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Poultry Sector Support and Protection, Structural Change and Disease Risk

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Dr Ray Trewin

Crawford School of Economics and Government
THE AUSTRALIAN NATIONAL UNIVERSITY

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By

Dr Ray Trewin,
Crawford School, ANU

ABSTRACT

Poultry sectors' domestic support and trade protection, or assistance, influences the way they develop, in particular their structure, trade, investments, and aspects of disease risk. Nominal Rates of Assistance (NRAs) measuring adjusted gaps between international and domestic prices were used in analysis of relationships between these factors. Structural data took the form of average chickens per holding as well as the predominant FAO Sector (I Industrial - IV Traditional). General "bird flu" incidence was obtained from an official website. Assistance constrains efficient trade, encourages smuggling/informal trade, diminishing the incentives for good management, leading to greater disease risk. It also constrains efficient investment, leading to greater disease risk through weaker SPS, research and other relevant institutions. Assistance can also constrain structural change, hindering development of efficient industrial production systems, or maintaining larger traditional sectors, resulting in greater disease risks.

The research illustrates that "true" (unassisted) exporters tended to have low NRAs and "true" importers high NRAs. Negligible trading countries mainly had low NRAs apart from those with strong self-sufficiency policies. Structurally, all countries experienced concentration with relative growth in industrial sector holdings. The NRA and structure scatter plot illustrated that the "true" exporters and "true" importers fell into two groups of mixed structures; low (high) NRAs, more (lower) market incentives and lower (higher) HPAI incidences. HPAI experiences also appeared to be regionally based.

A clear conclusion is that assistance does not determine structure – some countries had strong enough political economy objectives to be willing to pay the high cost of over-riding open market forces on their structures. However, assistance did determine whether structures were distorted and not economically efficient. Technically efficient developed structures in conjunction with (export) market incentives driving economic efficiency and encouraging better risk management, appear to positively impact on HPAI risk. High assistance levels hinder open markets' role in the demise of inefficient, poorly managed productions systems, whether they be traditional or not, and creates greater disease risk.

Poultry Sector Support and Protection, Structural Change and Disease Risk[1]

Dr Ray Trewin,
Crawford School, ANU

1. Introduction

The incomes and populations growth in developing countries, especially in urban areas, has created strong demand for livestock products. Supply responses to this growing demand have largely been in terms of an expansion of poultry production. This is because many countries can rapidly take up poultry production which has few religious/cultural concerns and has been able to maintain relatively lower prices through structural changes. These structural changes have been driven by aspects such as relatively transferable technological developments that ensure an efficient/economical conversion of grains to animal protein as well as concerns with disease controls. There is a variety of production systems from backyard, commercial to industrial with varying levels of bio-security, market outputs (exports, urban, rural), etc, with the industrial system taking up most of the growth. Impacts of these rapid poultry sector changes on aspects such as poverty alleviation and the environment are being studied. However, the impact of these on control of diseases has received relatively little attention.

Some initial research suggests that domestic support and trade protection (both positive and negative) of national poultry sectors influences the way it develops, in particular its structure, trade and investments in different components of the industrial poultry chain. It is felt, based on indications from recent HPAI epidemics, that some of these influences could impede a country's ability to prevent and control contagious diseases.

To test the hypotheses, especially the extent poultry sector development characteristics like structure are influenced by protectionist policies, will require quantitative measures of protection for the poultry sector. A sample of countries from each of the following categories will be selected, data collected and analysed:

- strong exporters (>10% of national production) of poultry products (generic stock & food products)(probable examples, the US, Brazil, Thailand and Netherlands);
- strong importers (>10% of national consumption) of poultry products (generic stock & food products)(probable examples being Caribbean countries); and
- negligible exports and imports (<2% of national production and consumption respectively) of poultry products (generic stock & food products)(probable examples being Indonesia, Vietnam, Egypt, Nigeria and China).

There are sub-categories within these categories, for example the strong exporters and importers are made up of a mix of developed and developing countries, and a number of countries within the negligible exports and imports category are major producers and consumers but their trade has been constrained by self-sufficiency policies. Some

[1] The author acknowledges support and feedback from the FAO in preparing and presenting a report based around this subject as input to the forthcoming State of Agriculture Report on "Livestock at the Turning Point" on which this study draws.

countries not falling into these categories are still major exporters or importers in quantity terms, even though their self-sufficiency ratios do not vary much away from 100% and an example of such countries will be included in the sample. The sample will also have coverage of countries that have and have not been able to prevent and control HPAI.

2. Relevant data collected

From the introductory discussion, there are a number of secondary data that may be required for each country over time (e.g. over the last 10 years) for the analysis:

- poultry sector structure and structural changes
- poultry production and consumption
- poultry trade and investment
- poultry industry input subsidies including feed
- poultry product and generic stock import tariffs
- public investments on poultry production and processing research and extension
- subsidies on poultry services – technical and management systems
- subsidies on the promotion of poultry products, nationally and internationally
- export subsidies
- poultry and poultry product export taxes
- Sanitary and Physo-Sanitary (SPS)-measures; and
- aggregate protection coefficients (e.g. OECD Producer and Consumer Subsidy Equivalents (PSEs and CSEs respectively – known as Support Estimates) and WTO Aggregate Measurements of Support (AMS))

Ratios of poultry exports to production, and imports to consumption, are required to classify countries into strong (or large) exporters, strong (or large) importers, and negligible exports and imports. Spreadsheet data provided by the Trade and Markets Division (EST), FAO contained these ratios for poultry meat (trade in livestock is relatively much smaller) from 1981 to 2006 for a large number of individual countries, though the European Union (EU) is presented without a breakdown of individual members (individual EU country information was obtained from FAOSTAT).

There were more strong importers than strong exporters with the number of countries with negligible exports and imports lying between. Some countries like Togo, Canada, Hong Kong, Oman, UAE, Bulgaria, Slovak Republic, Czech Republic, Croatia, Slovenia, Estonia, Latvia, Lithuania and Belarus were both strong exporters and importers in 2006 and will not be considered for the cross-sectional analysis that needs to separate these aspects. Probable examples mentioned above that did not fall into their nominated categories included Vietnam (2%<imports<10%), Egypt (2%<imports<10%) and China (2%<imports & exports<10%). Egypt and Vietnam have only fallen out in recent years (illustrating the extent of growth in the sector) and could be included in their nominated category on the basis of their situation over the majority of the 10-year period. China is a large exporter and importer in quantity terms (with imports generally higher than exports over the last 10 years except in two of the last 3 years collected, again illustrating the degree of growth) and will be included in the sample on this basis.

Poultry protection coefficients

There are a number of possible consistently-derived aggregate protection coefficients that could be used in the analysis, such as the OECD's PSEs/CSEs (see www.oecd.org), WTO's AMS (see www.wto.org) and the Nominal Rate of Assistance (NRA) recently developed in the World Bank's "Distortions to Agricultural Incentives" project (see www.worldbank.org/agdistortions and Anderson 2009). Aggregate measures are generally used as they are what is negotiated in the WTO and analysed, not individual measures like tariffs (especially bound rather than applied tariffs) that can be swamped by more significant trade impediments such as non-tariff barriers (NTBs), and on their own can give a false measure of sector level protection.

Individual measures are available for some countries (see Mehta 2003 for domestic support (values or prices) and export subsidies of poultry products obtained from notifications for selected WTO-member countries and years). Some individual measures are less significant representations of protection than others. For example, public investment on developing country research is available from ASTI (see www.asti.cgiar.org though poultry-related research is difficult to identify, dated and sparse) but would appear small relative to other individual measures like tariffs and input subsidies. There is also a question over its protection characteristics with some arguing that subsidies in this area are addressing a public-good market failure that results in under-investment in such research, the benefits of which spillover to the international community. Market price support (MPS) tends to dominate protection policies, increasingly in developing countries where budget funds for direct payments are scarce, and in conjunction with input subsidies (OECD 2007). Measures of MPS are available for poultry for Australia, Canada, Czech Republic, EU, Hungary, Iceland, Japan, Korea, Mexico, New Zealand, Norway, Poland, Slovakia, Switzerland, Turkey and the US.

Some of the individual measures of protection may have stronger relationships with trade, investment and structural impacts, and subsequently with impeded prevention and control of contagious diseases. The most obvious possibility of this would be differential import tariffs between generic stock and poultry product. A US Economic Research Services (ERS) spreadsheet of applied tariffs was used in conjunction with data on live-trade also provided by EST FAO to draw out some information on this aspect. The main live traders are US-Canada, EU-Eastern Europe, Hong Kong-China, Singapore-Malaysia and Egypt, not unanimously countries most associated with contagious disease breakouts, pointing to the fact that just small numbers such as might occur through smuggling, informal uncontrolled trade and wild birds could be responsible for such outbreaks, especially in unprepared systems. In terms of tariffs, these cascade with processing, for example Egypt has 5% applied on live and 32% on processed, China 10% and 20%, and US 2c/kg and 18c/kg (Canada and EU were too complex to summarize) though countries like the US generally have stronger SPS-type regulations.

The aggregate measures are related but each has its own advantages and disadvantages. Deficiencies in AMS are well described in FAO (2006) where it is pointed out that they are just the basis of legal commitments to reduce some trade distorting support in the WTO Agreement on Agriculture. Unlike the PSE, the AMS "is not a useful economic

tool to understand the degree and impact of distortions in agriculture" (Orden et al 2007) as is required in this analysis. AMS has a base period of 1986-88 whereas the PSE uses actual producer and border prices in a given year to provide a measure of total support to producers based on annual monetary transfers through policy measures (market price support, budgetary payments and budget revenue foregone). AMS only covers domestic support policies that are in the Amber Box, and unlike PSEs, excludes production-limiting policies (Blue Box), minimally trade-distorting policies (Green Box) and de minimis level of trade-distorting policies (FAO 2006).

The PSEs exclude agricultural research and extension but include some other more controversial general service expenditures like insurance schemes, environmental payments and some regional development expenditures (Orden et al 2007). Orden et al (2007) provided some other critiques of PSEs, which they use in their analysis of China, India, Indonesia and Vietnam, in two main categories of 1.) assumptions underlying the concept (e.g. independence between domestic and international prices, and the perfect substitution of domestic and international goods) and 2.) its interpretation (e.g. directly capturing the trade effect of agricultural policies, representing producer surplus, and whether farmers or others capture the benefits). Similar critiques are provided in Cahill and Legg (1990), and OECD (2007). Cahill and Legg (1990) compare PSEs with alternative measures of assistance such as NRAs (the difference between the "output incentive price" and the world price which accounts for all policies that raise prices received by domestic producers) and effective rates (ERs) which include border protection and assistance on inputs.

Anderson et al (2006) put forward a form of NRAs (the percentage distortion to the gross price of farm products) that attribute price distortion estimates for each farm and lightly processed product (e.g. milk and sugar) to specific border or domestic policy measures (e.g. tariffs and import taxes) after adjustments for transport, margins and quality. The components can be used in economic models that estimate policy impacts on social welfare etc. To collect long time-series for a wide range of countries with different complexities and data qualities requires such a simple indicator. The measures of distortion using NRAs, though strongly related, differ from the PSEs which are expressed as a fraction of the distorted value and are always smaller than NRAs.

PSEs are stated by Cahill and Legg (1990) to be "straightforward, easily understood and feasible" measures of (nominal) agricultural assistance required by policy makers. ERs may be a better indicator of the incentive effects of all relevant policies but the market-price support aspects of PSEs provide a good guide to the level of price distortion. Moreover, PSEs do not have the same substantial data demands facing ERs which is why relatively few have been estimated. ERs were not estimated in World Bank (2006) as this would have required each product's rarely available value-added share of output. In most developing countries, the value and distortions to farm inputs are relatively small compared to those applying to outputs. When these input distortions were significant, they were taken into account by calculating a NRA for these inputs and adding this to the NRA for output to obtain a total nominal rate of assistance to farm production.

Another important aspect in the choice of suitable measures such as NRAs and PSEs is data availability. Tangerman (2005) stated that PSEs were "the only available source of internationally comparable information on support levels in agriculture". Some comprehensive databases such as that developed in the GTAP model (https://www.gtap.agecon.purdue.edu) only measure tariffs, not NTBs and export taxes. Since 2005, however, the World Bank project on "Distortions to Agricultural Incentives" has developed a comprehensive collection of data on the distorting impacts of agricultural support and protection (World Bank 2006). It provides long time-series of measures such as NRAs for a large number of countries, especially developing countries for which such measures are relatively rarer, across all regions of the world. But there is generally a trade-off between such comprehensiveness and detailed component measures of domestic support and trade protection. It is more comprehensive than the OECD data on PSEs etc which only provides information for a few developing countries but at a broad level of component detail, for example commodity MPS which are sometimes needed to properly reflect changes in agricultural policy reforms masked in aggregate measures (Tangerman 2005). Some other collections like the WTO Trade Policy Reviews may have more detailed descriptive information that could be also used to reflect policy reforms but these are only available for intermittent years. The appendix **Table A1** lists the countries covered in the more comprehensive World Bank (2006) and the OECD databases that fall within the required categories. Top world rankings of live (L) and processed exports and imports are noted in brackets. India does not rank as a top exporter or importer because of a strong self-sufficiency policy, also applied by Indonesia and Korea (Dem.), but is ranked in the top 10 world production and consumption. Many of the negligible exports and imports countries had no poultry NRA details, reflecting poultry's relative insignificance in these countries' overall agricultural production.

Limitations on the existing protection data were outlined in the above discussion and included country coverage; the detail of the component measures that could be useful in determining what were the real impacts of policy changes; "effective rates" that fully take into account distortions to inputs; and accuracy (as is evident from the two NRA estimates for South Africa given in **Table A2**). These limitations are not critical to analysis being able to be undertaken on the hypotheses of interest.

Poultry structural change

Other key data, such as details on structural change, are not as readily or consistently available as is the protection data. The table from Narrod et al (2007) under Thailand in the Appendix, which shows an increase in large and a decrease in small poultry farms over 1988 to 2003, illustrates the extent of data that can be available. Econometric measures of such changes in structure based on the structural distributions could be developed. If such detailed structural distributions are not available, then (point trends of) distributional averages (e.g. chickens or meat/eggs production per production unit) could be used (the FAO website is a predominant source of summaries of most countries' Agricultural Censuses which generally have some details on poultry holdings and bird numbers – see **Table A3** for details). These measures link to some productivity measures and could be considered a representation of outputs in respect of management or technology inputs. Other possible proxies, when structural averages are not sufficient,

include dummy variables for the predominant structure of production systems (e.g. classification such as the predominance of FAO's Sectors I-IV[2] over (sub) periods)).

The interest in the structural data is to ascertain if there are consistent relationships between protection and structure (in its own right and as an intermediate to analyzing relationships between protection and disease risk). Broad data is probably most relevant here (e.g. low and high protection's association with a competitive, predominantly Sector I production system) as it is most unlikely there will be linear-type relationships such as NRAs change on average by x percent for each marginal chicken per holding.

The data being sought, given the general non-availability of structural distributions for many countries, are the structural averages. Such information, though somewhat dated is most readily available, hopefully on a reasonably consistent basis, from the FAO website. Separately listed census summaries were the main sources used from the website but on occasions more up-to-date or detailed information was available from listed linked websites, often the country's agriculture ministry or its statistics agency.

Although some components of the poultry industry are heavily traded (e.g. commercial poultry meats), others are not (e.g. native chickens). It might be argued that a relationship involving protection measures should be restricted to the structure of traded components but the broader relationship includes disease risk and there are strong interconnections between the flocks of the various components, especially the traditional sector, and even wild flocks, in this regard. Therefore it is more appropriate for the full purposes of this research to include in the relationships the structure of the countries' overall poultry industries. However, the structural averages are an aggregate of quite different components, for example less technically efficient traditional sectors that often survive by drawing price premiums, a bit along the lines of organic and some other less technically developed products. A focus on the traded broiler sector would change the structural averages but generally not the ordering of the countries – exporters averages would most likely change most, followed by importers (apart from perhaps Russia whose overall industry focus has been on an import-competing industrial sector) and then the others.

Another issue is whether a time series matching the protection data would be useful or whether just a trend or even a single average (which relate to intermittent censuses for different years and for different countries) would suffice. In descriptions in Appendix 1, countries that had several relevant censuses around the analysis period illustrated that there was generally no significant change in the structural averages – those that were predominantly Sector I-type production systems, etc remained so over the 10-year period. If background material suggested this was not the case, as it might with a fast growing developing country, then time sensitive measures of the changes in the structure were derived.

[2] Sector I intensive, large-scale, industrial poultry production (high bio-security); Sector II semi-intensive, medium-scale, commercial poultry production (moderate to high bio-security); Sector III semi-commercial, small-scale poultry production usually for live bird markets (low to minimal bio-security); and Sector IV traditional extensive backyard production consumed locally (minimal bio-security).

Some countries did not have any censuses listed (e.g. Russia) and others had minimal information (e.g. Indonesia just total heads of chicken). Here, other information was used to derive the required structural averages with details of this documented in an appendix.

SPS and other relevant poultry information

Some SPS-measures are said to address externalities associated with disease importation and care is required to separate those that are distortions from those that are appropriate market intervention measures (Anderson et al 2006). A measures that is so costly to consumers relative to disease prevention benefits for import-competing producers would not appear appropriate, as national welfare would be improved by their removal (James and Anderson 1998). Regardless of the underlying intent of the SPS-measures, in terms of the analysis in this project the effect could be the same – isolating the domestic industry from foreign competition that could influence structural development and its impact on a country's ability to prevent and control contagious diseases.

The effect of any distortionary impacts of SPS-measures can be captured in the estimated gap between domestic and international prices, adjusted for non-distortionary aspects such as quality differences, margins, transport costs etc. There are two basic approaches to measuring impediments, direct measures of specific impediments that could miss less transparent ones or adjusting the gap for known non-protection effects such as quality differences as are used here (Trewin et al 1995). SPS-measures tend to have selective bilateral effects. For example, the US bans Brazil poultry products but other competition keeps its NRAs low with adjusted domestic prices around international prices (with Brazil moving its product to other markets where it often out-competes the US). Thus it is unlikely that adjustments need to be made to the gap for SPS-measures unless they are applied universally and are non-distortionary.

The following Peterson and Orden (2005) table on bilateral SPS-barriers to poultry trade would require expansion to cover all potential sample countries (currently Thailand imports are banned by the EU and Japan, and Mexico bans imports from some US states) and updating (e.g. Russia now does not allow some EU imports, and Japan the same with China imports) if it was to be used in the analysis but it does illustrate the extent of SPS-measures, including in South-South trade.

	Importers					
Exporters	**US**	**Brazil**	**EU**	**China**	**Japan**	**Russia**
US	-	Banned	Banned	Allowed	Allowed	Allowed
Brazil	Banned	-	Allowed	Allowed	Allowed	Allowed
EU	Allowed	Allowed	-	Allowed	Allowed	Allowed
China	Banned	Banned	Banned	-	Allowed	Allowed

Petersen and Orden (2005) concluded that global trade would expand by more than 25% if non-technical barriers were removed by major importers, and even more with the removal of SPS-barriers (primarily US access to the EU).

Other key information required for a fuller analysis is that on a country's ability to prevent and control contagious diseases. Broad information on this aspect, much of it becoming evident in research that was reviewed for the key hypotheses of this research, was collected to assist in preliminary development of the broader hypotheses incorporating disease elements. For example, it was mentioned in one reviewed research report that EU HPAI outbreaks tended to be in non-commercial flocks or from wild birds. Information on official reports of outbreaks of notifiable poultry diseases is available on the OIE website (www.oie.int).

When available for the countries concerned, other relevant information can be provided from agricultural policy information held by the OECD (e.g. Nominal Protection Coefficients (NPCs) in OECD 2007) and other agencies such as WTO Trade Policy Reviews and country notifications, and USDA FAS GAIN reports.

3. Poultry protection coefficients and steps taken to derive them

From the above it can be appreciated that the NRA estimates from World Bank (2006) are the most appropriate, mainly on the basis of their comprehensive country coverage.

In terms of the sample choice, the following countries were suggested by the FAO with brief FAO HPAI assessments in brackets (these differed on occasions from the latest OIE listings, for example Japan and Russia were listed as having HPAI incidents over 2008):

Strong exporters:
- Brazil (never had HPAI)
- EU (quickly eradicated outbreaks of HPAI in some member countries)
- Thailand (several waves of HPAI)
- US (has had LPAI but not HPAI)

Strong importers:
- Japan (no HPAI)
- Mexico (no HPAI)
- Russian Federation (no HPAI)

Negligible exports/imports:
- Egypt (endemic HPAI)
- Indonesia (endemic HPAI)
- Vietnam (endemic HPAI)

Not categorized:
- China (endemic HPAI in some parts)

China, which was suggested on the basis of its large poultry production, was added to the strong importers category because of similar treatment in World Bank (2006) of countries like China that had significant trade year-after-year even though their self-sufficiency

ratio was never significantly (>10%) away from 100%, and because the majority of its poultry trade over the last 10 years resulted in net imports.

Added (negligible exports/imports) sample:
- Ecuador

Adding Ecuador, who has never had HPAI, along with China to the strong importers category, ensured a mix of HPAI experiences across categories. The final sample also has a mix of developed and developing countries amongst the strong exporters and importers with all the main exporters and importers included. The negligible exports/imports sample is made up of only developing countries, which might be expected to dominate this category given their developing trade, and covers the main developing country regions. Korea (Dem.), a developing country with HPAI, fell into the negligible exports/imports category because of its strong self-sufficiency policy, like Japan but more "successfully", and will enter some analysis using a broader sample of NRAs.

It was decided to treat the EU in terms of its individual member countries that had reported poultry NRAs in World Bank (2006) (no estimates were provided for some small members like Luxemburg) because of the evolution of its membership over the analysis period and some early period differences in some NRAs and other aspects like structure that had the potential for misleading aggregation effects. In broad terms, Germany, Sweden and the UK are major importers; France is a major exporter; and the Netherlands is both a major importer (re-exporter) and exporter. The other members with reported NRAs are Austria, Denmark, Italy, Ireland, Finland, Portugal and Spain.

The only country in the sample for which chicken meat NRAs were not estimated in World Bank (2006) was Egypt. These were derived on a consistent basis to the other Egyptian commodity NRAs that were estimated. This involved calculating the difference between domestic prices (from FAOSTAT) and international prices (from Georgia Dock weighted average wholesale price, ready to cook, presented in the Poultry News Report, Agricultural Marketing Service, USDA, plus a 25% transport margin).

Table A2 contains the NRAs collected and derived following the steps just described.

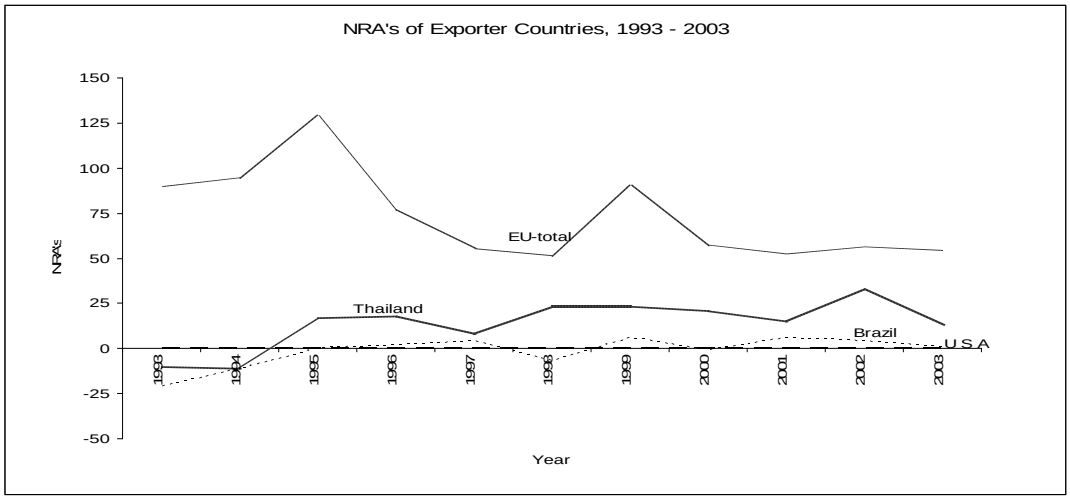
A potential element of protection that is not necessarily picked up appropriately in the protection coefficients concerns SPS-measures when these are universal and aimed at distorting agricultural trade flows rather than addressing some externalities associated with disease risk. However, in the hypotheses of interest in this project, any measure that distorts trade flows and effects structures etc, whether it is aimed at doing so or addressing externalities, is of interest. For this reason, SPS-measures will be dealt with in the later more general section on protection, structure, and infectious disease risks.

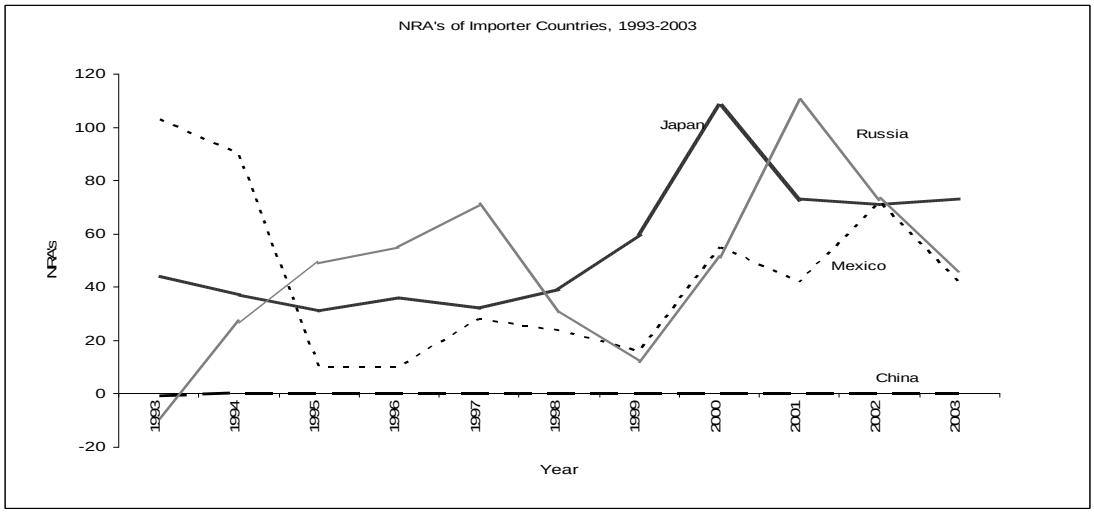
4. Descriptions of the patterns of poultry protection

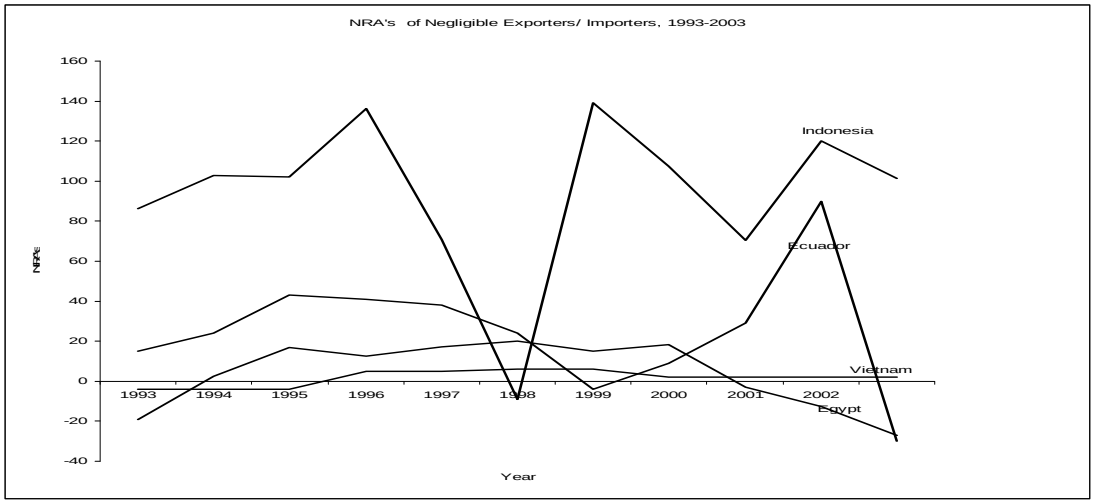
From Table A2, strong exporters have mainly low but some high NRAs (with some consistency within regions). Strong importers have mainly high but some low NRAs

(again generally consistent in regions). Countries with negligible exports/imports are a mix of the extremes of low or high NRAs in line with the country's overall level of agricultural assistance. These patterns are evident from **Figure 1** showing the sample NRAs over time within groupings of exporters, importers and others, especially when the EU and China are reclassified on the basis of analysis in World Bank (2006)(note scale changes in the various figures). In World Bank (2006), EU poultry is classified as an importable even though there are significant net exports as it has been judged that its trade status has been reversed by policy distortions such as a prohibitive import tariffs plus societal preferences for some production methods that add to costs (see Anderson et al 2006). China has changed from being a net importer at the start of the 10-year analysis period to an exporter for the last 3 years and poultry is classified as an exportable in World Bank (2006). With the negligible exports/imports shown in Table A2, Indonesia and Korea are the odd ones out amongst a group of developing countries that have lowering NRAs, having undertaken reforms and, in the case of Vietnam, acceded to the WTO. Indonesia and Korea have strong self-sufficiency policies that have been supported by border protection and input subsidies.

Figure 1: NRAs over time (1993-2003)



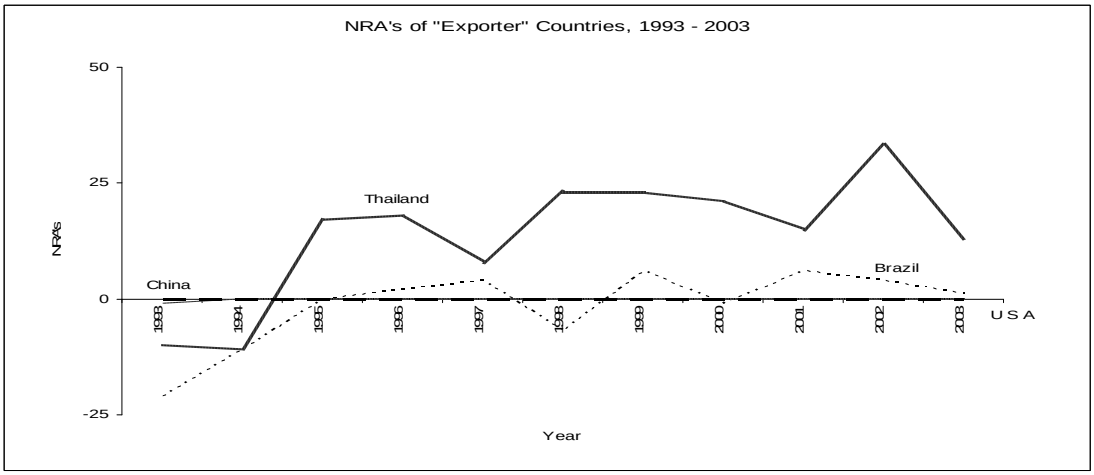


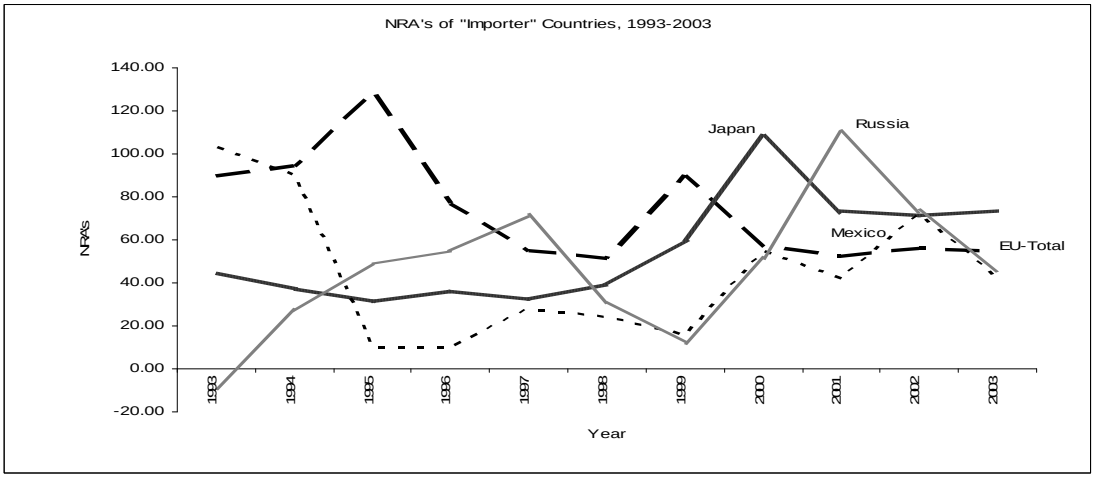


5. Preliminary analysis/commentary on protection impact on trade and investment

Figure 2 shows that true "exporters" had low NRAs, and "true" importers high NRAs.

Figure 2: NRAs over time (1993-2003)





As reflected in the EU being reclassified as an importer on the basis of the World Bank's analysis, if the Doha Round was implemented then the EU would have to cut tariffs, eliminate export subsidies and reduce trade-distorting domestic support which would significantly affect current trade flows and improve the economic welfare of both the EU and those countries that become new or greater exporters. These impacts of protection constraining trade are well understood but with poultry trade there is greater scope for applying protection through SPS-type measures. High NRAs are often associated with high income countries who can afford the high costs of protecting import-competing industries and this is the situation with the EU (including via direct payments), Japan and Korea but the US, an exporter, has low poultry NRAs. The opposite is often the case with low NRAs and more dynamic exporting developing countries like Brazil, China, and Thailand, as well as Vietnam, fitting this situation but Indonesia and Russia with strong self-sufficiency policies not.

Indonesia can be used as an example of the inappropriateness of some self-sufficiency approaches like which it re-introduced for rice following a period of open-trade under the IMF rescue package when it raised domestic prices over international prices and imposed import bans to try to achieve self-sufficiency by protecting and assisting domestic producers with some compensation for poor consumers (Warr 2005). The poor would have been better off with Indonesia staying open to the most efficient producers in the world (Thailand continued to export in the recent high-price environment) and subsidising food rather than domestic food production (as in the Philippines). (The case of subsidies being useful in the uptake of new technologies that increase production to new levels is well gone.) Indonesia would have probably gone close to achieving efficient self-sufficiency if they let high international prices flow through to the domestic market rather than banning exports in trying to clear the domestic market at a price below high international levels. This action of trying to force self-sufficiency would assist domestic consumers who will be encouraged to consume more than otherwise. Input subsidies aimed at compensating farmers for higher input prices and lower output prices, might induce some additional production than would be produced otherwise. With higher world prices closed out of the domestic market, hoarding of stocks and smuggling of rice out will occur (previously stocks were lowered and rice was smuggled in), and if they compensate producers through input subsidies, even in the short-term, these inputs will be smuggled out as well. Subsidising inputs, that has led to excessive use and environmental problems in the past, can crowd out any private enterprises in this area, and affect other non-rice production. Incentives for increasing production to what it would be under international prices will be diminished unless the full extent of the price differences are met by the subsidy. Subsidies were very expensive even at the old levels aimed mainly at encouraging the uptake of new technologies. Without the full subsidy, farmers may be better off producing other non-banned products or undertaking other activities. Closing the domestic market off from the international market not only makes Indonesia more vulnerable to weather situations but requires distorting the domestic market, losing benefits from better resource allocation and dynamic competitive forces. In the longer-term, investments in R&D and infrastructure, and more private sector involvement, will improve the efficiency of supplies on a more sustainable basis than

subsidies. Such policies were included along with more open trade and better market information in the "good" approaches laid out in IFPRI (2008). "Bad" approaches included trade bans/taxes and long-term input subsidies, the foundations of self-sufficiency approaches.

Spillovers from constraining trade can be complicated (e.g. protection may maintain a structure of relatively more smallholders which may be more vulnerable to contagious diseases unless other integrating approaches such as cooperatives and contracting are undertaken – initial responses to HPAI include immediate closing of free-range holdings that tend to be smaller than industrial structures and longer-term ones like moving traditional sectors out of urban areas). These complications will be dealt with later and just more direct relationships of protection on poultry trade and investment covered here.

With investment, it was wrongly thought that protection might attract investment behind tariff walls etc. International companies look more to a transparent, coherent and consistent policy environment rather than to preferences when making investment decisions. Protection is seen as a sign of a conservative mindset and tends to discourage investment in a globalized world that relies on open trade and investment. Poultry is dependent on competitive international inputs such as feed and technologies based around industrial-type structures if it is to remain competitive, and globalization is important to obtain access to these aspects. Investment data across countries at a level like poultry are difficult to obtain. Databases like UNCTAD's World Investment Report and WTO Trade Policy Reviews, at best, report consistently only on broad sectors like food and agriculture. Even at the specific country level like with Japan where ministries and JETRO provide detailed data on FDI, this is not at a specific sector-level apart from possibly in lists of significant investments (Drysdale et al 1999).

Low NRA poultry exporting countries might expect high incoming investment but data to determine this is hard to find. The given FDI source can be misleading with much coming from haven countries such as the British Virgin Islands. Figures for Brazil only have incoming FDI, as might be expected given its developing status, and although this is provided in terms of farming of animals, the stock of FDI in this sub-category had no entries for many years. With the US there are entries in both incoming and outgoing FDI in this sub-category and interestingly, the incoming stock of FDI is greater than the outgoing stock, supporting the view that investors can learn much in terms of their own industries from investing in efficient overseas countries. Import-competing countries might be expected to have less incoming FDI for the above reasons but also so their own industries capture the implicit rents that are contained in high NRAs. Japan has no incoming FDI in the primary industry category and outgoing FDI is only given for the broad agriculture etc category. There appeared no useful FDI information for China and Thailand.

6. Comments on relationships between protection, structure and infectious diseases

Poultry structure

The key quantitative focus of the study concerns protection influencing the development of a sector's structure, an aspect that was a strong intermediate element of the trade and investment impacts on disease risk. There has been a global trend in recent years towards large, international and highly vertically-integrated private poultry firms in most countries, especially some developing countries who production and exports have increased dramatically (e.g. in Thailand over 1988 to 2003, Narrod et al 2007). Small poultry farms still make up the majority of production in Less Developed Countries but the trend to larger poultry farms is still present. There are similar trends from live to more processed end-products being purchased by consumers.

Specific details on each sampled country's poultry industry structure are presented in **Appendix 1**.

From even a casual observation of the countries' data it can be appreciated that not all countries with significant efficient Sector I production systems will have the same broad level of NRAs. For example, exporters Brazil and the US have low NRAs (close to zero, though the US has more stringent SPS, anti-dumping and safeguard regimes that may need to be taken into account in terms of overall measures of protection) whilst the EU has high NRAs (averaging around 80% over the last 10 years, as well as stringent SPS, etc regimes) yet in terms of structural summaries, the EU falls between Brazil and the US in terms of chickens per holding. Obviously a bilateral relationship between the basic data is not capturing all relevant factors in terms of the hypothesized relationships. The EU is made up of a mix of countries and from the structural averages, the Netherlands and some others have predominantly Sector I production systems that compare favorably with the US in terms of technical efficiency but also a number have significant traditional sectors. Brazil has a large Sector I that can compete with the US on export markets but also larger other sectors, including traditional sectors, that can have a marked effect on the averages and aspects like disease risks. A FAO report on long-term farming trends using agricultural censuses (Anriquez et al 2007), had developing countries Brazil and Thailand with significant but relatively low shares of small farms compared to other developing countries (20% and 33% respectively). Brazil, the US, and to a lesser degree, Thailand, fit the usual scenario of competitive (predominantly Sector I) export industries being lightly protected. The EU is different in that it is highly protected but in World Bank (2006), EU poultry is classified as import competing.

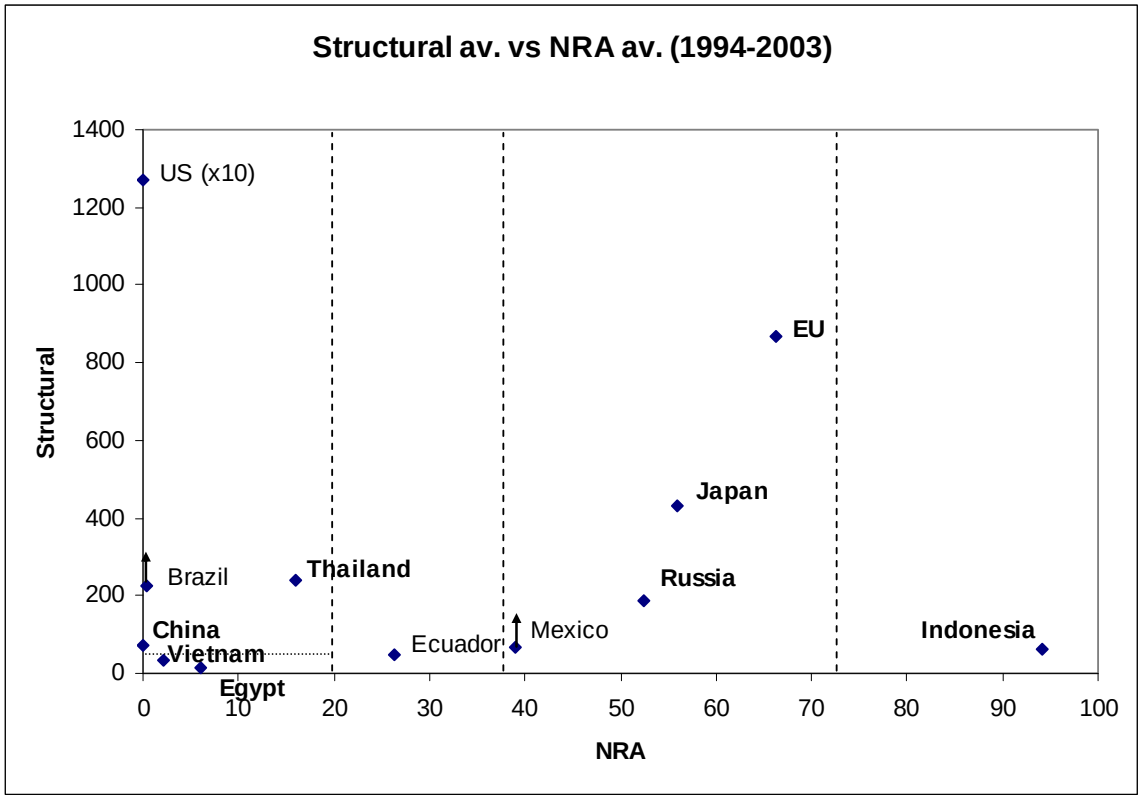
A common scenario for import-competing industries is that they are more highly-assisted or protected than export industries. This is the situation for the sample of importers apart from China which, as mentioned earlier, has changed from being an importer at the start of the 10-year analysis period to an exporter for the last 3 years, and poultry is classified as an exportable in World Bank (2006). The importers could have predominantly the more technically efficient Sector I production systems, especially if they can afford a strong self-sufficiency policy as is the case with Japan whose structural average is of a similar level to that of the developed country "exporter", the EU. China and Mexico have

structural averages that lie between those of the developing country exporters, Thailand and Brazil (China's share of small farms was estimated at 98% in Anriquez et al 2007). Russia is a developing country with a recent strong self-sufficiency policy (e.g. import quotas and duties, input subsidies and SPS controls) though its costs are causing some consumer tensions and its high NRAs will come under scrutiny in WTO accession negotiations. However, it has started to rapidly develop some agricultural industries since the 1990s, particularly poultry through new breeds, modern management etc. Although its initial estimated structural average (for agricultural enterprises which are a small 9% of poultry holdings but over 50% of output) in Appendix 1 is unrealistically high, it is still a reflection of such rapid development as described in various GAIN Reports.

The "negligible trade" sample is made up of developing countries that are mainly lightly protected, having undertaken reforms and, in the case of Vietnam, acceded to the WTO. Indonesia, the odd one out, has a strong self-sufficiency policy that has been supported by border protection and input subsidies, and fits more the above importers. Structural averages are generally relatively low, of the same order as China and Mexico. Egypt's structural average is the lowest of all the 12 countries sampled, having like a number of the other sampled developing countries, a very large traditional sector that had been supported by high levels of protection, now being brought down (Egypt's share of small farms was estimated at 96% whilst Vietnam's was 95% but Ecuador's only 43% in Anriquez et al 2007). Indonesia's estimated structural average is unrealistically high which reflects the limited treatment of the traditional sector in its estimation and has been proxied by Thailand's earlier 1998 average. The high levels of protection have assistcd the maintenance of its very large traditional sector and their appropriate inclusion would lead to much lower estimate of its structural average than initially made.

The following scatter diagram (with grid lines capturing broad groups along both axes) of the most recent structural average (the year average is around 1999-2000) and the average of NRAs (around the same year), illustrates the above discussion. Most recent structural averages of only in the 1990s for Mexico (1991) and Brazil (1996) are over 10 years old and, given the dynamics of these countries poultry industries, current structural averages will be much higher (at least double) , although movement of their scatter points up the diagram (see arrows) will not affect their groupings. A cluster of low NRA countries have both predominant Sector I systems (e.g. US) and significant traditional sectors (e.g. Egypt and Vietnam) but many of these are already developing towards predominantly Sector I systems with the incentives flowing from low NRAs and efficient exports (e.g. Brazil, Thailand plus China). This is not a development that necessarily involves the traditional producers moving up in scale to become part of the Sector I holdings, though arrangements like cooperatives and contracting can assist in this regard (see for example Trewin (2004) which mentions some Australian dairy cooperatives moving from a body of traditional producers to international dairy trading companies). High NRA countries again have a mix but the predominantly Sector I countries are dependent on the high assistance for their size (e.g. EU, Japan). Protection or assistance can be given in a form that will develop industries or not. Russia, a developing country, has a more predominant Sector I structure as a result of strong self-sufficiency policies. However, predominant traditional sector (developing) countries' assistance can maintain

their predominant Sector IV structure whilst aiming for self-sufficiency (e.g. Indonesia). The main difference between this type of industry development and that mentioned in relation to the exporters is that the latter is economic efficient and the former is not. Mexico and especially Ecuador fall in between these two cases with their assistance coming down and their structures concentrating.



Spread of infectious poultry diseases

A key question needed to be addressed in broader analysis is how do the structural impacts (bearing in mind trade, investment and other possible explanatory variables) correlate with the spread of contagious diseases? It is the relationship between protection and impeded prevention and control of contagious diseases that is a focus within the overall study, with the important structure-type impacts being intermediate to this key relationship. Information on these intermediate impacts could be replaced by proxy measures evident from the hypothesized relationships between protection, structure and impeded prevention and control of contagious diseases in a broader analysis.

Apart from the structural impact mentioned above, there might be other reasons why protection could be associated with increased risks of HPAI. It might be thought increasing trade in live animals, even though this is generally between a few mainly non-HPAI prevalent countries, could be one such risk. However, constraining trade gives an incentive for less controlled informal trade/smuggling which even in small numbers like with wild birds could be associated with increased risk of HPAI. Increasing trade in processed product could be associated with decreasing risk of HPAI for more than the

obvious reasons (e.g. allowing imports/exports might lead to more SPS-type and other relevant institutions, relevant research etc and more care in relation to HPAI aspects, all of which appear more cost-effective than border controls in keeping down HPAI impact costs – there may be no processing or exports due to higher input costs from distortions). A number of new relevant institutions were developed in Indonesia and other Asian countries following the Asian Financial Crisis, for example those related to competition policy that would affect structures.

More SPS-type institutions etc could also apply to increased investment which would appear associated with decreasing risk of HPAI. In addition, investment would bring in large global private companies able to invest in HPAI research and with more awareness and private incentives to self-police HPAI seeing an outbreak would have more private costs and less public costs. This was the experience with contract poultry growing in eastern Indonesia where compensation for pre-emptive culling became part of the management system to maintain confidence in the industry.

Most importantly in relation to the specific quantitatives of this overall study, concentration of industry structure into larger firms unconstrained by protection would appear to decrease the risk of HPAI (research has shown that large vertically-integrated firms tend to have safer production processes e.g. Agrifood Consulting International 2006) and recommended policy responses aimed at smallholdings reflected this.

The following outlines the sample countries' protection, structure and HPAI situation:
Brazil – Brazil has low poultry NRAs and has developed a significant Sector I that supplies substantial exports. It also has a medium-large traditional sector but has never had HPAI. Given their significant exports, they have taken strong precautionary actions in relation to HPAI outbreaks elsewhere (e.g. banning Asian visitors to farms, Asian rice for feed and generic stock, as well as heavily monitoring migratory birds but nothing specific in relation to the traditional sector).

EU – The EU has high poultry NRAs and many of its members have developed large Sector I-systems, though a number still have substantial traditional smaller poultry holdings the protection helps maintain. These non-commercial/free range holdings are thought to be the source of some HPAI outbreaks, along with wild birds, in some member countries (e.g. importers, the UK and Germany). These outbreaks have been controlled reasonably well, for example by closing down free-range holdings. General EU monitoring is undertaken but true exporting members like the Netherlands would have more incentives for precautionary actions.

Thailand – Thailand has low poultry NRAs and is continuing to develop a large Sector I that exports to the world. There is a shrinking but still medium-large traditional sector and there have been several waves of HPAI. Thailand takes strong actions to maintain its export markets, for example following the outbreak of HPAI it transformed a lot of its trade from raw to cooked product.

US – The US has low poultry NRAs and a very concentrated structure. There have been no HPAI outbreaks but incidences of LPAI have led to the US being locked out of some markets. It has strong incentives to keep the region free of HPIA.

China – China has low NRAs and is concentrating its poultry sector structure rapidly but still has a large traditional sector and HPAI has been endemic. Actions such as compulsory vaccination and zero tolerance of imports from pathogenic countries have been undertaken and the HPAI situation seems to have improved.

Japan – Japan has very high NRAs and a predominant Sector I driven by a strong self-sufficiency policy. The OIE reported HPAI incidences in 2008.

Mexico – Mexico has had high NRAs which are trending down. It has developed a significant Sector I but still has a substantial traditional sector. It has had no HPAI incidences which could be a function of being in the (north) America region and the strong incentives for ensuring the region is disease free.

Russia – Russia has high NRAs, driven by a strong goal of self-sufficiency. It has developed a significant Sector I but still has a large traditional sector. The OIE reported incidences of HPAI in 2008. It has introduced stricter SPS border measures, said to be in response to disease outbreaks elsewhere but which would assist self-sufficiency goals.

Ecuador – Ecuador is bringing its poultry sector NRAs down. It does not have as significant a Sector I as some of its neighbours such as Brazil and its traditional sector is medium-large. There have been no HPAI incidences but this appears a characteristic of the region.

Egypt – Egypt has had high NRAs which it is bringing down. Its structure is concentrating but it still has a very significant traditional sector with a lot of live trade. HPAI has been endemic in recent times.

Indonesia – Indonesia has high NRAs, a consequence of a strong self-sufficiency policy based around maintaining a very large traditional sector. HPAI has been endemic and resulted in the most recorded human deaths in the world. Some strong actions have been taken in response, such as providing incentives for the removal of poultry production from Jakarta and more control through caged production.

Vietnam – Vietnam has low NRAs as a consequence of reforms, reinforced through WTO accession. Its Sector I is growing strongly but there exists a large traditional sector. HPAI has been endemic.

Returning to the scatter plot of NRAs and Structure where countries in **bold** have had HPAI incidences, it can be seen that some exporters have low protection, predominant or significant Sector I's and incentives to be HPAI free (e.g. US and Brazil). However, others have substantial traditional sectors and HPAI incidences, though they are developing more to Sector I systems and away from HPAI risks (e.g. China and

Thailand). Some other developing countries, currently with negligible trade, appear to be following these countries' lead (e.g. Egypt and Vietnam). The importers have high NRAs, a consequence of strong self-sufficiency policies, and some have predominantly Sector I systems, but few economic incentives to be HPAI free (e.g. EU, Japan and Russia which have all had HPAI incidences, and Mexico which has not, probably because of regional factors). Indonesia fits this description apart from the predominant Sector I systems; its self-sufficiency policies assisting in maintaining a substantial traditional sector. The assisted Sector I structure has not been enough to prevent HPAI incidences, in part because of the lack of associated incentives to maintain efficient export markets. Ecuador, and to a lesser extent perhaps Mexico, fall in between the two groupings but there is a trend to lowering NRAs and increasing concentration along the lines of the exporters group.

The following are a few preliminary hypotheses building off the above. These could evolve as interaction is undertaken with other researchers focusing on the structure and disease risk element, and relevant data is brought in for further analysis. Countries that seem best able to comply with disease and SPS-measures have simple poultry sector structures dominated by Sector I. Low NRA exporters/Sector I's want to maintain their markets so they appear more vigilant in relation to HPAI. This includes those countries that have significant outdoor flocks like China (98%) as well as other countries like Brazil (20%) and Thailand (33%). The US has had some LPAI outbreaks but these have had minimum costs as "true" exporters, including Brazil and Thailand, want to maintain exports. Thailand in the past has taken strong actions to maintain its export markets against SPS-actions by other countries. The opposite applies for high NRA importers and self-sufficiency proponents. In some cases, as with Australian bananas, social-welfare would increase with an outbreak of disease that would remove the rationale for banning cheaper imports. The EU, apart from the Netherlands and other true exporters, would have less to lose from a HPAI outbreak than the larger, efficient exporters. Recent outbreaks have been in major EU importers, Germany and the UK.

7. Conclusions

The focus of the research has been mainly on the influence of support and protection on poultry industry structure and also some aspects of disease risk. Some of the collected measures are inexact, as evident from the observed differences in South African estimates of the same measure of protection under a World Bank project and by the OECD in Table A2. These differences point to the need for, at least initial, robust cross-sectional analysis of groups of countries with broad differences in support, protection, structure, etc.

The specified hypotheses have been tested with sufficient data being available for an appropriate level of analysis to be undertaken. Support and protection data was mainly obtained from NRAs measuring adjusted gaps between international and domestic prices in World Bank (2006). Structural data took the form of average chickens per holding, mainly obtained from agricultural censuses, as well as the predominance of particular FAO Sectors I-IV (industrial-traditional). General HPAI incidence information was obtained from the OIE website.

The quality of the available data may not be sufficient for sophisticated multiple regressions/modeling as undertaken in Anderson (2009) between NRAs, revealed comparative advantage etc. However, it has been sufficient for more robust analysis that addresses the research questions and could point the way for more detailed data collection, including case studies, and then modeling. These research questions concerned the relationship between support, protection, trade, investment, structure and spread of infectious diseases. Support and protection constrains efficient trade, encourages smuggling/informal trade etc, diminishing the incentives for good management and leading to greater disease risk. It also constrains efficient investment which could lead to greater disease risk through weaker SPS, research and other relevant institutions. Protection can also constrain structural change, hindering development of efficient Sector I production systems, or maintaining larger traditional sector, and can result in greater disease risks.

Figure 2 illustrated that the "true" exporters tended to have low NRAs and that the "true" importers tended to have high NRAs. Countries with negligible trade mainly had low NRAs apart from (developing) Indonesia and (developed) Korea with their strong self-sufficiency policies.

In terms of structure, all countries were experiencing a concentration with relative growth in industrial Sector I holdings. The NRA and structure scatter plot illustrated that the "true" exporters and "true" importers fell into two groups; low NRAs, a mix of structures, more market incentives and lower HPAI incidences, and high NRAs, a mix of structures, lower market incentives and higher HPAI incidences (HPAI experiences also appeared to be regionally based) respectively.

A clear conclusion is that support and protection do not determine structure – some countries had strong enough political economy objectives to be willing to pay the high cost of over-riding open market forces on their structures. However, support and protection did determine whether structures were distorted and not economically efficient. Technically efficient developed structures in conjunction with (export) market incentives driving economic efficiency and encouraging better risk management, appear to positively impact on HPAI risk. High protection levels hinder open markets' role in the demise of inefficient, poorly managed productions systems, whether they be traditional sectors or not. Sector support and protection where there is no efficient export motivation may protect small (e.g. Indonesia) or large (e.g. Russia) scale producers but in the longer-term, inefficient production and the lack of market incentives creates greater risk of disease.

To further analyse the broader relationship between support and protection, and impeded prevention and control of contagious diseases, would require appropriate measures of the latter aspect such as deaths, incidence of outbreaks, cullings, breadth/length of control etc.

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Table A1: Countries within required trade categories in PSE and NRA databases

World Bank NRAs	OECD PSEs
Strong Exporters	
Brazil (1)	Brazil (1)
Chile (9) (no poultry detail)	
Thailand (5)	
US (2) (L3)	US (2) (L3)
EU15 (3) (L1)	EU(15) (3) (L1)
Poland (L8)	
Hungary (L6)	
Strong Importers	
Cameroon (no poultry detail)	
Cote D'Ivoire (no poultry detail)	
Mozambique (no poultry detail)	
South Africa (9)	South Africa (9)
Mexico (6)	Mexico (6)
Japan (2)	Japan (2)
China (Taiwan)	
Russian Federation (1) (L9)	Russian Federation (1) (L9)
Tajikistan (no poultry detail)	
Ukraine (L9)	Ukraine (L9)
Romania	Romania
	Switzerland
Negligible Exports and Imports	
Egypt (no poultry detail)	
Ethiopia (no poultry detail)	
Kenya (no poultry detail)	
Madagascar (no poultry detail)	
Nigeria (no poultry detail)	
Senegal (no poultry detail)	
Sudan (no poultry detail)	
Tanzania (no poultry detail)	
Uganda (no poultry detail)	
Zambia (no poultry detail)	
Ecuador	
Bangladesh (no poultry detail)	
India (no poultry detail)	
Indonesia	
Korea, Dem.	Korea, Dem.
Malaysia (no poultry detail)	
Pakistan (no poultry detail)	
Vietnam	
	Norway

Table A2: Poultry NRAs for selective countries 1994-2003

Country	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Exporters													
Brazil	-21	-11	0	2	4	-7	6	-1	6	4	1	2	2
EU15			129	77	55	51	90	57	52	56	54	101	69
- Austria	65	71	129	77	55	51	90	57	52	56	54	101	69
- Denmark	110	114	129	77	55	51	90	57	52	56	54	101	69
- France	6	23	129	77	55	51	90	57	52	56	54	101	69
- Finland	110	114	129	77	55	51	90	57	52	56	54	101	69
- Germany	110	114	129	77	55	51	90	57	52	56	54	101	69
- Ireland	110	114	129	77	55	51	90	57	52	56	54	101	69
- Italy	110	114	129	77	55	51	90	57	52	56	54	101	69
- Net'lands	110	114	129	77	55	51	90	57	52	56	54	101	69
- Portugal	110	114	129	77	55	51	90	57	52	56	54	101	69
- Spain	110	114	129	77	55	51	90	57	52	56	54	101	69
- Sweden	13	11	129	77	55	51	90	57	52	56	54	101	69
- UK	110	114	129	77	55	51	90	57	52	56	54	101	69
Hungary	28.8	37.3	32.8	33.1	32.4	39.2	28.4	37.5	48.2	60.7	50.9	Na	Na
Poland	32.9	65.6	48.1	54.2	32.4	40.7	29.8	11.9	9.2	10.1	1.6	Na	Na
Thailand	-10	-11	17	18	8	23	23	21	15	33	13	Na	Na
US	0	0	0	0	0	0	0	0	0	0	0	0	0
Importers													
China	-1	0	0	0	0	0	0	0	0	0	0	0	0
Japan	44	37	31	36	32	39	60	108	73	71	73	45	Na
Mexico	103	90	10	10	28	24	16	55	42	72	42	27	Na
Romania	22.1	57.4	40.3	31.4	32.7	101	55.9	45.4	130	192	146.4	167	50.9
Russia	-9	27	49	55	71	31	12	51	110	73	46	79	114
Sth. Africa	20	13.7	15.5	19.6	21.0	3.6	4.9	-1.6	-14.9	-10.0	20.4	20	22
" (OECD)	Na	8.0	15.9	8.6	21.1	0.0	0.0	0.0	0.0	0.0	0.0	Na	Na
Taiwan	168	178	167	167	195	242	372	347	254	237	Na	Na	Na
Ukraine	-48.4	6.0	-14.9	-1.4	45.4	69.9	0.2	53.1	43.9	93.8	66.2	58.9	95.3
Negligible													
Ecuador	15	24	43	41	38	24	-4	9	29	90	-30	Na	Na
Egypt	-19.2	2.5	16.8	12.7	17.2	19.9	15.1	18.4	-2.9	-12.7	-27.0	-35.2	-24.7
Indonesia	86.2	102.9	102.1	136.2	70.9	-8.9	139.2	107.5	70.4	120.2	101.2	Na	Na
Korea	165	198	171	185	161	135	206	220	201	164	131	180	Na
Vietnam	-4	-4	-4	5	5	6	6	2	2	2	2	2	2

Notes:
Individual EU member values are available up to 2007.
South Africa (OECD) consists of NRAs derived from OECD PSE estimates which are broadly consistent in terms of trend and turning points apart from 2000 and 2003, the latter being put down to an imperfect pass-through of a currency appreciation to domestic wholesale prices. Differences are mainly put down to different international reference prices and the OECD not estimating negative NRAs.

Table A3: Heads of poultry inventory per holding

Country	Head	Holdings	Head/ Holding	Comments
Brazil	718,500,000	3,200,000	225	1996 census. Large Sector I and larger traditional sector.
EU	937,260,000	1,081,200	867	2005 Eurostat. Predominantly Sector I though some large traditional sectors in some "Below EU median" members.
- Austria	11,310,000	63,600	178	Below EU median
- Denmark	17,030,000	3,560	4,784	Above EU median
- Finland	10,020,000	1,760	5,693	"
- France	202,570,000	210,790	961	Below EU median
- Germany	107,260,000	88,690	1,209	Above EU median
- Ireland	10,540,000	9,620	1,096	Below EU median
- Italy	126,510,000	110,150	1,149	"
- Netherlands	92,920,000	2,860	32,490	Above EU median.
- Portugal	27,400,000	296,710	92	Below EU median
- Spain	156,950,000	250,300	627	"
- Sweden	14,260,000	5,260	2,711	Above EU median
- UK	160,490,000	37,900	4,235	"
Thailand	95,172,590	3,249,177	241	2003 FAO estimate of stocks and Narrod et al 2007 holdings. Large Sector I and larger traditional sector.
US	1,732,714,202	136,252	12,717	2002 census. Predominantly Sector 1.
China	5,330,000,000	75,820,000	70	Ke et al 2005 estimates. Large Sector I and much larger traditional sector.
Japan	3,576,312	8,302	431	2000 census. Predominantly Sector 1.
Mexico	232,600,000	33,62,919	69	1991 census. Large Sector I and traditional sector.
Russia	112,000,000	607,000	185	2004 – 1/1000 of GAIN 2008 chicken and OECD 2007 poultry meat agricultural enterprises (Sector 1)
Ecuador	28,767,251	584,762	49	1999/2000 census. Sector I and larger traditional sector.
Egypt	62,040,389	3,765,009	16	1999/2000 census. Very large traditional sector.
Indonesia	872,416,000	3,206	63	BPS 2004 (Sector 1) estimate does not cover large traditional sector so Thailand 1998 used as a proxy.
Vietnam	152,200,000	8,400,000	32	Agrifood Consulting International 2006 estimate for 2004. Large Sector I but larger traditional sector.

Appendix: Determination of countries structural averages

Brazil

Brazil's poultry industry is becoming increasingly highly concentrated and its export market dominated by only a few large companies. Comprehensive statistics on changes in the distribution of livestock farms by size in Brazil are not available. Brazil's Agricultural Censuses provide a time series of data but only on the farming sector as a whole in terms of farm area sizes and only aggregate figures on poultry for 1996.

There is some information on the increasing concentration in the chicken production size distribution between 1985 and 1996; the proportion of chicken farms with less than 10,000 (greater than 10,000) chickens declining (increasing) from 58% (42%) in 1985 to 22% (78%) in 1996 (Delgado et al 2003). If this trend continued there would be few farms left with less than 10,000 chickens by now, in fact a 2001 survey had no sample farms of less than 10,000 chickens in the main producing region (Delgado et al 2003). Poultry production has continued to trend upwards since 1996; increasing by over 100% from 4.052m t in 1996 to 9.297m t in 2005.

The total number of chickens and chicken holdings in 1996 is available from the Agricultural Census on the FAO website which gives an average chickens per holding of 718.5m/3.2m = 224.5 (Table A3). This also would have increased since 1996, at least around the 300 mark, as inventories have increased by 2.7% p.a. over 1981-2006 whilst the industry has become more concentrated (Upton 2007).

EU

Austria

Livestock tables for 1990, 1999 and 2005 with chicken numbers and holdings were available from the FAO website; 2005 from a related web-link and the others directly from census summaries. The most recent figures were available for all EU members from a Eurostat data base and are presented first for all members:

'05	Chickens	holdings	63,600	head	11,310,000	Av. = 178 (Table A3)
FAO linked website:						
'05	Chickens	holdings	64,000	head	11,340,000	Av. = 177
'99	"	"	81,000	"	13,654,000	
FAO listed census:						
'99/00	Broilers	holdings	2,150	head	7,010,000}	Combined av. = 163
"	Laying hens	"	79,700	"	6,630,000}	
'90	Chickens	"	-	"	12,218,046	

The estimates show a continuing concentration into predominantly Sector I production.

Denmark

'05	Chickens	holdings	3,560	head	17,030,000	Av.=4,784 (Table A3)
FAO linked webpage:						
'07	Chickens for slaughtering	holdings	286	head	11,758,204	Av = 41,100
'06	"	"	230	"	12,924,281	Av = 56,000
FAO listed census:						
'99/00	Broilers	holdings	460	head	14,920,000}	Combined av. = 2,918
"	Laying hens	"	6,370	"	5,010,000}	

‘89	Chickens	“	13,858	“	16,266,298	

Finland

‘05	Chickens	holdings	1,760	head	10,020,000	Av.=5,693 (Table A3)
FAO listed census:						
‘99/00	Broilers	holdings	220	head	7,920,000}	Combined av. = 5,116
“	Laying hens	“	2,190	“	4,410,000}	
‘90	Chickens	“	-	“	9,520,018	

France

‘05	Chickens	holdings	210,790	head	202,570,000	Av. = 961 (Table A3)
FAO listed census:						
‘99/00	Broilers	holdings	125,630	head	126,300,000}	Combined av. = 569
“	Laying hens	“	231,820	“	77,070,000}	
‘88	Chickens	“	-	“	130,830,722	

Germany

‘05	Chickens	holdings	88,690	head	107,260,000	Av. 1,209 (Table A3)

FAO linked webpage:

Table chicken holdings in 2005 and 2007 were 80,400 and 75,800 respectively, and chicken numbers 107.3m and 114.6m respectively, suggesting averages of approximately 1,340-1,520 and further concentration into Sector I.

FAO listed census:

‘99/00	Broilers	holdings	115,120	head	58,330,000}	Combined av. = 530
“	Laying hens	“	15,460	“	10,640,000}	
‘95	Poultry	“	187,900	“	96,000,000	

Ireland

‘05	Chickens	holdings	9,620	head	10,540,000	Av.=1,096 (Table A3)
FAO listed census:						
‘99/00	Broilers	holdings	1,350	head	10,800,000}	Combined av. = 1,231
“	Laying hens	“	8,990	“	1,930,000}	
‘91	Poultry	“	-	“	12,052,800	

Italy

‘05	Chickens	holdings	110,150	head	126,510,000	Av.=1,149 (Table A3)
FAO listed census:						
2000	Broilers	holdings	300,568	head	96,708,718}	Combined av. = 181
“	Laying hens	“	479,420	“	44,781,166}	(this figure is
‘90	Chickens	“	-	“	142,100,216	suspiciously low)

Netherlands

‘05	Chickens	holdings	2,860	head	92,920,000	Av.=34,490(TableA3)

FAO linked webpage:

Tables were available of broiler holdings, head and production 1975-2007:

‘07	Broilers	holdings	748	head	43,352,000	Av. = 58,000

‘06	“	“	674	“	41,914,000	Av. = 60,200
FAO listed census:						
‘99/00	Broilers	holdings	1,230	head	53,250,000}	Combined av. = 25,005
“	Laying hens	“	2,960	“	51,520,000}	
‘89	Chickens	“	-	“	89,777,520	

Portugal

‘05	Chickens	holdings	296, 710	head	27,400,000	Av. = 92 (Table A3)
FAO listed census:						
‘99	Chicken(meat)	holdings	162,687	head	25,928,167}	Combined av. = 95
“	Laying hens	“	235,276	“	11,980,332}	
‘89	Chickens	“	-	“	415,852	

Spain

‘05	Chickens	holdings	250,300	head	156,950,000	Av. = 627 (Table A3)
FAO listed census:						
‘99	Poultry	holdings	329,020	head	182,446,000	Av. = 555
‘89	Chickens	“	-	“	109,972,000	

Sweden

‘05	Chickens	holdings	5,210	head	14,260,000	Av.=2,711 (Table A3)
FAO listed census:						
‘99/00	Broilers	holdings	90	head	5,860,000}	Combined av. = 2,052
“	Laying hens	“	6,590	“	7,850,000}	

UK

‘05	Chickens	holding	37,900	head	160,490,000	Av.=4,235 (Table A3)

There is some confusing data due to changes to what represents broiler holdings from 1997. It was stated there were 200 holdings with greater than 100,000 birds in 1995 and by 2005 that this had doubled to 400 who produced 69% of production.

The Poultry Site:

‘05	Broilers	holdings	3,100	head	111,500,000}	Combined av. = 3,800
“	Layers	“	37,400	“	40,966,800}	
FAO listed census						
‘99/00	Broilers	holdings	1,970	head	105,300,000}	Combined av. = 5,771
“	Laying hens	“	27,080	“	47,810,000}	

Thailand

Thailand’s poultry sector is concentrating and quite comprehensive statistics are available that measure this as demonstrated in the following table:

	% share in no. of chickens				% share in no. of holdings				
Flock no.	**1978**	**1988**	**1993**	**1998**	**1978**	**1988**	**1993**	**1998**	**2003**
1-19			9.15	10.15	69.30	69.77	64.24	61.35	35.3
20-99			16.91	20.15	30.00	29.11	33.00	36.09	57.1
100-499			4.80	4.96	0.53	{0.84	2.03	1.99	{6.8
500-999			1.54	1.00	0.05	{	0.15	0.08	{
1000-9999			29.11	31.16	0.09	{0.28	0.50	0.42	1.4
10000+			38.49	32.58	0.03	{	0.09	0.06	0.4
Total (m)	54.157	86.679	154.922	169.102	2.638	3.249	2.617	3.174	1.028

Source: Narrod et al (2007) and Delgado et al (2003)

A measure of concentration could be the percentage of "production" divided by the percentage of larger farms that deliver it (e.g. 38.49/0.09 = 428 in 1993 and 32.58/0.06 = 543 in 1998 – a trend of 5.4% p.a. Corresponding structure averages are 154.9/2.6 = 60 chickens/holding and 169.1/3.2 = 63 – a trend in this non-comparable concentration measure of 1% p.a. Using FAO 2003 stocks gives an average 241.1/1.0 = 241 (Table A3)
FAO listed census:
'88 Chicken holdings 3,249,177 head 95,172,590 Average = 29
The 2003 average of 241 is over 8 times this, reflecting increasing concentration.

United States
Poultry industry concentration is probably most advanced in the US but, somewhat surprisingly, statistics on this development are hard to find and obtain, despite requests of USDA. It was not until 2007 that the Agricultural Resource Management Survey included a broiler version. From Agricultural Census information, farms with chickens have continually declined from a very high 87.7% in 1910 to 5.6% in 1992, whilst receipts have increased from $127m to $9,176m over the same period.
Census information from the FAO site had 35,500 broiler holdings with 1,214m broilers in 1997. Comparable figures are available on layers that can be combined to determine a structural average. In terms of numbers sold, there were 27,737 farms selling 7,367m head in 1997 (7,367,000/28 = 263,000) compared to 32,000 selling 8,500m head in 2002 (8,500,000/32 = 266,000), and with the largest holdings of 750,000 or more broilers increasing from 1,407 to 2,211 over the period (a more detailed distribution is available).
Farms with gross sales of $100,000 or less were 54% of poultry farms in 1995 but produced just 12% of the value of production whilst the top 3% with sales of $1m or more accounted for around a third of the value. There is other information available on changes over time, for example medium farms that produced 605,000 birds in 2006 were producing 520,000 birds in 2002 and 300,000 birds in 1987 (Hoppe et al 2007). Family farms with at least $500,000 in production value held 75.2% of poultry and egg production in 2003, up from 48.3% in 1989 (MacDonald et al 2006). If this trend has continued then these larger farms are probably producing between 80-90% of the value of production. The following census figures illustrate a similar strong concentration trend.
FAO listed census:

'02	Broilers	holdings	37,937	Head	1,398,279,047}	Combined av.=12,717
"	Layers	"	98,315	"	334,435,155}	(Table A3)
'87	Chicken	"	144,438	"	375,577,186	Av. = 2,600

China

China's poultry sector has developed rapidly in recent decades. Inventory increased from 1.98b birds to 5.33b birds between 1985 and 2005 (Ke Bingsheng et al 2007). Farm numbers in 2005 were 34.6m broiler farms and 41.2m layer farms, mainly small and down from 104.1m in 1996 (producing 3,094m birds). The average number of chicken per holding was 70 in 2005, over double that in 1996 (Table A3). The number and share of large producers increased (producers with an annual output of greater than 10,000 birds increased from a share of 25% in 1996 to 49% in 2005). There is still a dichotomy of small and large producers in Chinese poultry. Poultry output and meat production has increased even more over this period, in the latter case from 1.60m t to 14.64m t. The 1996 Agricultural Census provides the earliest detail on the Chinese poultry production structure, but there are no chicken details in the FAO website listed entry.

Japan

MAFF provided detailed statistics on the number of farm households raising broilers by size of shipment (per year) as summarized in the following table which shows falling number of holdings, concentrating in the largest size, and falling or static shipments:

Year	**No. of households raising broilers by size of shipment ('000)**					**No. of broilers shipped ('000)**
	Total	**<50**	**50 to <100**	**100 to <300**	**>300**	
1995	4,328	1,393	785	1,838	312	606,494
2000	3,502	963	677	1,512	340	569,234
2004	3,240	777	614	1,052	410	589,957
2005	3,120	673	572	1,049	404	606,898

Some Agricultural Census figures were also available from the FAO website and for 2000 this had lower broiler holdings at 2,721 and the following total chicken numbers.
FAO listed census:
2000 Chickens holdings 8,302 head 3,576,312 Av. = 431 (Table A3).

Mexico

The 2008 GAIN Report MX8057 provided some distributional information over time by size of chicken farm companies which shows a strong concentration trend:

	Companies		**Percentage of production**	
Size/Year	**1996**	**2007**	**1996**	**2007**
Large	2	3	33	56
Medium	27	28	40	40
Small	181	150	27	4

The Report stated 255,933,839 broilers per cycle were produced which if achieved by the above 181 farms provides an average of 1.4m chickens per holding. Live chicken sales are significant but trending downwards, from 31% to 26% between 2001 and 2007. Correspondingly, supermarket sales increased, from 5% to 7% over 2007. The FAO census figures are dominated by small holdings.

FAO listed census:

‘91	poultry	holdings 3,362,919	head 232.6m	Average = 69 (Table A3)

Russia

Statistics on the Russian poultry industry structure are hard to find, one reason being the recent major changes with the transition towards a more commercial sector. GAIN Reports contain some relevant information, mainly on poultry meat production over time and split between agricultural enterprises and private households. However, it is difficult to align these changes with those in holding numbers. In the Structures section of the Russia chapter in OECD (2007) it is described how the three types of producers (agricultural enterprises (organizations), household plots, and family (“peasant”) farms) have changed over time. Measured livestock output in 2005 is produced only by enterprises (45%) and households (55%), with the latter produced primarily for self-consumption and of much less importance in marketed production. Amongst the enterprises, a group of successfully developing, investing and modernizing producers is emerging. Similarly, some households are rapidly evolving into small-scale commercial producers, doubling their supplies of fresh meat for retailing and processing over 2000-05. OECD (2007) had poultry meat enterprises at 607 in 2004 when the GAIN report (RS7019) had them producing 1.1m t or 79% of Russian poultry meat. However, a World Poultry article had 166 enterprises in 2002 producing 1.4m t or 59% of production whereas the 2008 GAIN report had agricultural enterprises producing only 0.7m t in 2002. These sets of figures are incompatible and cannot be used to determine trends. An average number of broilers per holding of 184,514 was obtained for 2004 by adjusting the 2008 GAIN estimate of 280m chickens for the 15% annual growth rate and dividing by the 607 poultry meat agricultural enterprises estimated by the OECD for 2004. The 2008 chicken numbers estimate excluded household birds which are significant given a binomial industry structure and inflates the estimate. A background paper for the last Russian agricultural census stated there were approximately 25,000 large and medium agricultural organizations, 8,000 small enterprises, 264,000 private (peasant) farms, 16,000,000 private household farms, 14,600,000 families that have collectives and individual kitchen gardens, and 5,000,000 families that have plots for individual construction, and other agricultural producers. These numbers total to around 36,000,000 with only 33,000 being in the first two “enterprise” groups suggesting the earlier structural average should be adjusted to one thousandth of its value, or 185 (Table A3)

Ecuador

FAO listed census:

‘99/00	Chickens (courtyard)	holdings 582,492	head 9,172,193}	Combined av. = 49
“	Broilers (intensive)	“ 2,270	“ 19,595,058}	(Table A3)

This should be seen as a lower bound as much larger estimates of the number of chickens were presented in agribusiness publications on the associated website provided with the FAO census figures (e.g. four fold figures of 83.7m birds for fat and 3.4m hens in 1997).

Egypt

Household poultry in 2004/05 had holdings of 3,829,769 and 68,452,380 head. Overall backyard production numbers are not well known but have been estimated at between

200-250m. Other information from FAO material included that over 1991-2005; broilers farms went from 13,356 to 14,698 holdings and actual capacity from 140,676,000 to 491,231,000 chickens (broilers have 4-5 cycles per year). Estimates of overall production have been as high as 900m. With layers, farms went from 1,336 to 1,728 over 1992-2005 and actual capacity from 2,931,000 to 20,670,000 chickens. FAOSTAT estimated poultry numbers of 89m in 2000 and 95m in 2006. Farm numbers in 2004 were given as 19,637. This is a confusion of figures – the FAO website census figures appear to be associated with households and would miss the more dynamic commercial holdings which are important in terms of the overall structure and its influence on disease risk, though the large backyard production could have more influence. The following chickens per holding estimate should be considered a lower bound.

FAO listed census:

'99/00	Poultry	holding	3,765,009	head	62,040,389	Av. = 16 (Table A3)
'90	"	"	2,872,580	"	78,255,296	

Indonesia

A 2007 GAIN Report (ID7035) had Indonesia's broiler population at 889m birds in 2007, with estimated production of 824,000t, and is expected to increase slightly to 899m birds in 2008. Poultry (including ducks) inventories increased from 1,207m in 2005 to 1,225m in 2006, to 1,250m in 2007, and is estimated to be 1,275m in 2008. Corresponding production figures were 1.147m t, 1.180m t, 1.215m t and 1.250m t.

Indonesian Agricultural Census figures off the FAO website had only the number of head of chicken at a low 102m in 1993. The website associated with this Indonesian entry provided a time series of data on broiler establishments and populations from Statistics Indonesia which is laid out in the following table:

	2000	**2001**	**2002**	**2003**	**2004**	**2005**
Native pop. (m)	259	268	275	277	277	287
Layer pop. (m)	69.4	70.3	78.0	79.2	93.4	98.5
Broiler pop. (m)	531	622	865	848	779	864
Layer establishment	1,397	1,601	1,275	1,377	1,768	na
Broiler establishment	834	1,095	956	1,040	1,438	na

The broiler populations are of the same order as those given in the 2007 GAIN Report. In 2004, the total number of layer and broiler holdings was 3,206 and the total population of associated chickens 872.4m, giving an unrealistic average chickens per holding of 272,120. What is missing in the substantial number of backyard producers often associated with native chickens that would bring this average down substantially, providing a better reflection of an industry with a significant commercial sector but a more substantial, in terms of holding numbers, backyard sector.

The next table, produced in Hall et al (2006) from CASERED (2004) and MoA (2005), gives information on the size of Sector III and IV. It can be seen the backyard sector dominates in terms of numbers of birds and if Indonesia was like the more developed Thailand industry, based on the over 500 birds per holding averages of the Sectors I and II farms, 95% of holdings at least would be in Sectors III and IV, suggesting the earlier average should be closer to Thailand's 1998 average of 63 (Table A3).

System	Centres	No. of farms	Birds (m)
Commercial integrated (Sector I) - Broiler	354	13,520	3.00
“ - Layer	128	2,418	6.70
Commercial (Sector II) – Broiler		45,934	38.30
“ – Layer		37,707	19.90
Other (Sector III)			32.39
Backyard (Sector IV)			175.00
Total			275.29

Vietnam

The Vietnam Agricultural Census figures off the FAO website had just poultry population numbers in 1994 at 93m. There was no associated website with the Vietnam entries but a FAO report by Agrifood Consulting International (2006) had the number of chickens at 159.2m in 2004. Vietnam poultry is mainly, in terms of holdings, backyard flocks with an average size prior to the HPAI outbreaks at around 16 birds (4 hens, 1 cock, 11 growers and chicks). Only 1% of flocks consist of over 100 birds (FAO). Hong Hahn et al (2007), stated, drawing on DLP (2006), that there were more than 7.9m households engaged in traditional extensive poultry production with an average flock of 32 birds and representing 94% of all producers, suggesting a total of 8.4m holdings. This is the same number as given in Agrifood Consulting International (2006) report which had the number of chickens at 159.2m, giving an average of chickens per holding of around 20. It would be expected that the inclusion of commercial producers would raise the average from the 32 chickens per holding given above so this higher number could be used instead, though in terms of reflecting the structure, 20 versus 32 makes little difference (Table A3). In 2005, 70-75% of Vietnam’s total chicken population was raised under the traditional system but in 2006 this had fallen to slightly above 60%.

The following table in Hall et al (2006) and from Delquigny et al (2004) gives some information on the distribution of poultry holdings; the large number of family holdings with a relatively low percentage of production and a significant industrial sector:

	System		
Characteristics	**Family**	**Semi-industrial**	**Industrial**
No. of producers	13,000,000	5,000	2,000
Av. Flock size	<500	1-3 groups of 500 to 2,000 birds/year	>2,000
% production	65%	10-15%	20-25%
System details	Sector IV		Includes state farms