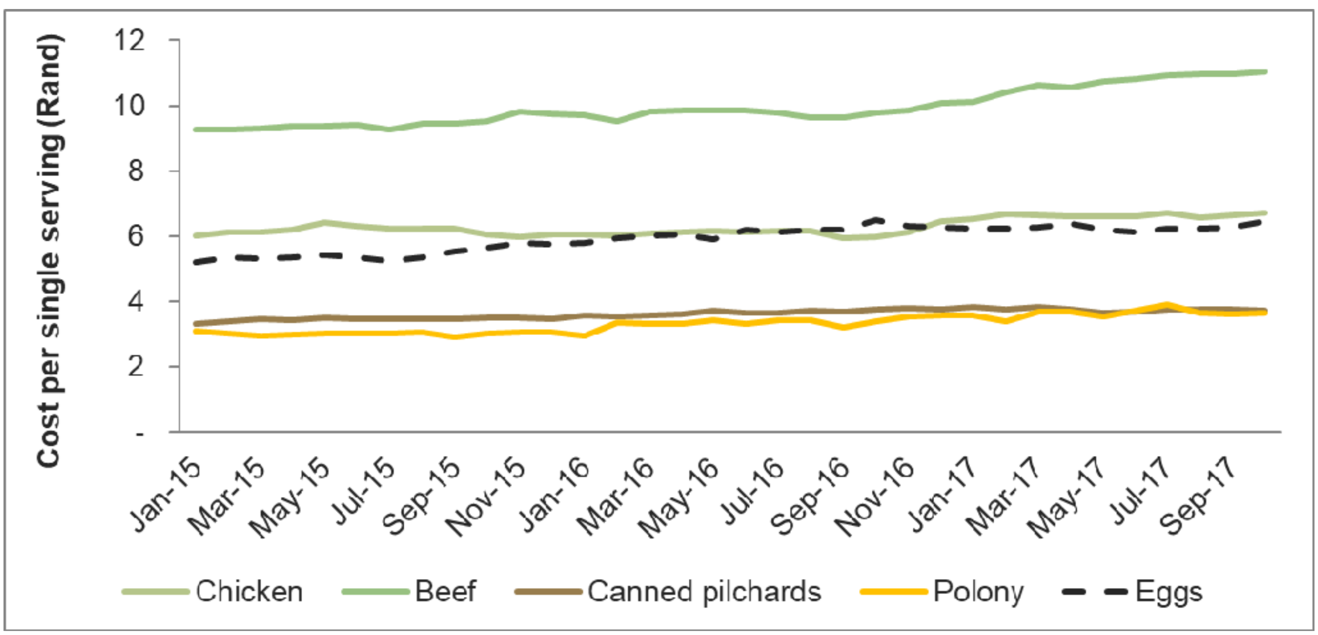

FIGURE 1: PER SERVING COSTS OF DIFFERENT PROTEIN SOURCES IN SOUTH AFRICA AT RETAIL LEVEL

Source: Calculated from Stats SA, 2017

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Figure 2 illustrates the composition of consumers accounting for expenditure on eggs in South Africa. Data is based on the income expenditure survey from Statistics South Africa (Stats SA), the latest of which is 2010/11 data. It indicates that 23% of total expenditure on eggs in South Africa is by the 40% earning the lowest income. A further 45% is associated with middle income consumers and 32% with high income consumers. The aggregate own price elasticity of demand applied in the model is -0.7, which implies that, when all other factors are unchanged, a 10% increase in the egg retail price results in a 7% decline in egg consumption.

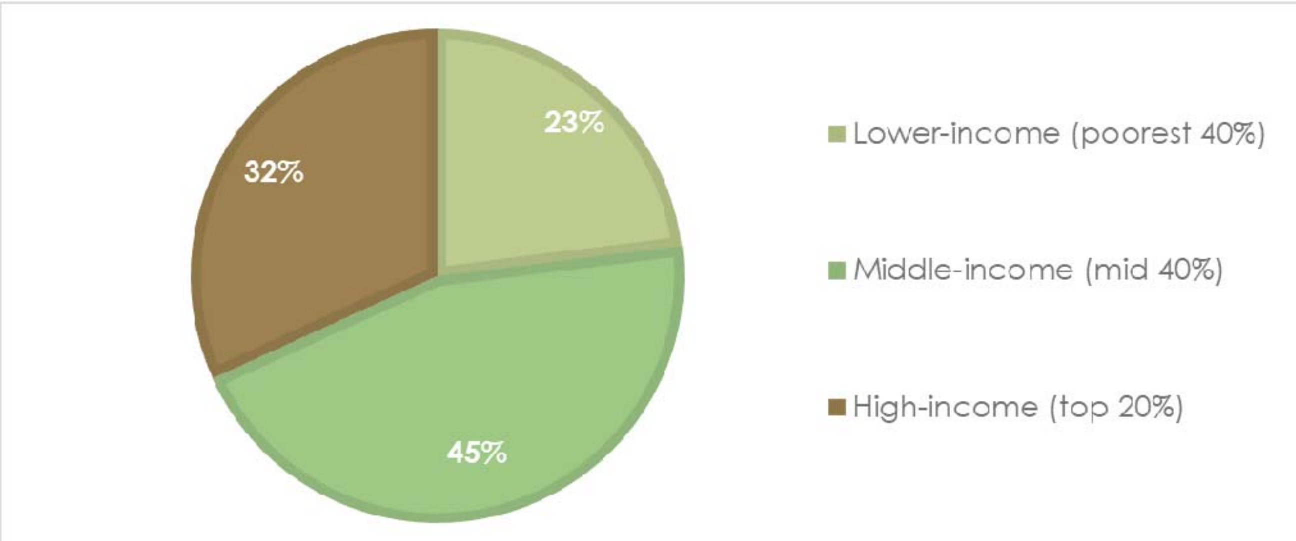

FIGURE 2: COMPOSITION OF EGG EXPENDITURE IN SOUTH AFRICA BY INCOME GROUP

Source: Stats SA, 2011

3.2 Quarterly simulation of the South African egg industry

The partial equilibrium model used for the quarterly simulations in this study is based on balance sheet principles. Within the South African egg industry, the different components of supply and demand are estimated based on historic data, to quantify the impacts of critical drivers of supply and demand decisions. Assuming that historic relationships will continue to hold in future, these equations are solved simultaneously to obtain an equilibrium price level at which total supply equals total demand. This first step of any forward-looking analysis within the partial equilibrium context provides the baseline. The baseline is not a forecast per se, but provides a single plausible future scenario subject to a range of macro-economic assumptions. It represents a benchmark against which alternative future outcomes can be measured and understood.

Macro-economic factors such as income growth and population growth are critical factors influencing the demand specification, whereas exchange rates influence the relative cost of imported and domestically produced eggs, as well as the cost of feed related inputs. Supply decisions in the modelling framework are derived from profitability indicators, considering the price of eggs and the price of feed, both with the appropriate number of lags to reflect a typical production cycle. Key macro-economic assumptions underpinning the baseline projection are

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provided in Table 4.

TABLE 4: MACRO-ECONOMIC ASSUMPTIONS RELATED TO THE QUARTERLY BASELINE OF THE SOUTH AFRICAN EGG INDUSTRY

	2017		2018				2019			
	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Real GDP (% change)	0.6	0.8	1.1	0.7	0.8	1.2	1.3	1.5	1.7	1.9
Exchange Rate (Rand / USD)	13.19	14.00	14.10	14.15	14.15	14.23	14.30	14.30	14.25	14.30
Population (Million People)	56.43	56.54	56.65	56.77	56.88	56.99	57.10	57.21	57.32	57.43
CPI inflation (% change)	4.8	4.7	4.5	5.1	5.4	5.3	5.3	5.4	5.6	5.6

Source: Bureau for Economic Research, 2017

Based on the macro-economic assumptions provided in Table 4, the baseline outlook for domestic supply, domestic demand and prices is presented in Figure 3. Trade is also estimated in the model, but historically, due to the nature of the product and the cold chain requirements, it reflects a very small share in domestic egg consumption and is therefore not a large influence on domestic price levels.

FIGURE 3: BASELINE PRODUCTION, CONSUMPTION AND PRICE OF EGGS IN SOUTH AFRICA

Following a period of exceptionally high feed costs as a result of the drought in South Africa through 2015 and 2016, egg production in the first quarter of 2017 declined to its lowest level since early 2014. Feed prices declined sharply in 2017 on the back of a record maize harvest,

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profitability has improved significantly, leading to a projected expansion over the next 12 months. This expansion slows in the second half of the outlook, as egg prices respond to the reduction in prices resulting from increased production levels.

Quantification of the impact of the 2017 HPAI outbreak on production, consumption and price levels towards the end of 2019 is based on the cull levels reported in Section 2. The shock is introduced during the third and fourth quarters of 2017, but it is assumed that henceforth, the disease is controlled, hence no speculation on further outbreaks is included at this point. In the first scenario, the reduction introduced in quarters 3 and 4 of 2017 is not re-introduced into the system exogenously. Based on the response by producers, particularly in the Western Cape, that they would not consider restocking unless a vaccination strategy is approved, expansion following the initial production shock is merely derived from economic considerations. Hence, the expansion presented in this scenario is merely a result of producers responding to higher prices.

The first scenario described is illustrated in Figure 4. Given that no restocking is introduced exogenously, the increased production through 2018 and 2019 is simply an economic response – higher production due to improved profitability in a higher price scenario. This constitutes a response derived from historic sensitivity, when no HPAI outbreak had ever occurred in South Africa. Consequently, the possibility exists that the response will be smaller, as the increased risk of AI may make producers less inclined to expand when profitability improves. The response and risk appetite of producers in this scenario remains largely unknown however, as it has never been tested. It is assumed however that, while producers in the Western Cape, where the concentration of production increases the risk of outbreak, may not be inclined to restock, other areas with a lower risk profile may expand in response to high prices. Improved profitability may also make it worthwhile for current production units to be relocated to lower risk areas.

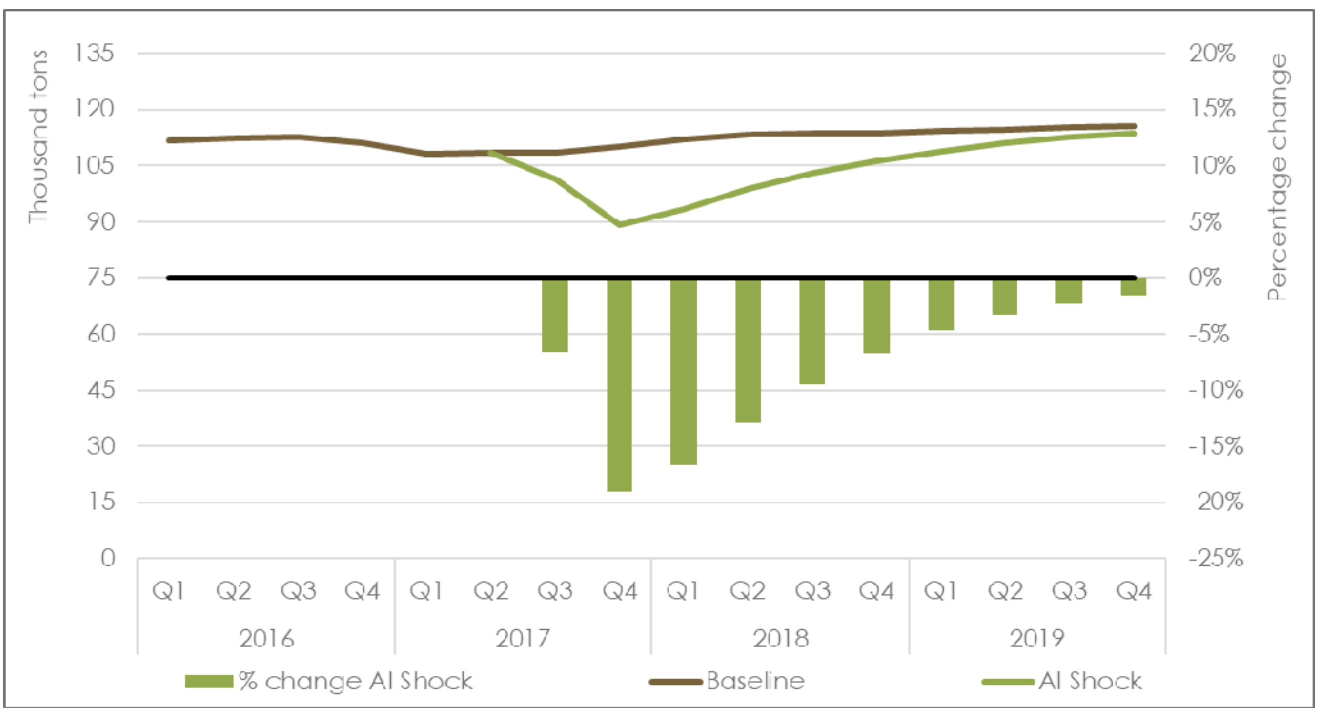

FIGURE 4: PRODUCTION IMPACT OF THE 2017 AI OUTBREAK

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Under a second scenario, it is assumed that a vaccination strategy is approved, in which case the loss in production as a result of the 2017 outbreak is re-introduced exogenously within the confines of restocking possibilities. The scenario is based on the assumption that vaccination will be successful, as the success of possible vaccination strategies is beyond the scope of this study. This results in the full shock being re-introduced by the second quarter of 2019. This scenario is presented in Figure 5 and results in production exceeding baseline levels. This is a result of the initial price response resulting from the outbreak, which induces expansion in producers that face a lower risk profile. Given that affected producers then also restock, the result is production levels that exceed the initial baseline projection where the 2017 price shock was absent. The assumptions associated with restocking rates are presented in Appendix 1.

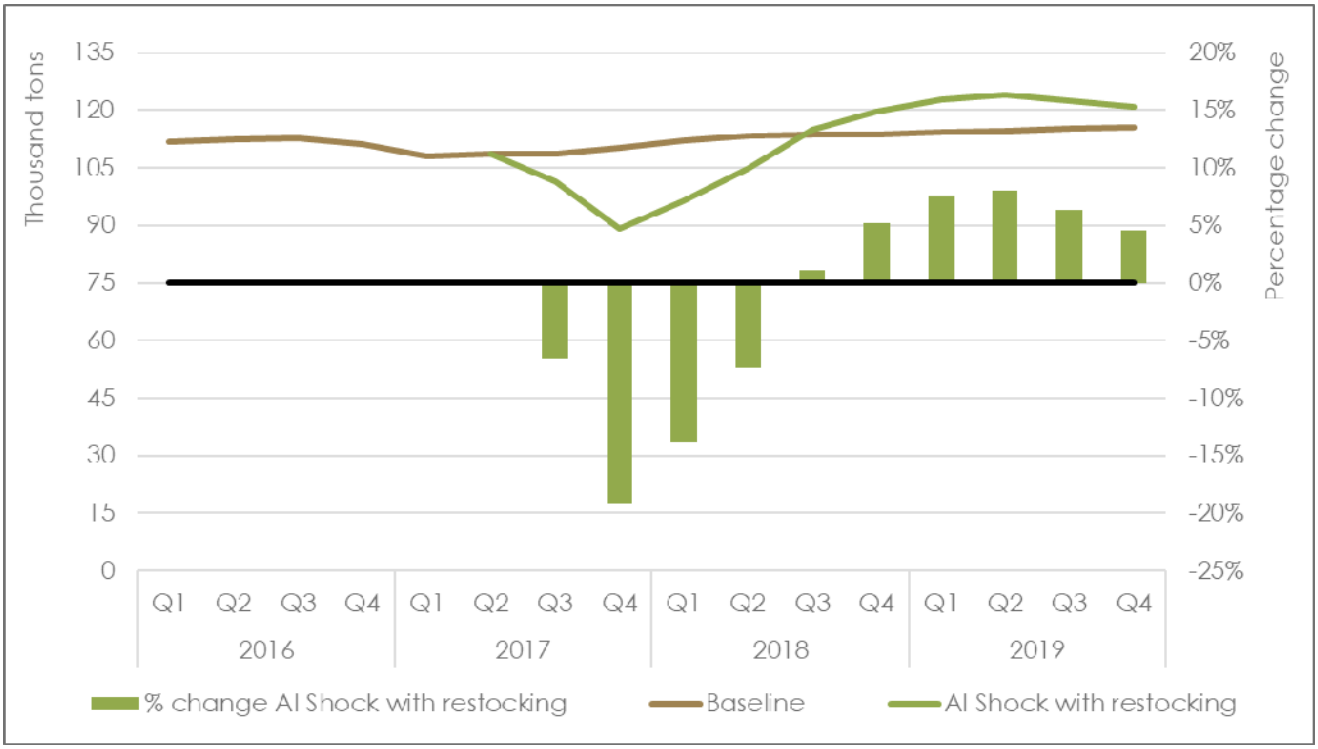

FIGURE 5: PRODUCTION IMPACT IN A SCENARIO WHERE AFFECTED PRODUCERS RESTOCK

While the second scenario presented is associated with the assumption that a vaccination strategy is approved, allowing affected producers to restock, the model coverage does not account for additional factors associated with vaccination, such as the impact on the live bird market for culls. In the event that vaccination occurs, such culls will have to be slaughtered as opposed to the current strategy of live sales. Producers will therefore have an additional cost associated with production, whilst a number of hawkers and informal traders that act as middlemen between large producers and individual consumers will not be able to continue with their current business model.

The limited role of trade in the domestic egg market implies that prices are particularly sensitive to domestic supply and demand fluctuations. Thus, the broader economic impact of the shock must also consider the price increase resulting from the outbreak. The price shock associated with the two different scenarios is presented in Figure 6. Given the typically inelastic response of consumers

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to food price increases, it is not unusual for the price impact in industries such as eggs, with low trade volumes, to exceed the production shock. This was also the case when the production shock related to the HPAI outbreak was introduced, with a 19% decline in production in the fourth quarter of 2017 resulting in a 22% increase in domestic egg prices. When expansion is based only on economic responses rather than the introduction of restocking for affected producers, prices almost fall back to baseline levels by 2019. Should producers respond in a more risk averse fashion, prices will remain higher for longer. When restocking is introduced along with a normal economic response, prices fall up to 11% below baseline levels by the first quarter of 2019, before starting to recover somewhat to 6% below baseline levels by the fourth quarter of 2019.

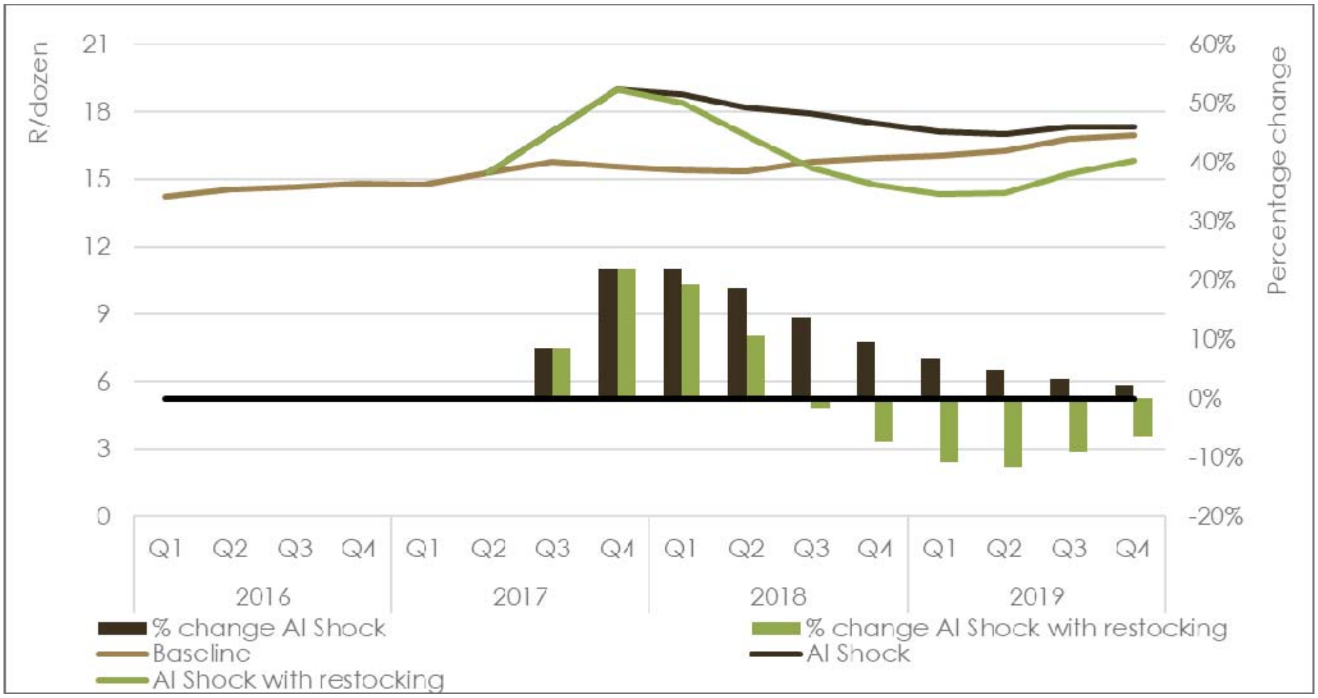

FIGURE 6: PRICE IMPACT ASSOCIATED WITH THE 2017 HPAI OUTBREAK

It is important to note that producers affected by the AI outbreak that had to cull flocks are unable to benefit from higher prices. Therefore, while the impact on the industry as a whole may be reduced by the price effect, this is a result of producers that were not impacted making higher profits, while losses to affected producers remain incredibly high, as noted in Section 2.

3.3 Annual simulation within the broader agricultural sector in South Africa

The second step in the forward-looking analysis is to introduce the shock in the egg and broiler industries into the BFAP sector model, which considers more than 50 subsectors in South African agriculture. The BFAP sector model is a dynamic, recursive, partial equilibrium model, which links grains to livestock through feed. By implication, any shock in the livestock sector will influence the demand and hence also prices of feed grains. This is an important attribute considering that the broiler and layer industries account for more than 60% of feed consumption in South Africa.

Within the broiler industry, the impact of the HPAI outbreak in 2017 was significantly less than in the

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layer industry, as illustrated in Section 2. Given that the restocking process is far less constrained than in layers and that the outbreaks occurred only in the breeder flock, a once off shock is introduced into the broiler sector in 2018. In the layer sector, the production shock from the quarterly model relative to the baseline is emulated in the annual model. This combination allows the impacted to be simulated across the rest of the agricultural sector, as well as the aggregated impact on agriculture as a whole.

Introduction of the combined broiler and egg production shock associated with the HPAI outbreak into the bigger model results in a reduction of 3.8% (mention tons as well) in maize used as animal feed if restocking is based on economic reasons only. When all affected producers are restocked in scenario 2, the reduction in maize used as animal feed is 2.8%. While these percentages may seem small, the AI shock in scenario 1 results in a reduction of 200 thousand tons of maize used in the animal feed industry in 2018. BFAP (2015) notes that the animal feed sector adds the most value to domestically produced maize, which implies a significant loss if this maize is exported as opposed to being used in the animal feed sector.

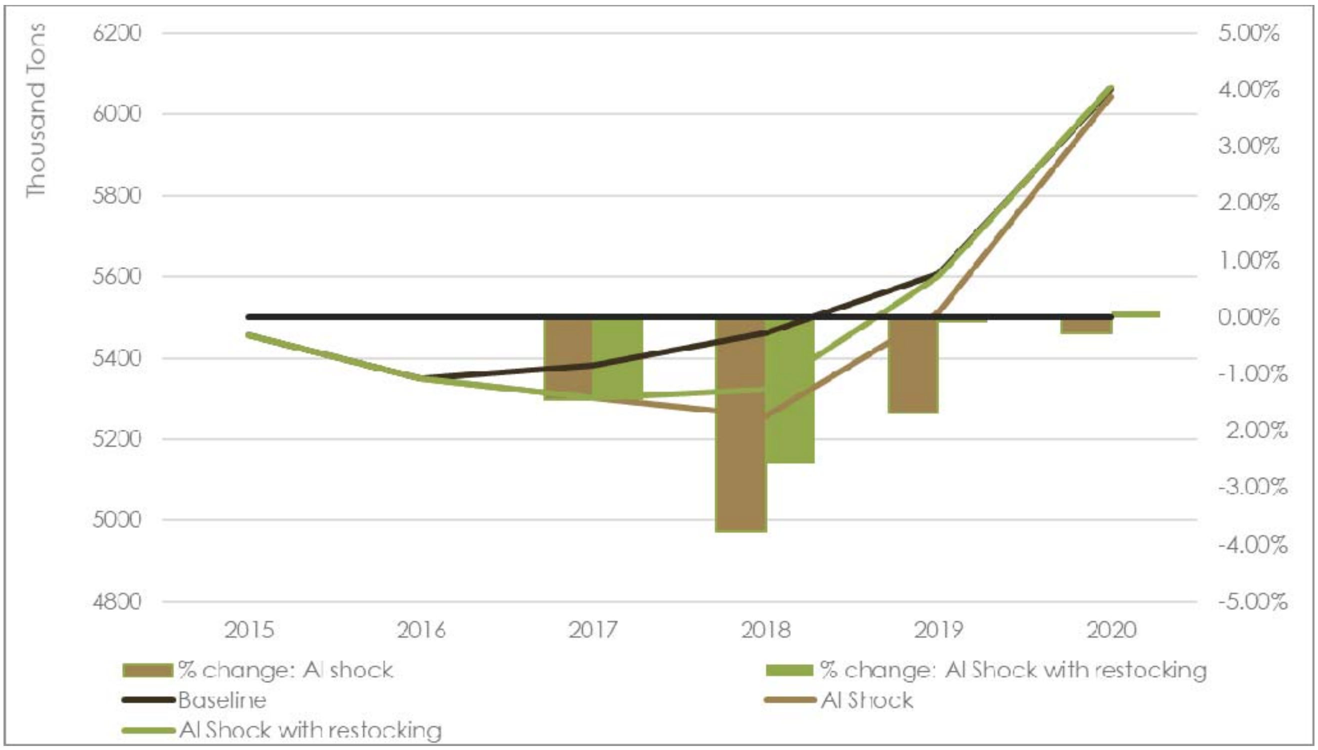

FIGURE 7: FEED USE IMPACT UNDER BOTH SCENARIOS

The impact of the two different scenarios on agriculture’s contribution to GDP is small – with both scenarios inducing a reduction of less than 1% per annum between 2018 and 2020. In 2017, the national impact is marginally positive, as the price effect outweighs the reduction in quantity of eggs produced (Figure 8). The impact on GDP also does not include the effect on trade in Ostrich meat, which is not included in the BFAP Sector model, but discussed in briefly in Section 3.5.

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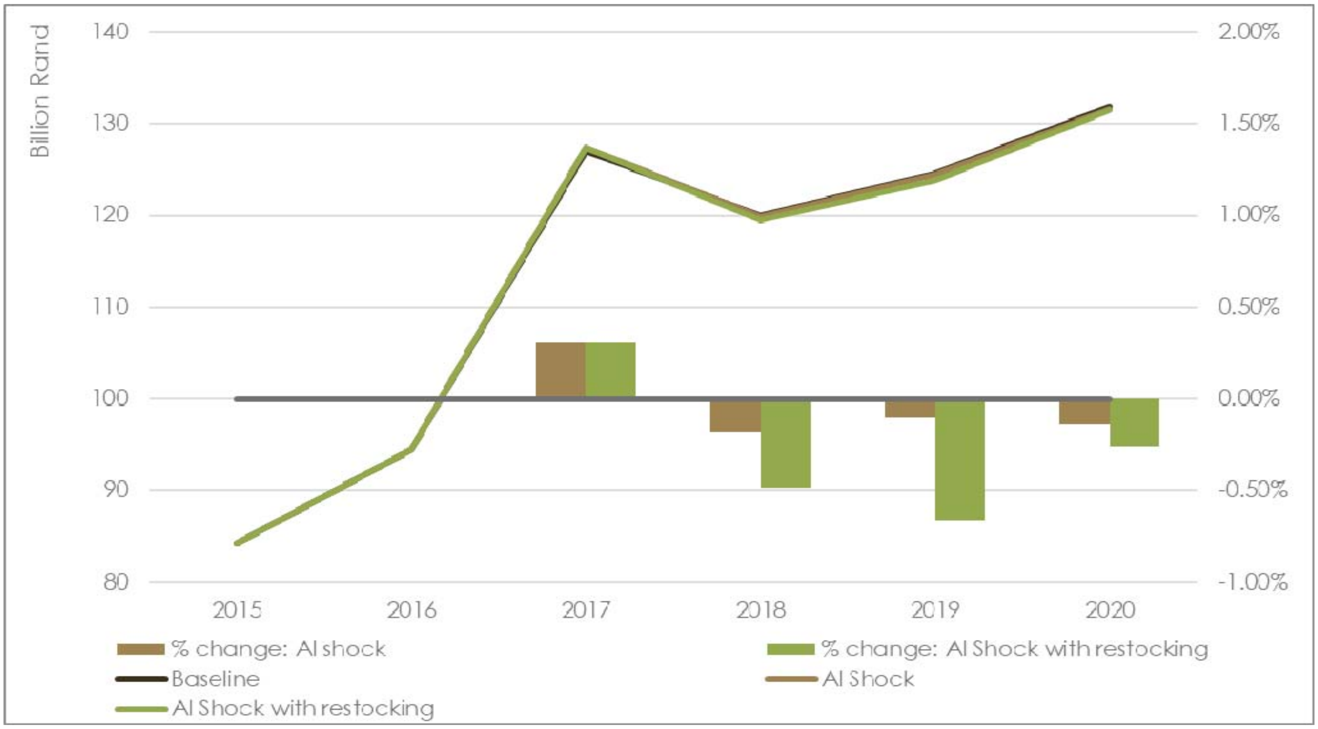

FIGURE 8: IMPACT ON AGRICULTURAL GDP OF BOTH SCENARIOS

Given that the impact on national GDP is limited, the biggest impact of the HPAI shock is undoubtedly on producers that had an outbreak and hence were unable to benefit from higher prices. At the same time, the increase in egg prices is substantial and will affect a large number of consumers that rely on eggs for an affordable source of protein negatively.

Within the broiler industry, this price impact is very limited, due to fundamental differences in price formation between the 2 industries. In the broiler industry, imports already account for more than 20% of domestic consumption, hence lower production volumes result in higher import volumes, but limited price impacts, as the domestic price is already closely related to import parity levels. Within the broiler industry, a possible concern is a scenario where HPAI becomes endemic to South Africa, resulting in changing trade patterns. A possible export strategy for the broiler industry will be affected negatively by an HPAI endemic status. Furthermore, there is the possibility of additional imports coming from countries such as China, where the disease is already endemic. Presently, South Africa is unable to import poultry products from HPAI endemic countries, which will change in the event that the disease becomes endemic to South Africa.

3.4 Trade related considerations of the HPAI outbreak on unprocessed poultry meat

The global poultry industry has also been affected by a number of recent outbreaks of HPAI, restricting supply in a number of countries in Europe, Asia, and Africa (Rabobank, 2017). Asian markets also experienced further supply shortages due to difficulties in trading breeding stock hampering supply in markets like China, Thailand, and several other Asian countries. During the second quarter of 2017, a strong recovery in supply volumes was evident. Consumption in many markets has also been restored after a significant reduction of global HPAI cases restored

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consumer confidence.

The HPAI outbreaks in several key exporters and the ensuing trade restrictions severely distorted global poultry trade during 2017. Additionally, the 'weak flesh' scandal[5] in Brazil caused a significant reduction in poultry exports from the world's largest exporter between March and May as international customers reduced orders. Global trade volumes have dropped by 4% (to 5.9 million tonnes) over the first half of 2017, with an exceptionally weak second quarter, which saw a 7% drop in trade. Although trade volumes have been dropping, prices have been performing well, especially for leg quarters (+16% in Q2 and +7% in Q3) and processed meat (+22% in Q2). Global exports shifted sharply in the second quarter, with the biggest drop in Brazil (-9%) due to the meat scandal, and the EU (-9%) and China (-6%) because of domestic HPAI issues. Thailand (+9%) and the US (+5%), and to a lesser extent Argentina and Chile, have increased exports over this period. HPAI risks could rise again in the northern hemisphere winter, starting in October, when cases usually increase due to bird migration.

3.4.1 South African trade in unprocessed poultry meat

Figure 9 indicates that South Africa imported mostly frozen leg quarters (48%), drumsticks (10%) and carcasses (4%) over the first eight months of 2017. On average, the price of unprocessed imports has increased by 19% between March and August 2017. Brazilian export prices to South Africa rose 27% since January, indicating that these exporters gained from the absence of the Netherlands and other European exporters due to the HPAI related trade ban, the general supply shortage and higher prices in European markets due to widespread HPAI outbreaks.

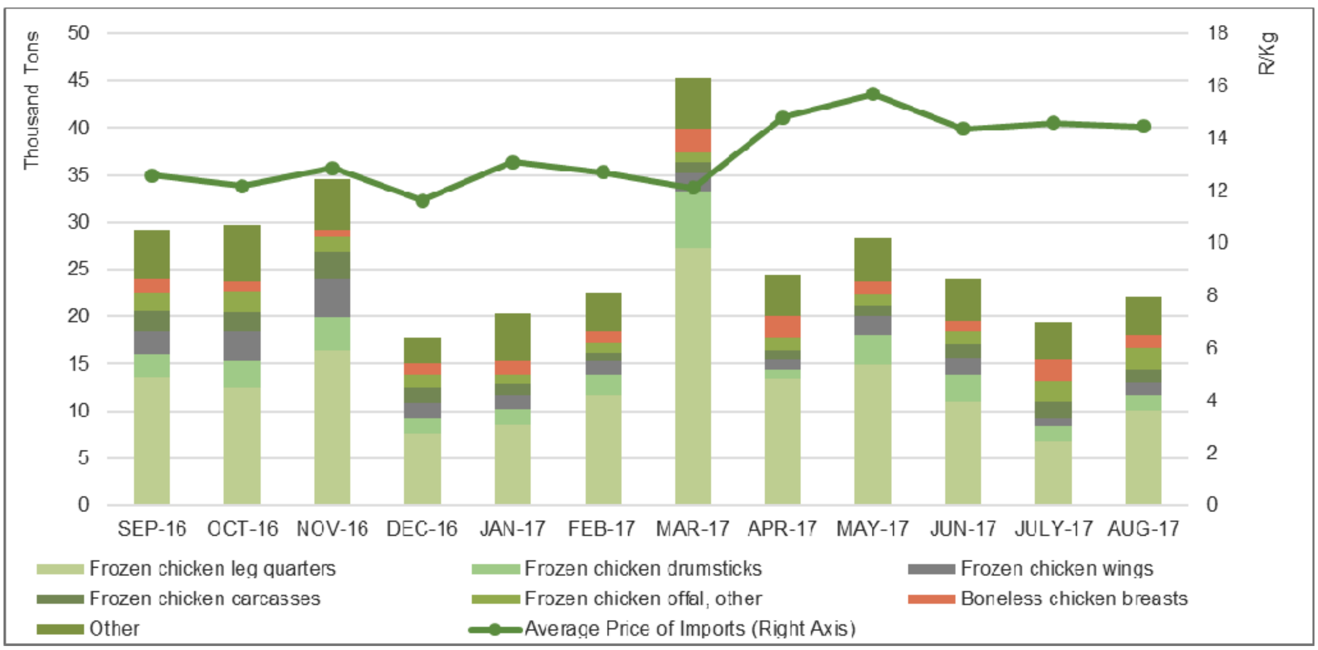

FIGURE 9: SOUTH AFRICA UNPROCESSED POULTRY IMPORT MIX AND AVERAGE IMPORT PRICES

Source: SAPA, 2017

[5] The Operation Carne Fraca or Operation Weak Flesh was action enforced by the Federal Police of Brazil, the Brazilian federal police, started on March 17, 2017 which investigated alleged bribery of food-sanitation inspectors. China, Mexico, Chile, Japan, the European Union and Hong Kong subsequently took measures to avoid importing Brazilian meat.

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Figure 10 indicates leading suppliers of South African unprocessed poultry imports between 2014 and 2017 (up to August). It is evident that European countries affected by HPAI outbreaks and trade bans, namely the Netherlands, the United Kingdom, Spain, Hungary, Germany, Poland and France, have all virtually halted all exports to South Africa. This lack of supply was however soon replaced by exports from Brazil and the United States (US). Note that 2017 figures only represent trade volumes up until August.

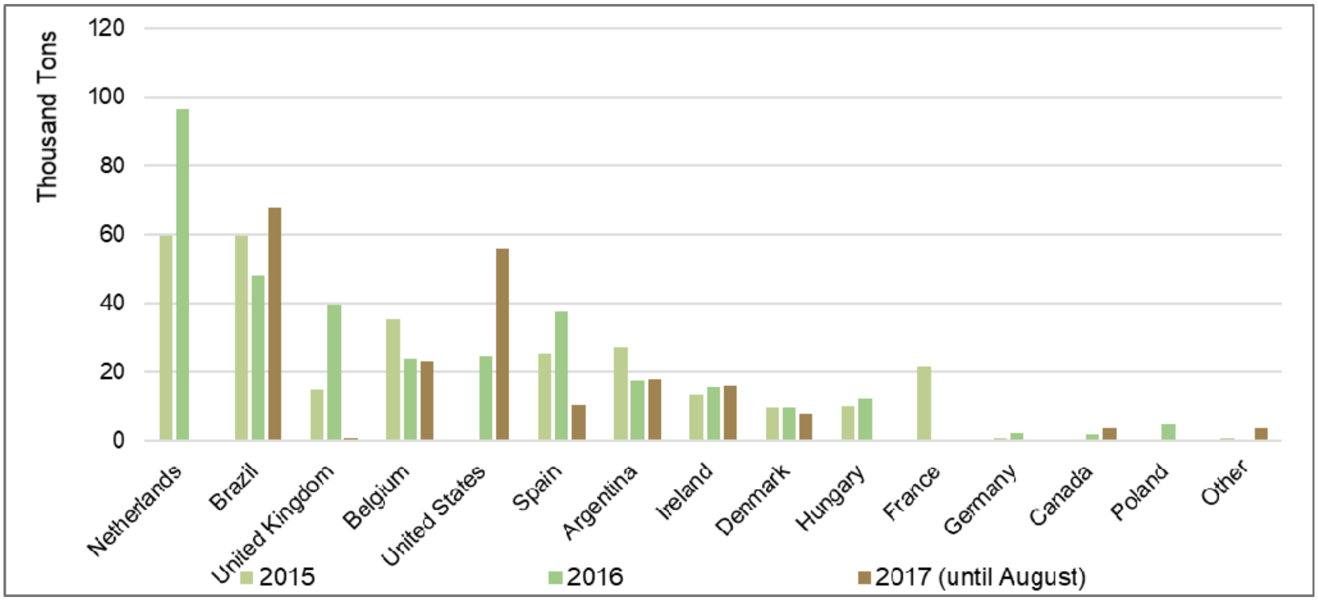

FIGURE 10: SOUTH AFRICAN POULTRY IMPORTS BY ORIGIN

Source: SAPA, 2017

3.4.2 Potential HPAI trade impact

Given the above global and South African context, this section will explore possible impacts on South African unprocessed poultry trade should HPAI become an endemic disease in South Africa. First, HPAI disease incidence among the leading exporters and HPAI endemic countries will be considered. Thereafter, endemic markets that could potentially gain access to South Africa will be explored in terms of the poultry products that typically exported (also referred to as a country's 'export mix') and the relative price attractiveness of South Africa for these markets.

3.4.3 HPAI in leading export markets

Figure 11 categorizes leading poultry exporters according to the incidence of HPAI during 2017. Even though HPAI was not present in the world's largest exporter, namely Brazil, it is evident that the disease was present in most of the leading exporters during 2017. After an outbreak, exporters usually take steps to eradicate the disease and to regain their status as free of the disease in order to resume export activities. From a trade perspective, outbreaks complicate trade flows as countries can regain or lose their free status even within the same year. In the case of South African imports, even though the US had an HPAI outbreak in early 2017, US exporters were able to

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replace some of the Netherland's exports when the country lost its free status and South Africa imposed a trade ban.

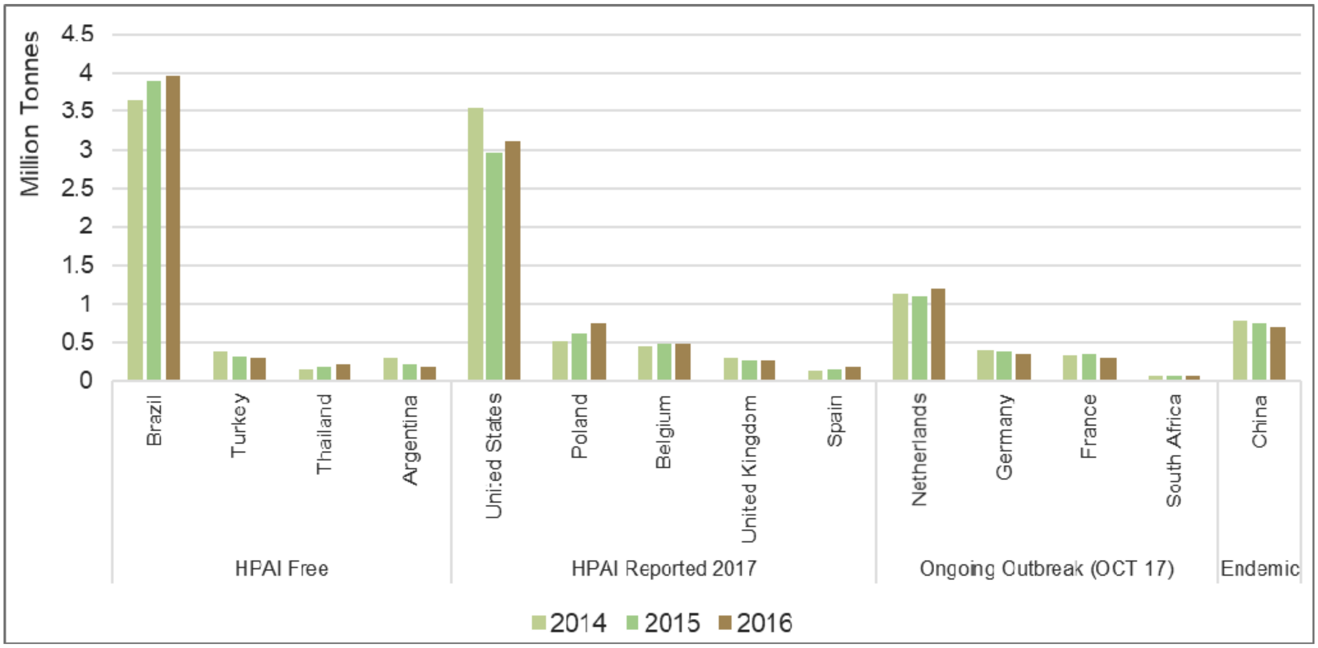

FIGURE 11: LEADING UNPROCESSED POULTRY EXPORTERS PER DISEASE STATUS IN 2017

Source: Trade Map,2017; SAPA, 2017; OIE, 2017a; and OIE, 2017b

In the event that HPAI is classified as being endemic in South Africa, based on current disease- and trade patterns illustrated in Figure 11, China would likely be the only HPAI-endemic[6] country that can realistically export significant volumes of unprocessed poultry meat to South Africa (Figure 12). When comparing the export mix of mainland China and the separate Chinese export region of Hong Kong with the import mix of South Africa, Figure 13 clearly illustrates that mainland China mostly exports products that are not the same as those that South Africa typically imports. However, South Africa does import the products that Hong Kong typically exports, namely frozen poultry feet (indicated in orange) and frozen poultry wings (indicated in green).

[6] As of 2011, the United Nations Food and Agriculture Organization considered six countries to be endemic for HPAI H5N1 virus in poultry: Bangladesh, China, Egypt, India, Indonesia, and Vietnam. Note that outbreaks of HPAI H5N1 virus and other, more recent strains also occur among poultry in non-endemic countries (CDC, 2017).

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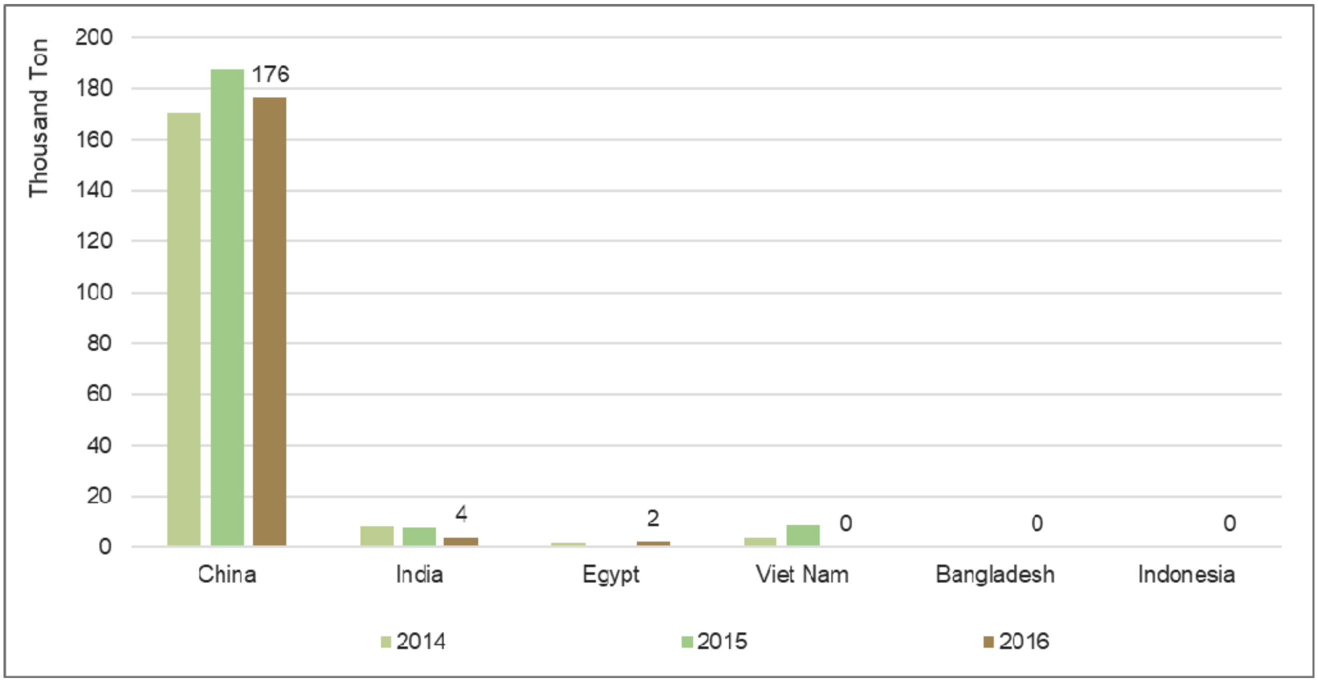

FIGURE 12: UNPROCESSED POULTRY EXPORTS AMONG HPAI H5N1 ENDEMIC COUNTRIES

Source: Trade Map, 2017; CDC, 2017

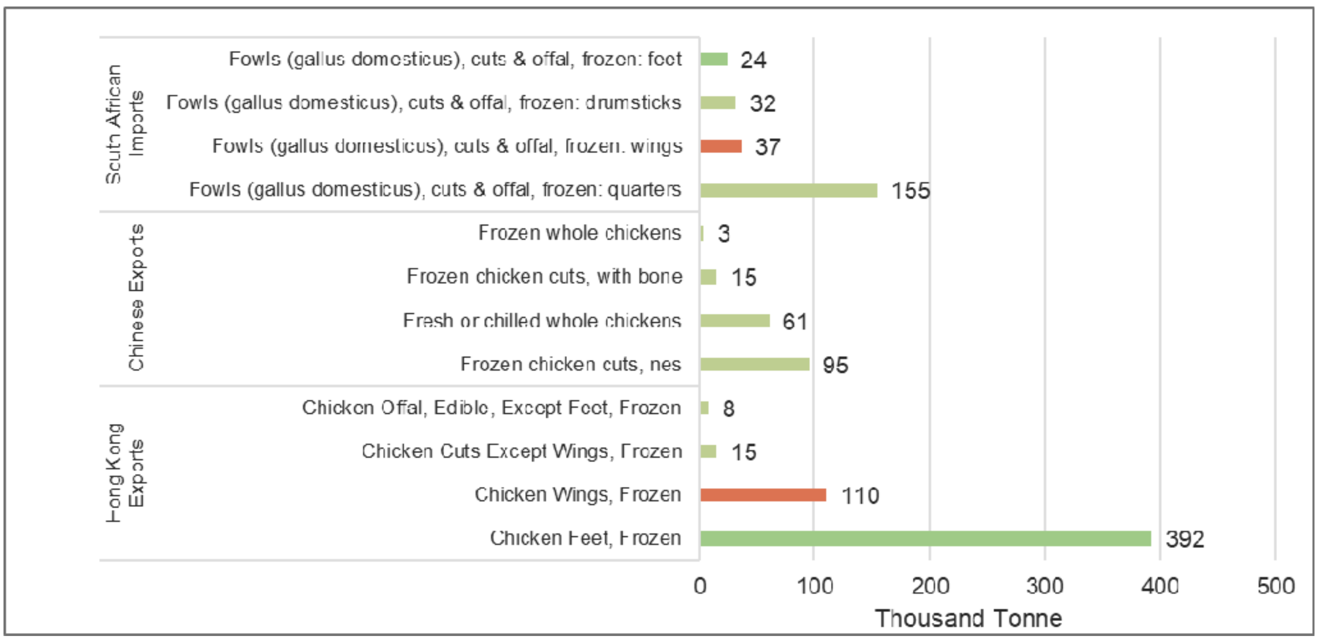

FIGURE 13: 2016 SA, CHINA AND HONG KONG TRADE MIX COMPARISON

Source: Trade Map, 2017

Figures 14 to 16 consider average export prices among leading exporters, including the traditional suppliers of South African poultry (Brazil, US and the Netherlands), and average export prices for mainland China and Hong Kong and how these export prices compare to South African import prices. Firstly, Figure 14 indicates that South African import prices are on average below the average export prices of its main suppliers and well below those of China. However, these

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average prices only represent aggregate exports and can easily hide exports at prices well below the national average.

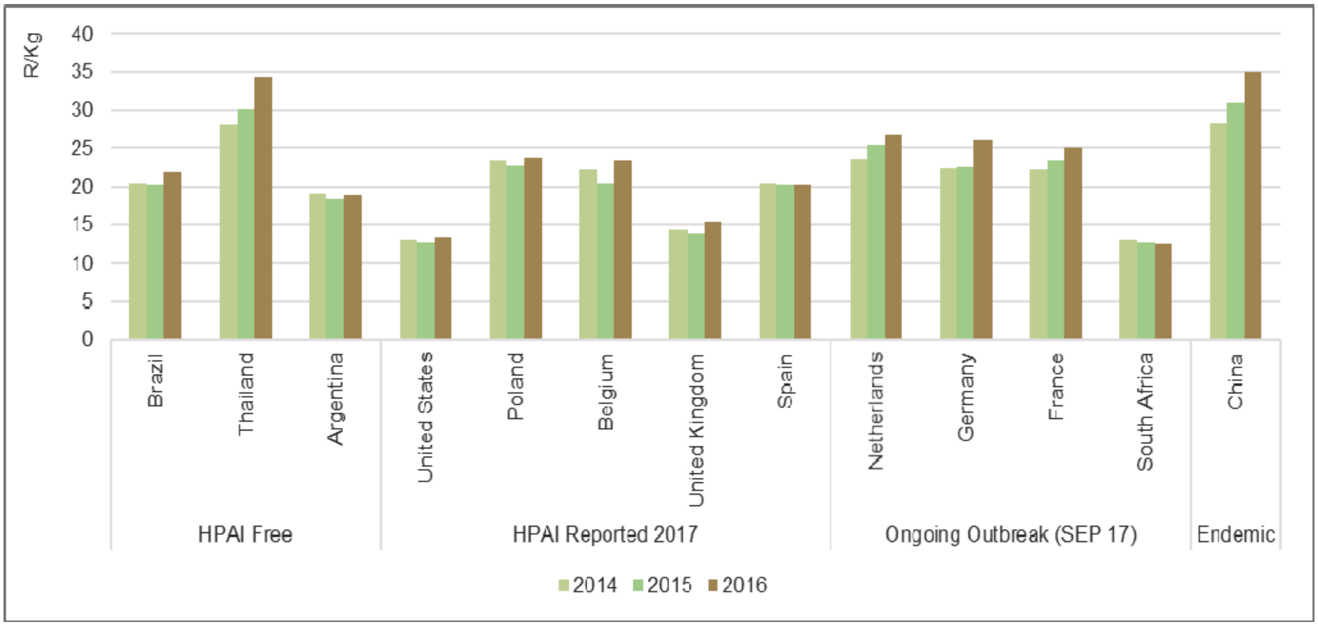

FIGURE 14: EXPORT PRICES AMONG LEADING EXPORTERS AND SOUTH AFRICAN IMPORT PRICES

Source: Trade Map, 2017; SAPA, 2017; OIE, 2017a; and OIE, 2017b

From Figure 15, it is clear that although mainland China exports unprocessed poultry products at an average price of R29,83/kg, the country exports these products to other markets at prices well below this average. However, the average price at which South Africa imports these products was R6/kg lower than that of China's lowest priced export markets, indicating that South Africa would be a relatively unattractive export destination for Chinese exporters. Figure 16, which compares the average export prices of Hong Kong to South African import prices, paints a similar picture in that South Africa would also be a relatively unattractive market for exporters given their current export markets.

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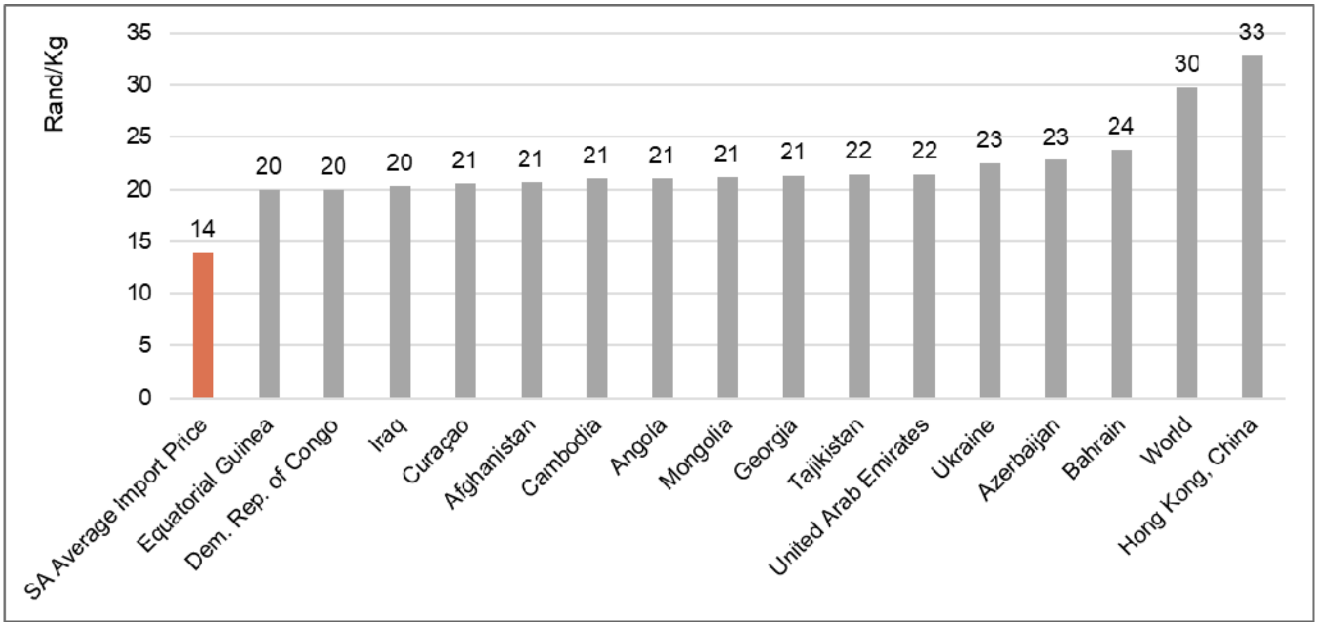

FIGURE 15: CHINA H1 2017 AVERAGE EXPORT PRICES COMPARED TO SA IMPORT PRICES

Source: Trade Map, 2017

Lastly, Table 5 indicates the *ad valorem* tariff rates that South Africa applies to unprocessed poultry imports from China and its traditional suppliers. Clearly, the Netherlands receives a significant benefit under the Economic Partnership Agreement[7]. Should South Africa be classified as an HPAI endemic country and HPAI related import restrictions on Chinese imports be relaxed, Chinese exporters will have no excise benefit against South Africa's traditional suppliers. This information, coupled with the average export prices illustrated in Figure 14, supports the notion that Chinese exporters will find it difficult to compete against South Africa's traditional exporters on a price basis.

Despite the likelihood of limited imports from China due to the high costs and export mix illustrated in this section, A situation where HPAI becomes endemic to South Africa should be avoided to allow for the development of an export strategy and the continuation of live bird markets, where Louw, Davids & Scheltema (2017) note that many smaller producers earn a living. The danger of HPAI becoming endemic to South Africa that has been raised in relation to a possible vaccination strategy, but it should also be noted that a vaccination strategy need not result in endemic status. A compartmentalised strategy can also be followed, which will protect parts of the flock, whilst still guarding against the disease becoming endemic to South Africa.

[7] SA has a free trade agreement with the EU through the Economic Partnership Agreement (EPA). The EPA replaced the trade chapter in the Trade, Development and Cooperation Agreement (TDCA) on 10 October 2016.

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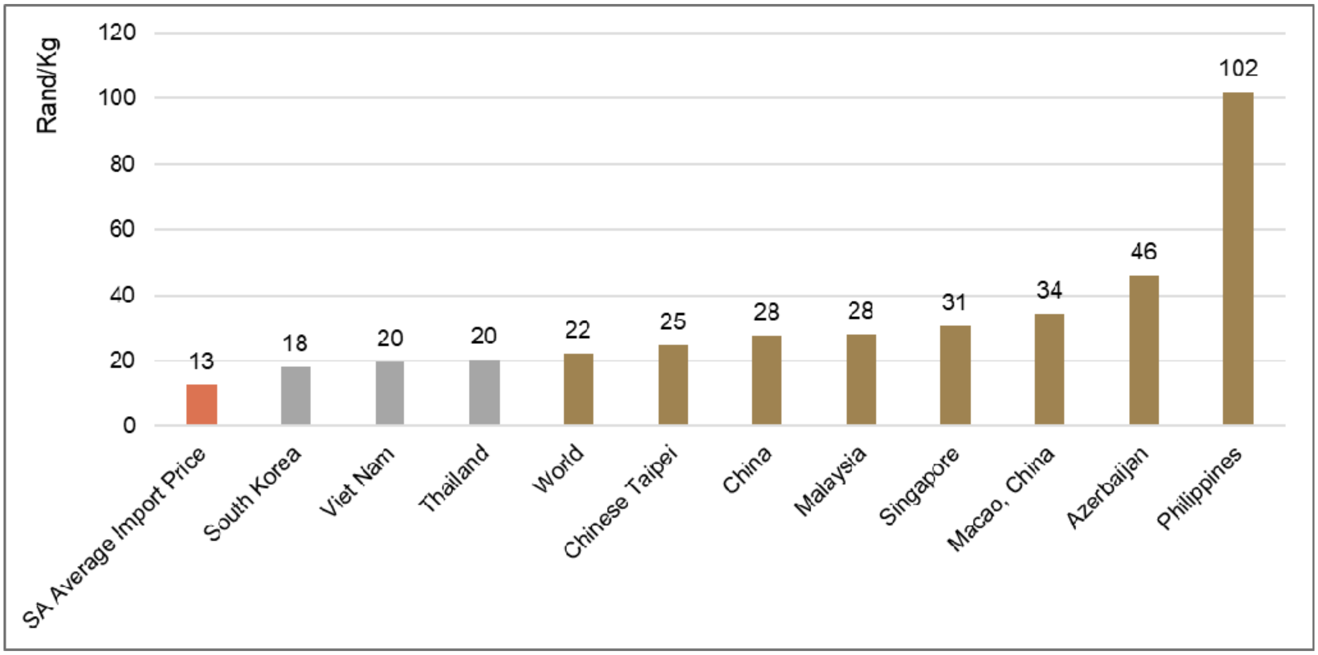

FIGURE 16: HONG KONG 2016 AVERAGE EXPORT PRICES COMPARED TO SA IMPORT PRICES

Source: Trade Map, 2017

TABLE 5: TARIFF RATES APPLIED BY SA TO PRODUCTS FROM DIFFERENT EXPORTERS

HS Code	Product	China and Hong Kong	Brazil	Netherlands	United States
020712	Frozen fowls of the species Gallus Domesticus, not cut in pieces	37.67%	37.67%	0%	37.67%
020714	Frozen cuts and edible offal of fowls of the species Gallus Domesticus	29.64%	29.64%	0%	29.64%

Source: Market Access Map, 2017

3.5 Trade related considerations of the HPAI outbreak on ostrich meat

Figure 17 below illustrates South African ostrich meat exports since 2009. The drastic decline in exports during 2011 was due to an outbreak of AI in April of that year. The European Union, South Africa's leading export destination at that time, implemented a trade ban that would last more than four years, forcing South African exporters to focus on exporting processed or cooked meat products. Figure 18 shows how, once the ban was lifted in August of 2015, unprocessed export volumes soared, and export prices stabilised once access to European markets was regained. **Since South Africa experienced a new outbreak of HPAI during the third quarter of 2017**, the impact on unprocessed meat exports will only be evident once new trade data is released.

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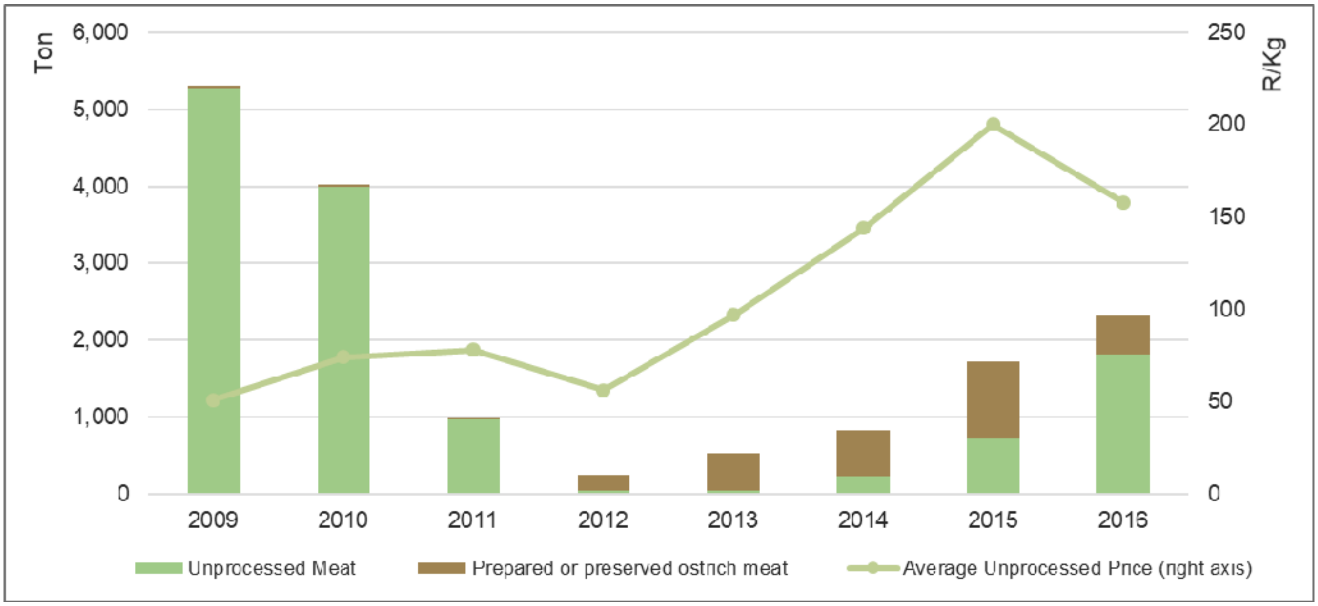

FIGURE 17: YEARLY SA OSTRICH MEAT EXPORTS

Source: Trade Map, 2017

FIGURE 18: MONTHLY SA OSTRICH UNPROCESSED MEAT EXPORTS

Source: Trade Map, 2017

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4 Conclusions

In light of the importance of the South African poultry industry in the broader agricultural context, the purpose of this report was to evaluate the economic impact of the 2017 outbreak of HPAI on both the broiler and the layer industries in South Africa. The evaluation of this impact was approached through a retrospective as well as a forward-looking assessment.

The retrospective analysis aimed to determine a number of things:

- The impact of the disease to date in terms of the number of birds lost or culled
- The associated value of such birds lost or culled
- Quantification of the direct cost associated with the outbreak for affected producers
- Quantification of income foregone as a result of culls and quarantine related restrictions, which implies that affected producers are unable to generate an income for a significant period.

Significant findings from the retrospective analysis are as follows:

- Surveys indicated that as much as 5.4 million birds have been culled to date on commercial production units
- A biological loss of just over R317 million, split proportionally between the laying industry (76%) and the broiler industry (24%).
- Direct costs associated with an outbreak amounted to an estimated R40.5 million
- The estimated income foregone as a result of the outbreak required strong assumptions regarding the production process and length of the remaining cycle.
    - The economic effect of this component is, by far, the largest with the aggregate income foregone estimated at just over R1.5 billion.
    - It should however be noted that this is not an instantaneous effect and the aggregate effect will be spread out over a period of between 18 and 24 months.
    - If all these factors are taken into consideration the total effect of the AI outbreaks in 2017 could be as large as R1.87 billion, spread over a period of 18 to 24 months. This amounts to 18.35% of the total gross value of egg production in 2016 and 1.6% of the total gross value of animal products in 2016.

The forward-looking analysis was aimed at quantifying the price impact associated with the loss of production, as well as differences in restocking strategies. Using a quarterly partial equilibrium model of the South African layer industry, it evaluated 2 different scenarios:

- The first introduces the initial shock in production based on the retrospective analysis and allows industry expansion and recovery to occur as a result of economic incentives, such as the higher price resulting from lower production volumes.
    - The price increase resulting from the production shock peaked in the first quarter of

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2018, at 22% above baseline levels.

- In a second scenario, it was assumed that a vaccination strategy is approved, which allows affected producers to restock incrementally as the production system allows.
    - Some expansion also occurs as a result of the economic incentives associated with higher price, hence production volumes ultimately exceed that of the baseline projection, before starting a declining trend in the third and fourth quarter of 2019 due to lower prices.
    - The price shock peaks in the fourth quarter of 2017 at almost 22%, before reducing to levels 10% above the baseline by the second quarter of 2018.
    - The price ultimately declines below baseline levels, owing to higher production volumes. This was also evident in the USA after recovery from the HPAI outbreak in the layer industry in 2014.

The year on year increase of approximately R4 per dozen by the fourth quarter of 2017 will impact negatively on egg consumer, many of which fall in lower income levels and rely on eggs for an affordable source of protein. Within the broiler industry however, the price impact is far less pronounced, due to trade playing a much larger role in the market under normal conditions. As such, the reduction in domestic production, which is much smaller than in the layer industry, can more easily be compensated for through higher import levels.

Combining the shocks in the broiler and layer industries into the annual BFAP sector model provided the impact of the disease on related industries, such as feed grains, while also providing an aggregated impact on agricultural GDP.

- The price increase resulting from reduced production volumes mitigated the bulk of the effect on national value added from layer production
- Hence, the effect on agricultural GDP and consequently the South African economy was small.
- Affected producers are unable to benefit from such price increases and therefore, losses on affected production sites remain substantial.
- Producers that did not have an outbreak will increase revenue significantly as a result of higher prices

Globally, two different strategies have been employed to curb HPAI. Some countries, such as the USA and Europe have followed a culling strategy, which is typically accompanied by compensation to producers that have to cull. Others employ a vaccination strategy. While this study did not attempt to quantify the success of possible vaccination strategies, it did illustrate that affected producers, particularly in the Western Cape, were loath to restock unless it is approved. Hence the scenario where production lost as a result of the HPAI outbreak is re-introduced into the market exogenously, in addition to expansion resulting from higher prices, can be considered to represent a successful vaccination strategy. Under this scenario, the impact on related industries, as well as egg consumers, is significantly reduced and towards the end of the projection period, even becomes positive. It should however be noted that the effect of

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vaccinations on the live bird market for spent hens was not factored in. This is a significant consideration, as such birds will need to be slaughtered as opposed to sold live, resulting in hawkers and informal agents acting as middle men in live transactions unable to continue in their current business model.

The last factor that would be influenced as a result of a vaccination strategy is possible changes in trade patterns should HPAI become endemic to South Africa. This will affect possible broiler export strategies which are currently being considered, whilst also allowing countries where HPAI is currently endemic to export to South Africa, which is not currently possible. The only large exporting country in the global market where HPAI is endemic was China. It was shown however that the export mix originating from China does not match the South African import mix very well. Furthermore, China receives higher prices than South Africa's historic import price in a number of its current markets. Factoring in the general duty on bon-in imports into South Africa, it was shown that Chinese producers would find it hard to compete with traditional export markets into South Africa. The concern of additional imports should therefore not be overstated, but it should also be noted that a compartmentalised vaccination strategy need not result in endemic status.

As with most agricultural sectors, it should be noted that the effect of a disease such as HPAI entailed severe losses in certain areas, while producers that were not affected in fact benefitted from higher prices. Therefore, one should not consider the aggregated national impact, without noting that affected areas suffered severe losses. Compensation of such losses is critical when a culling strategy is followed to contain the disease. Despite the decline in production volumes, the nature of the product implies that trade has a very limited role in the domestic market and therefore, the disease also resulted in substantial price increases, which does entice some producers to take the risk of expanding production, but also results in a much higher cost and reduced consumption levels.

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Appendix 1: Assumptions related to restocking rates

Broilers:

- Outbreaks only occurred in the breeder flock
- 5% reduction in broiler breeder flock results in a 4% loss of production volume for the year
- Parent stock laying from week 26 to week 60
- In the event of an outbreak, it takes 42 days of quarantine, plus a further 26 weeks before hens are available to start laying again
- Laying efficiency factor of 0.85 per hen per year

Layers:

- 42 days / 6-week quarantine period before repopulation starts
- Incremental repopulation: 15% assumed to be repopulated every 9 weeks
  - Based on a laying cycle of 52 weeks per hen (from age of 21 weeks to age of 72 weeks)
  - Delivered in increments of 6000 hens when stocking
  - 9 week increments to optimise laying efficiency
  - Variation will occur based on number of houses
- 21 weeks for hens to reach maturity
- Industry average laying efficiency of 0.85 eggs per hen per day

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