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This paper is from the
GTAP Annual Conference on Global Economic Analysis
https://www.gtap.agecon.purdue.edu/events/conferences/default.asp

The revival of interest in self-sufficiency in Indonesia and its likely consequences
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Contributed paper at the
Thirteen Annual Conference on Global Economic Analysis
Penang, Malaysia, June 9-11, 2010

Abstract

Following the global spike in food prices in 2008, there has been a renewed interest in food security. A modest increase in prices over long-term trend in 2009 and some forecasts of higher commodity prices in the longer term have reinforced concerns. In addition, export bans imposed by some countries in 2008 lend support to the view that the international market can no longer be relied upon to deliver adequate supplies at reasonable prices. In response, many countries are attempting to reduce reliance on imports and achieve self-sufficiency where possible. In Indonesia, policies are being implemented to increase domestic production of not only staples such as rice, but of non-staple products such as sugar and soybeans. Furthermore, policies have been introduced to reduce the country's dependence on beef imports, with the objective to move to becoming 90 per cent self sufficient by 2014.

Achieving self-sufficiency across a range of commodities may be technically feasible, but the cost of such policies is considerable. Production costs are higher, subsidies of inputs or outputs are generally required, and the quality and variety of product are reduced. In addition, while moderating the price effects of external shocks, such as those experienced in 2008, a self-sufficiency policy with minimal reliance on trade leaves the domestic market exposed to internal shocks such as those caused by floods, droughts or disease. Indonesia's trading partners, including ASEAN who have an agreement on food security, may also object.

A computable general equilibrium model, GTAP, is used to analyse the impacts of moving towards complete self-sufficiency in live cattle and beef. Before running the scenarios, the Armington elasticity between domestic and imported cattle is

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estimated for Indonesia rather than using those provided. The revised, lower, estimate significantly influences the results, suggesting virtually eliminating cattle and beef imports beef is still achievable, but at an even more significant cost to consumers and taxpayers. Annual welfare would be reduced by an estimated US$458 million if cattle and beef imports were reduced by 90 per cent. Alternative policies may be more suitable. A $40 million subsidy to cattle producers is a transfer that creates fewer distortions and welfare losses but is well short of the needed to achieve self-sufficiency. A policy of subsidising research and development would provide greater gains, although these could take some additional time to show benefits.

Introduction

Following the global spike in food prices in 2008, there has been a renewed interest in food security. Despite food prices returning towards the long-term downward trend in real food prices, a modest increase in prices over long-term trend in 2009 and some forecasts of higher commodity prices in the longer-term have reinforced food security concerns. In addition, export bans imposed by some countries in 2008, including by net importers like Indonesia, lend support to the view that the international market can no longer be relied upon to deliver adequate supplies regardless of prices that were willing to be paid.

In response to such concerns, many countries are attempting to reduce reliance on imports and achieve self-sufficiency where possible. Self-sufficiency is taken as a high share of domestic production in total domestic use, excluding stock changes. In contrast, food security is defined as existing "when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (World Food Summit 1996). In brief, food security can be thought of as a satisfactory balance between food demand and supply at reasonable prices and at the population rather than national level like food self-sufficiency.

The next section outlines some relevant characteristics of the Indonesian live cattle and beef sector. A section outlining the scenarios and modifications to the database precedes presentation of the results. The paper ends with some discussion on the implications of the results and some conclusions relating to self-sufficiency.

Relevant policies

There are a number of relevant policies that affect the Indonesian cattle and beef sectors, some direct and others more general. The most direct policy is a proposed specific input or credit subsidy to import breeders and sperm (reported in the Jakarta Globe as a subsidised interest rate of 5 per cent when current market rates are 14 per cent, costing US$15 million, but reported in the Jakarta Post 2010 as costing US$200 million over 5 years, or an average of US$40 million per annum). Currently, imports of breeding stock are not allowed under the nucleus-plasma scheme described later. Such a credit subsidy policy has been tried previously but

failed in 2005 in achieving its self-sufficiency objectives, despite additional assistance with Artificial Insemination and extension services.

There are various forms of specific border measures that have or could be applied to Indonesian cattle and beef trade. These include tariffs (currently low at 5 per cent and heading to zero under some Free Trade Agreements such as AANZFTA in 2020), value-added taxes on imported cattle, much more impacting bans or near bans on cattle and/or beef trade (these are currently being implemented through the non-issuing of import licenses), and potential non-tariff barriers such as quarantine inspection constraints.

Another specific charge or tax that affects the Indonesian cattle and beef sectors, lowering external trade by adding to internal transaction costs, is a retribution tax or charge on internal trade collected by provincial governments on cattle passing through their provinces (Hadi et al. 2002).

Buffer stocks, like used in the rice sector to try to stabilise the supply-side of the market when it is either under or over-supplied, and assist poverty alleviation for consumers and producers (see Oktaviani et al. 2010 for more details), are less of an option for beef which is more open to deterioration. Excess stocks of cattle can perform this role but at a high cost especially for Indonesia which has carrying capacity constraints, and in also Indonesia's case, one of the factors that has hindered the build up of stock levels has been the strong de-stocking response of cattle owners to a rise in meat prices, breeder cattle being as much a store of wealth as a productive asset.

A policy that, if successful, delivers benefits to consumers and producers is the funding of research and development to improve productivity in the beef cattle production cycle, for example in reproduction and in fattening (processing costs make up less of the total cost structure in the value chain but margins between wholesale and retail are high, and this is not due to labour costs (Hadi et al. 2002)).

Indonesia's nucleus-plasma policy is where feedlots, which have financial and management resources, are obliged to provide cattle, and sometimes feed, as well as technical assistance to smallholders and then to purchase back the fattened cattle at market prices less all pre-financed costs which are reimbursed to the feedlot. This policy is aimed at introducing productivity gains made in larger scale, more specialised establishments to smallholders by providing them with improved stock, feeding and animal health care approaches, to raise the number of calves produced

and the rate of fattening. Improvements have been suggested in this system such as the approach being voluntary so only efficient partnerships are formed (Hadi et al. 2002).

A policy that affects Indonesia's cattle and beef sector more broadly is the ASEAN Integrated Food Security (AIFS) framework which, though mainly focused on grain staples, includes some relevant cattle and beef aspects around the stated cooperative objectives of increasing sustainable food production, promoting conducive market and trade for agricultural commodities and inputs (such as animal breeds), ensuring food stability, and promoting availability and accessibility to agricultural inputs. This framework, operating as it does within the ASEAN Free Trade Agreement, must draw into question the effectiveness of any ban or near ban that Indonesia may put on cattle and beef imports from non-ASEAN members when other ASEAN members have the basic resources to be able to develop a competitive feeder cattle sector and export cattle or beef into Indonesia under ASEAN agreements.

Beef production and trade

The current cattle population is around 12.6 million head and growing at around 4.8 per cent a year (figure 1). Most of this is home grown, supplemented by imports of breeder cows and feeders. According to local data (DG Livestock), imports of breeding cattle amounted to 1,300 head in 2008, up from only 100 the previous year. Feeder cattle imports amounted for 485,057 head in 2007. Exports are minimal, only 262 head in 2008. Although the imported feeder cattle make up a small share of the stock, they make a sizable contribution to the number of slaughtered cattle, that is, beef production. A discussion of how to derive appropriate estimates of self-sufficiency from these data is contained in Box 1.

Figure 1. Beef Cattle Population 2005-2009 (million head)
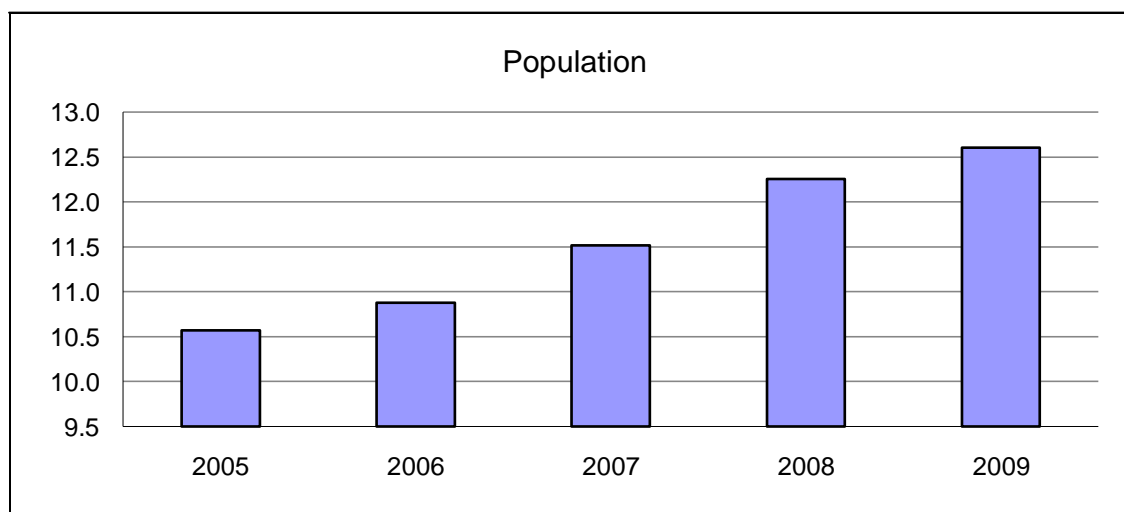
Source: Indonesian Directorate of Livestock, www.ditjennak.go.id

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Box 1 Self-sufficiency measures in the Indonesian cattle and beef sectors

Policies (e.g. specific credit subsidies) have been introduced to reduce Indonesia's dependence on cattle and beef imports, with the objective of moving from 60 to 90 per cent self-sufficient by 2014 (Jakarta Globe 2009). As stated earlier, self-sufficiency is taken as a high share of domestic production in total domestic use, excluding stock changes. More formally, it is defined as the ratio of production to production plus imports minus exports.

Indonesian livestock and meat statistics appear not very reliable. The Jakarta Post 2010 quotes a figure of 80 per cent self-sufficiency currently. However, in terms of more reliably estimable demand it has been estimated that Indonesia would need to rear 800,000 extra cattle to produce the 117,600t extra beef required to meet 90 per cent of underlying demand of around 400,000t; that is around 30 per cent extra beef (Jakarta Globe 2009). Data from international sources, FAO, Comtrade and GTAP, on Indonesian imports and production of cattle and beef are consistent (though they are most likely derived from the same primary source) and provide high self-sufficiency estimates for cattle and beef of around 93 per cent and 91 per cent respectively, suggesting the policy objective is already being met.

One possibility of why livestock and meat statistics are being unreliably reported is that the self-sufficiency definition can be misleading when the product can

be in different forms. For example, production in the case of Indonesian beef should be that from cattle in Indonesia that have <u>not</u> been imported for the purposes of relatively short-term fattening and slaughtering for beef ("beef on the hoof"). Imports, and whatever exports, should be made up of cattle traded for this purpose, as well as product in the form of beef meat ("beef in boxes"). The imported products are heavier in live form and priced higher than the domestic equivalents, making conversions between numbers, weights and values more complicated. Ignoring the small amount of exports, recent (FAO 2007) Indonesian figures of 2,836t of beef imports and 485,057 feeder cattle imports equates to 111,489t at the average slaughter weight of 224kg (average live weight of 416 kg with 210/390 used as the ratio of slaughter to live weight), which with domestic production of 396kt minus 111kt (production from imported cattle) equates to a self-sufficiency ratio of $(396 - 111)/(396 + 3) = 71$ per cent. This ratio would be expected to be lower in value terms as imports are valued higher. GTAP has Indonesian beef imports valued at \$105 million, cattle imports at \$160 million (this would be live animals but the slaughter value following value-adding for fattening etc is required for meat self-sufficiency estimates), cattle production at \$2,075m (presumably new cattle produced but could include cattle "imported" into the herd) and beef production (which would include feeder cattle) at \$1,128 million, giving a beef self-sufficiency ratio of around $(1,128 - 160)/(1,128 + 105) = 79$ per cent.

Similarly, in the case of Indonesian cattle, to be self-sufficient in the current market circumstances would require enough additional cattle to sustainably produce the amount of beef imported as boxed beef or live, relatively-mature cattle for short-term fattening and slaughtering, which will be much greater than the number of currently imported live cattle because the breeding cycle needs to be taken into account. No imports of cattle does not mean that a country is self sufficient in cattle as the earlier definition would suggest for it is the meat product from the cattle that is important in a self-sufficiency sense. A country may have no imports of cattle but importing most of its beef requirements. A country that does not need to import any cattle or beef to meet its consumption requirements is truly self-sufficient in both. If the breeding cycle was the same in Indonesia as in the exporting countries which have a comparative advantage in this area, then it would be expected the level of self-sufficiency in cattle and beef should be the same when the market is in equilibrium. The higher cattle rearing productivity in exporting countries (quicker cattle rearing

from herds of the same size) implies Indonesia's level of self-sufficiency in cattle would be lower than what the following calculations would suggest. Input requirements, including scarce Indonesian resources such as suitable land, capital and feed, are much greater under a livestock rearing scenario than they are under an intensive fattening scenario. Smallholder Indonesian production is constrained by low breeding productivity and available feed in some regions (Hadi et al. 2002). Indonesia had a stock of 11.51 million cattle in 2007, according to data reported to FAO, which minus the 0.485 million cattle imports suggests domestic cattle numbers equal 11.02 million. With domestic beef production at 396kt, including a feeder cattle component of 111kt, real domestic beef production is 285kt. With beef cattle imports of 3kt, domestic use is 399 kt. Proportioning up, fully self-sufficiency stocks would be 11.02 x 399/285 or 15.43 million and the self-sufficiency ratio 11.02/15.43 or 71 per cent. If buffalo are included the ratio falls to 65 per cent. Using the standard definition, the self-sufficiency ratio for cattle in value terms is estimated at an unrealistically high, given the quantity-based and meat self-sufficiency estimates, of (2,075 - 160)/2,075 or 92 per cent. One reason for this is that this estimate just covers the cattle imports and not the imported beef that as pointed out earlier would require around an additional 800,000 cattle in a herd of around 11 million or at least an additional 7 per cent increase to be 90 per cent self-sufficient (earlier press estimates put this at 30 per cent) which would shift the self-sufficiency ratio down to around 85 per cent at least. Estimates based on beef meat self-sufficiency in conjunction with cattle self-sufficiency appear much more consistent and realistic.

The above discussion, does not question data such as that from GTAP, only its interpretation. However, it does have implications for the policy shocks and interpretation of the results. Rather than self-sufficiency requiring no shock to Indonesian cattle numbers and beef production because the self-sufficiency ratios as formally measured are over 90 per cent, policy shocks would have to increase production by around 15 per cent. Such shocks should have partial impacts of a complete ban of imports of beef and cattle, though at a larger market size.

Scenarios

To analyse the potential impact of polices encouraging self-sufficiency in live cattle and beef production four scenarios are simulated:

(1) A quota reducing imports into Indonesia of live cattle to ten per cent of baseline levels;

(2) A quota reducing imports into Indonesia of live cattle and beef to ten per cent of baseline levels;

(3) A live cattle production subsidy of $40 million (2 per cent); and

(4) A 10 per cent productivity improvement in live cattle production.

A reduction of 90 per cent is modelled because it is difficult to imagine a complete ban could be implemented, given Indonesia's porous borders.[2] A restriction on live cattle imports alone is relatively ineffective because imported beef can be substituted for domestic production. To stimulate the live cattle sector, it is more effective to control imports of the finished product as well.

Rather than a trade ban, an alternative or perhaps complementary approach is to stimulate local production. A credit subsidy of $40 million a year paid to live cattle producers, scenario 3, is modelled as a production subsidy on output.[3] The fourth scenario examines the impact of a productivity improvement, driven by expenditure on research and development. It is assumed here that the improvement is externally funded, perhaps by an aid agency.[4]

Methodology and data

The Global Trade Analysis Project (GTAP) model is used to measure the impact of changes in trade policy on the agricultural sector. GTAP is a multi-country and multi-sectoral computable general equilibrium (CGE) model and fully documented in Hertel and Tsigas (1997). For each country or region, there are multistage production processes which combine primary factors of land, labour, capital and natural resources with intermediate inputs assuming a constant elasticity of substitution technology. Returns to factors, i.e. income, are taxed by the

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[2] This is a convenient assumption because the GTAP is not designed to model elimination of bilateral trade flows in any sector. Prices become unrealistically large as quantities approach zero.

[3] The Government proposed a credit subsidy scheduled to run for five years, at a total cost of $200 million. A credit subsidy could be modelled as a shock to capital but this is used by every sector in GTAP, not just targeted to the particular sector. Also the capital tax/subsidy variable is condensed out of the model so there are fewer variables to solve for but then some effort is required to readily implement the shock. A production subsidy can be made equivalent and more transparent.This would have only a minimal impact of production and self sufficiency.

[4] The productivity improvement is modelled as an exogenous shock. We don't specify how much needs to be spent to generate a 10 per cent productivity increase. However, a meta-analysis of agricultural research by Alston et al. (2000) has a modal rate of return on livestock research of 14 per cent (http://ideas.repec.org/p/fpr/resrep/113.html).

government, saved or spent by the single representative household. While there is no substitution between intermediate inputs and primary factors or among the intermediate inputs, there is substitution between different sources of intermediate inputs, namely domestic and imports from each region. The regions are linked together by imports and exports of commodities. Similar commodities, which are produced by different countries, are assumed to be imperfect substitutes for one another. The degree of substitution is determined by the Armington elasticities (Armington, 1969).

One modification is made to the standard GTAP database, relating to the Armington elasticity. In GTAP, it is standard procedure for the elasticity of substitution between different sources of intermediate inputs is half the of elasticity substitution between different imports from different countries. These elasticities determine how the gains from trade are shared between countries. Unfortunately, they are rarely estimated. In GTAP, one elasticity value is used for all countries for any given commodity. This of course will affect the precision of simulation-based estimates given potential heterogeneity in elasticities of substitution between imports and domestic goods across countries and within-country across sectors. In this paper empirical estimates are presented for elasticities of substitution between the imported and domestically produced forms of live cattle and beef in Indonesia. The elasticities are estimated based on the differentiation of products with respect to their origin and the imperfect substitution in demand between imports and domestic supply. A description of the procedure is contained in the Appendix. An error correction method is used because price and quantity are co-integrated (move together). The estimate of elasticity of substitution is 0.876. This compares with the default GTAP parameter, which is 2.0. The 95 per cent confidence interval of the elasticity of substitution is between 0.068 and 1.68. This parameter is used in the following simulations. The Armington elasticity between sources of imports is also adjusted. This parameter makes a large difference to the results, significantly increasing the welfare costs of restricting imports because consumers find domestic products to be a poor substitute for imports that are less readily available. Evidence in Indonesia is that much local beef meat is a poor substitute for imported beef meat.

Results

Banning 90 per cent of live cattle imports encourages domestic production of cattle by an estimated 17 per cent in response to an increase in domestic prices. Producers are unambiguously better off under such a policy, although the nation as a whole is worse off. The welfare loss is $380 million. Consumers are worse off because the production and consumption of beef, the final product, is reduced by 13 per cent. The welfare loss occurs partly because of negative allocative efficiency effects, but also because the Government forgoes any tariff revenue that was previously captured or would have been obtained had a tariff policy been used to reduce imports.

Table 1 Impact of Indonesian ban on imports of live cattle

	Cattle	Beef
	%	%
Production	17	-13
Price	6	27
Imports	-90	111

Source: GTAP simulation. Production refers to quantities. Price refers to producer prices. Imports are in value terms.

Under a ban on Indonesian live cattle imports, the main exporter, Australia, suffers a loss in national welfare of $17 million because of a rise in the value of beef exports does not offset the loss of live cattle exports.

A ban on Indonesian live cattle imports is not so effective because imports of beef increase. Imports double under this scenario. An obvious policy response is to restrict imports of beef as well. Table 2 shows the impact of such a policy if it could be effective given Indonesia's regional trade agreements. Production of live cattle increases by 28 per cent and beef 7 per cent. Higher prices reduce demand. The higher prices reflect the higher cost of production of domestic versus imported beef. Welfare losses amount to $458 million. Australia's welfare losses are $32 million, because it can no longer export beef instead of cattle to Indonesia as in the previous scenario. Both outlets are lost, and Australia must divert exports to other destinations.

Table 2 Impact of Indonesian ban on imports of live cattle and beef

	Cattle	Beef
	%	%
Production	28	7
Price	11	32
Imports	-90	-90

Source: GTAP simulation. Production refers to quantities. Price refers to producer prices. Imports are in value terms.

A domestic subsidy, such as subsidised credit paid to cattle producers, has only a limited effect on production and hence imports. This is shown in table 3. The subsidy raises incomes received by cattle producers, but ultimately reduces the price received for beef because the additional supply dampens consumer prices. Imports of cattle and beef are partially displaced by domestic production, but the impact of a two per cent subsidy is nowhere near as large as a trade ban nor, as shown in table 4, a productivity improvement.[5]

Table 3 Impact of domestic subsidy

	Cattle	Beef
	%	%
Production	0.41	0.64
Price	-1.79	-1.27
Imports	-1.14	-4.15

Source: GTAP simulation. Production refers to quantities. Price refers to producer prices. Imports are in value terms.

A ten per cent productivity improvement, funded by an aid agency (i.e. with no budgetary impact) is shown in table 4. In this case domestic price are reduced 11 per cent, so most of the benefits flow through to consumers. Welfare gains are $196 million. These are positive because the research and development costs, not specified here but expected to be much lower than these gains, are funded externally. This policy is less costly than a subsidy because the increase in production is some

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[5] A production subsidy is a better instrument to improve self sufficiency than a trade restriction, but a 2 per cent subsidy is insufficient. A 68 per cent subsidy would be necessary to reduce beef imports by 90 per cent, as in the second scenario. A 38 per cent subsidy would reduce beef imports by half, according to simulated GTAP estimates.

multiple, perhaps ten to one, of the initial investment. Once in place, the benefits of a productivity improvement continue into the future, whereas a subsidy needs to be renewed continually.

Table 4 Impact of productivity improvement

	Cattle	Beef
	%	%
Production	3	4
Price	-11	-8
Imports	-7	-24

Source: GTAP simulation. Production refers to quantities. Price refers to producer prices. Imports are in value terms.

A summary of the welfare effects is shown in table 5. Productivity improvement is the best policy, but this is somewhat artificial because the estimate includes no cost of bringing about the improvement although if costs were included they would be a lot smaller than the subsidy to have the same desired impact. The specified input subsidy which is nearly 20 times that proposed in the current policy shows a small gain, a benefit of $1.5 million on a $40 million outlay, but does not achieve the self-sufficiency objective. The trade bans show significant negative effects, with the more comprehensive bans showing greater welfare losses.

Table 5 Welfare impact of alternative scenarios

	$m
Restriction on imports of live cattle	-380
Restriction on imports of live cattle and beef	-458
Domestic subsidy	2
Productivity improvement	196

Source: GTAP simulation. Welfare refers to equivalent variation.

Implications and conclusions

Achieving self-sufficiency across a range of commodities such as beef may be technically feasible, and may moderate the price effects of external shocks in the

short-run such as those experienced in 2008, but a self-sufficiency policy with minimal exposure to international market prices imposes high costs to maintain self-sufficiency:

- Production costs are higher if self-sufficiency is forced beyond what an open market would deliver as, by definition, marginal costs will be higher than marginal revenues, requiring subsidies of inputs or the higher-cost outputs to encourage more self-sufficient production levels;

- Stockholding levels and costs are higher under a self-sufficiency approach;

- The quality and variety of product are reduced from what would be provided with a more open market (currently wet markets based around domestic product dominate Indonesian sales with supermarkets selling predominantly imported product);

- A self-sufficiency policy with minimal reliance on trade leaves the domestic market exposed to the more frequent internal shocks such as those caused by floods, droughts or disease, and less able to be offset by spreading the risk;

- International competition that encourages international standard performance, competitive exports etc is lacking;

- Indonesia's trading partners, including ASEAN who Indonesia is a member of and who have an agreement on food security, may also object to Indonesian constraints on trade associated with a self-sufficiency policy, as ASEAN may also with Indonesia trying to obtain special treatment for agricultural and other products in relation to the ASEAN-China FTA, even though the main loser from such action would be Indonesia (BIES 2010);

- Self sufficiency in Indonesian cattle and beef meat would result in a lost opportunity of Indonesia drawing on relatively cheap, extensively-reared cattle in Australia's near north and New Zealand, and using its comparative advantage in cheap labour to intensively fatten these and competitively provide what could be rapidly increasing supplies to the domestic market as well as export products to some very wealthy near-neighbours or others with similar Halal etc requirements such as Singapore and Brunei; and

- There are also environmental concerns with self-sufficiency because of an expansion of new agricultural lands into sensitive tropical forests or peat lands that are holding large amounts of carbon, leading to bans on some Indonesian exports such as CPO and possibly livestock products.

It might be argued that there are non-economic benefits from food self-sufficiency that match these costs, such as political stability. However, this is more an argument for food security which can achieve such underlying objectives in a less costly way than a self-sufficiency approach that is so vulnerable to more frequent internal shocks. Other past rationales for self-sufficiency such as developing countries being exploited on international markets, or in internal marketing systems, are losing whatever justification they may have had with the continued development of markets, including associated institutions and instruments.

There seems little justification for self-sufficiency in livestock on poverty grounds and trying to achieve this through input subsidies and quantitative restrictions will just lead to higher costs and prices as well as lost opportunities for Indonesia in value-adding processed products. Indonesia would be better to invest in research that would improve productivity in the sector. Australia is increasing its aid to Indonesia and using this aid to increase agricultural productivity and quality may help place Indonesia in a position where it could supply the products of fattened imported feeder cattle to Singapore and other countries in the region.

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Appendix 1 Estimation of Armington Elasticities for the Livestock Sector in Indonesia

A Theoretical Baseline[6]

Let $X_j^I(t)$ and $X_j^D(t)$ denote the quantity of imports and domestic production, respectively of commodity j at time t and let $P_j^I(t)$ and $P_j^D(t)$ denote their respective price indices. The elasticity of substitution between imported and domestic goods for sector j , σ_j , can be defined as:

$$\sigma_j = \frac{\partial \log\left(\frac{X_j^I(t)}{X_j^D(t)}\right)}{\partial \log\left(\frac{P_j^I(t)}{P_j^D(t)}\right)} \tag{1}$$

The above function can be transformed –suppressing the time variable t — into:

$$x_j^s = x_j^\bullet - \sigma_j \left(p_j^s - \Sigma_{g \in G} \ H_j^g p_j^g \right) \tag{2}$$

Where $s = I, D; G = \{I, D\};$ and $j = 1, \dots, J$ where J is the total number of commodity j . Variables depicted in lower case Roman letters indicate proportional changes in the respective variables expressed in levels in Equation (1). For example $x_j = \frac{\partial X_j}{X_j}$. The variable $x_j^\bullet$ denotes the proportional change in the demand for the composite commodity j and is assumed as exogenous in this paper. H_j^g refers to the share of source g (either domestically produces or imported) in total demand for good j where $H_j^D + H_j^I = 1$.

The demand for domestic supplies $(s = d)$ becomes:

$$x_j^D = x_j^\bullet - \sigma_j \left(p_j^D \left(1 - H_j^D\right) - p_j^I H_j^I \right) \tag{3}$$

But since $H_j^I = 1 - H_j^D$ Equation (3) implies:

$$x_j^D = x_j^\bullet - \sigma_j H_j^I \left(p_j^D - p_j^I\right) = x_j^\bullet + \Sigma_{s \in G} \beta_j^s p_j^s \tag{4}$$

Where $\beta_j^D = -\sigma_j H_j^I$ and $\beta_j^I = \sigma_j H_j^I$ implying $\beta_j^D + \beta_j^I = 0$. Therefore, this two-commodity case the Armington equation is equivalent to a flexible functional

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[6] The methodology outlined here closely follows that of Kapuscinski and Warr (1999).

form demand equation which is homogenous of degree zero in the two commodity prices.

Kapuscinski and Warr (1999), based on transformation of Equation (1), suggest a testable relative demand equation:

$$\log\left(\frac{X_j^I(t)}{X_j^D(t)}\right) = \alpha_j^0 + \alpha_j^1 \log\left(\frac{P_j^D(t)}{P_j^I(t)}\right) + e_j(t)$$

(5)

Where α_j^0 is a constant, $e_j(t)$ the error term and the estimated value of σ_j is given by the estimate of α_j^1.

Data and Methodology

Data are taken from Food Agricultural Organisation Statistics (FAOSTAT 2010a; FAOSTAT 2010b; FAOSTAT 2010c; FAOSTAT 2010d; FAOSTAT 2010e). For live animals, the quantity of the stock, both domestic production and imported animals, is measure in head, except for ducks and chickens. We find two problems with the dataset. First, we have no complete information on import price. We are, however, able to derive import price by dividing import value by quantity and yield the so called "unit values". To be comparative to domestic price, which is measured in "USD/tonne" (instead of USD/head"), we must make an assumption on the weight of one (head of) cattle in tonne. Comtrade shows Indonesian imports of HS 0102 from Australia in 2008 at of 494,254 head valued have net weight 205,548 tonnes which implies an average of 416 kg per head. One may argue that Australian imported cattle might be in the higher end of import distribution. In addition, since 2008 the Indonesia government has regulated that the maximum weight of live cattle is 350 kg.[7] We therefore assume that one cattle weighs 350kg. Nevertheless, we conduct some sensitivity analysis and find that the estimates of elasticities of substitution is unchanged regardless the assumption on weight we use.[8]

Due to short period of import data, we are only able to use data between 1991 and 2007.

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[7] *Peraturan Menteri Pertanian Nomor 7 Tahun 2008 tentang Syarat dan Tata Cara Pemasukan dan Pengeluaran Benih, Bibit Ternak, dan Ternak Potong* (Minister of Agriculture's Regulation No.7 Year 2008 on Requirements and Methods of Entry and Exit of Seeds, Livestock Seeds and Livestock.
[8] The statistics for a series of tests are also unchanged. Only the constants in each equation slightly differ across models with different assumptions.

The paper focuses on the cattle sector. Following Kapuscinski and Warr (1999), the paper employs three alternative methods: the Ordinary Least Squares (OLS), the Partial Adjustment Model (PAM) and the Error Correction Models (ECM). The specifications are as follow:

(i) OLS:
$$\log\left(\frac{X_j^I(t)}{X_j^D(t)}\right) = \alpha_j^0 + \alpha_j^1 \log\left(\frac{P_j^D(t)}{P_j^I(t)}\right) + e_j(t)$$

(ii) PAM:
$$\log\left(\frac{X_j^I(t)}{X_j^D(t)}\right) = \beta_j^0 + \beta_j^1 \log\left(\frac{X_j^I(t-1)}{X_j^D(t-1)}\right) + \beta_j^2 \log\left(\frac{P_j^D(t)}{P_j^I(t)}\right) + e_j(t)$$

(iii) ECM:

$$\Delta\log\left(\frac{X_j^I(t)}{X_j^D(t)}\right) = \gamma_j^0 + \gamma_j^1 \Delta\log\left(\frac{P_j^D(t)}{P_j^I(t)}\right) + \gamma_j^2\left[\log\left(\frac{X_j^I(t-1)}{X_j^D(t-1)}\right) - \gamma_j^3\log\left[\left(\frac{P_j^D(t)}{P_j^I(t)}\right)\right]\right] + e_j(t)$$

Δ indicates the difference operator. For simplicity, the logarithm of relative demand for imported products will be denoted as $\log QI_{QD}$, while the logarithm of relative domestic price will be denoted as $\log PD_{PI}$. The difference operator and the lagged operator will be denoted as "D" and "L", respectively.

OLS method may still be able to produce unbiased and consistent estimates. But the problem with the OLS method is it cannot capture the dynamics relationship between imports, domestic production and prices. Given the time-series data we use in the analysis, it is most likely that the estimates are inefficient due to auto-correlation. The model cannot control specific-commodity effects either. For example the Indonesian government might protect beef production more that it does on live cattle.

The inclusion of the level of relative demand for imports in the previous period eg. $t-1$ might be able to capture such time-variant commodity-specific effects. The problem with this PAM method, however, is possible autocorrelation of the error terms as a result of the inclusion of lagged dependent variable. It could yield bias estimates of elasticity of substitution $\left(\beta_j^2\right)$. More specifically, if the coefficient for β_j^1 is larger than one than the autoregressive estimates are non-stationary. If this is the case, then stationarity can be achieved by simple differencing or some other transformation.

Apart from differencing, there is an alternative method to deal with trending variables. One problem with the PAM method is often relative demands for imports in the long-run are drifting together with the relative price index at roughly the same rate i.e. co-integrated. The ECM method aims to distinguish the long–run relationship between the two variables (potentially drifting together) and the short-run dynamics ie. deviations of relative demand for imports from its long-run trend and deviations of relative price-index from its long-run trend (Engle and Granger 1987). The differencing method would not preserve such information. As shown by Equation (6.iv), the term $\left(\log\left(\frac{X_j^I(t-1)}{X_j^D(t-1)} \right) - \log\left(\frac{P_j^D(t)}{P_j^I(t)} \right) \right)$ refers to the error correction term. The elasticity of substitution is estimated based on the coefficient γ_j^1 which captures the short-run relationship between relative domestic price and relative demand for imports. Coefficient γ_j^2 tells us the proportion of the disequilibrium which is corrected with each passing period. This coefficient should be negative and less than the absolute value of one indicating its re-equilibrating properties.

Results

Before turning to estimation results, table 1 presents test results for stationarity and co-integration. The price variable has a unit root, implying non-stationarity. The two variables have a co-integrating relationship. The use of ECM is therefore preferred.

Table A1 Stationarity and co-integration tests

	Augmented Dicky-Fuller test		Johansen test
	Price Variable	Quantity variable	H_0 =number of co-integration relations=1
Statistics (p-value in parentheses)	-1.258	-3.112	2.090
	(0.648)	(0.026)	
Decision	Accept H_0	Reject H_0	Accept H_0

Although ECM is preferred, estimates are shown for the three alternative methods: OLS, PAM and ECM. For the favoured method, two different approaches are shown (Table A2).

Table 2. Estimation: Live Cattle

	OLS	PAM	ECM_ two-step	ECM_ one-step
	b/t	b/t	b/t	b/t
logPD_PI	0.555	0.742*		
	(1.549)	(2.306)		
L.logQI_QD		0.721*		-0.504***
		(2.809)		(-7.461)
D.logPD_PI			0.799*	0.876*
			(2.361)	(2.362)
L.logPD_PI				0.441
				(1.805)
L.EC			-0.509***	
			(-7.650)	
_cons	-4.479***	-1.288	0.281*	-2.032***
	(-13.382)	(-1.253)	(2.779)	(-5.733)
Implied coeff_elasticity	0.555	0.742	0.799	0.876
r2	0.026	0.656	0.808	0.811
Durbin-Watson	0.403	2.037	1.914	1.889
No. of parameters	2	3	3	4
Durbin-Watson ($H_0 =$ no serial correlation)	Accept H_0	Reject H_0	Reject H_0	Reject H_0
N	17	17	16	16

Notes: Durbin-Watson critical values (lower and upper bounds) at 5% level of significance: DW(2,15)=0.95-1.54; DW(3,15)=0.82-1.75; DW(4,15)=0.69-1.97; DW(2,20)=1.10-1.54;DW(3,20)=1.00-1.68; DW(4,20)=0.90-1.83

Column (3) presents results from the two-step ECM. The lagged error-correction term is derived from residuals based on the OLS regression in Column 1. Note that the term, EC, indicates the speed at which it returns to its equilibrium level. It is negative as expected suggesting the process equilibrates. Column 4 presents the one-step ECM in which the error correction term consists of lagged $\log QI_{QD}$ and lagged $\log PD_{PI}$. Both show similar results. Based on the coefficient of determination and Durbin-Watson test results, the one-step approach provides the marginally better estimates among alternative specifications. It explains around 81 per cent of variation in $D.\log QI_{QD}$. The estimate of elasticity of substitution is 0.876. with a 95 per cent confidence interval between 0.068 and 1.68.

In conclusion, given that the quantity and price variables are cointegrating, the Error-Correction Model is most preferred among the three methods tested in the study, i.e. OLS, PAM and ECM. The point estimate of elasticity of substitution for live cattle was 0.876 with a five per cent confidence interval between 0.068 and 1.68.

Given the short time-series data, the estimates may be subject to small sample bias. Furthermore, given limited number of available data, there are some potential variables not included in the analysis which may potentially cause omitted variable bias. Other studies for example include trade restrictions, relative quantity production, relative distance, and wage (Erkel-Rousse and Mirza 2002).