ECONOMY-WIDE IMPACT OF A MORE EFFICIENT TANJUNG PRIOK PORT

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1. Introduction

Indonesia’s growth has long been constrained by sluggish infrastructure development. An often-cited example of this is Tanjung Priok port, which serves more than two-thirds of the country’s international trade. The port was developed over 100 years ago and has since undergone only a few minor extensions. It is now struggling to deal with rising container traffic, while container dwell time has increased consistently since 2010, reaching eight days in 2014, which is triple the dwell time of the most efficient port in Southeast Asia. This situation has added significant costs and delays to both importers and exporters. Contrary to popular perception, the hard infrastructure of Tanjung Priok is not the largest contributor to increased dwell time. The main cause of the increased dwell time is the port’s soft infrastructure.

This paper has two objectives: First, to examine the causes of the increased dwell time and identify solutions. Second, to analyze economy-wide benefits of improved efficiency in Tanjung Priok using IndoTERM, a bottom-up and dynamic computable general equilibrium model for the Indonesian economy.

The findings of the analysis suggest that a 50% improvement in Tanjung Priok’s efficiency over the next five years will generate additional national growth of about 1.1%. Jakarta and its surroundings will benefit the most from this improvement, while other regions trading with Jakarta will also benefit.

2. The Current State of Tanjung Priok Port

Most of Indonesia’s international trade is facilitated by five ports. The largest is Tanjung Priok, serving about 70% of the country’s internationally traded goods. Tanjung Priok also handles 29% of container traffic between Java and other islands. It experienced a spike in container traffic when high economic growth returned after the 1997–98 Asian financial crisis. According to state-owned port operator Pelindo II, which oversees Tanjung Priok, container traffic increased by 160% from 2010 to 2015.

While Tanjung Priok is Indonesia’s most efficient port, its productivity is much lower than that of major ports in Southeast Asia. Container dwell time in Tanjung Priok reached seven days in August 2013, compared with only 4.9 days in 2010. While dwell time started to decline moderately in 2015, it is still three times higher than Singapore and almost double that of Tanjung Lepas in Malaysia (Figure 1).

The prolonged dwell time at Tanjung Priok has a number of adverse effects. First, the delays increase costs for domestic businesses and ultimately the prices paid by consumers. Second, bottlenecks at the port reduce the competitiveness of export-oriented industries. Although
dwell time for exports is slightly lower than for imports, it directly increases logistics costs for exports. A significant portion of inputs for the country’s manufactured exports are imported, so delays lead to higher costs for manufacturers. Long dwell time also reduces Indonesia’s ability to benefit from declining international shipping costs and hence hampers the country’s integration into efficient worldwide supply chains.

**Figure 1. Dwelling time in selected countries (days, March-Sept 2014 average)**

Contrary to popular perception, the hard infrastructure of Tanjung Priok is not the largest contributor to increased dwell time. While the rapidly growing amount of container traffic has generated congestion at certain times, a deeper examination suggests that the port’s soft infrastructure is a bigger part of the problem.

Dwell time measures the time from the arrival of a vessel until it leaves the port. The process can be broken down into three parts: the upstream process between the arrival of the ship and the submission of import declarations to Customs; Customs clearance; and the downstream process from Customs clearance until leaving the gates of the port. The biggest cause of delays is the upstream pre-clearance process, averaging about four days. The quality of port infrastructure does influence the speed of unloading the container, but the bulk of the upstream delay is due to administrative processes related to border control, quarantine, and various checking requirements. Next, the Customs clearance average time is already competitive by international standards at around one day. The final step, removing a container from the port by truck, is still rather long and takes more than one day.

The quality of hard infrastructure contributes to the downstream delay due to congestion around the port, which partly explains the increased cost of transporting containers to manufacturing sites. The cost of delivering a container from Cikarang (the nearest industrial zone) in West Java to Tanjung Priok across a distance of 56 kilometers is $750, much higher...
than the cost ($450) across a similar distance in Malaysia (from Pasir Gudang to Tanjung Pelepas).

A lasting solution to Tanjung Priok’s problems will require improvement of both hard and soft infrastructure. The government has started efforts on both fronts. An expansion project commenced in 2014 and is scheduled to be completed in 2018. Further investment is expected after 2018 to further expand Tanjung Priok’s capacity. The government has also started to improve the port’s soft infrastructure by introducing measures to reduce corruption. These include abolishing cash payments at container terminals and eliminating face-to-face interactions with Customs officials at the gate.

Some low-hanging reforms can also be implemented more quickly to reduce time wasted during the upstream processes.

First, the current dwell time for priority importers averages four days, but priority status is given to only a limited group of importers and accounts for only 16% of total containers handled at the port. The government can enlarge membership of the priority group by establishing clear, reasonable, and transparent criteria for importers to join.

Second, the government has established the Indonesia National Single Window (INSW), an integrated system for unifying data for export-import licensing, but its function could be improved. Ideally, INSW should allow users to submit the information required by several agencies in a single entry, with a single sign-on, including payments. Such a system will further reduce face-to-face and paper-based transactions.

Third, introduction of an Integrated Physical Inspection Facility would allow Customs, Quarantine, and other relevant agencies to conduct inspections more efficiently.

Fourth, allowing a more flexible and parallel process, where possible, instead of sequencing the steps, could potentially help to reduce pre-clearance times.

Dwell time should decline in coming years if the government implements the aforementioned measures. Increased efficiency of Tanjung Priok port will have widespread impacts on the economy. These impacts are analyzed below using IndoTERM, a computable general equilibrium (CGE) model for the Indonesian economy.

3. Methodology
Like most CGE economic models, IndoTERM represents the entire national economy but with an aggregation of detailed microeconomic behavior. The model is represented in a system of non-linear equations with endogenous variables and many more exogenous variables. The equations determine prices and quantities of commodities and inputs (including primary inputs, e.g., labor, capital, and land, as well as intermediate inputs). The equations specified in the CGE model are a representation of optimizing rational economic agents, in this case, producers and
consumers who interact in a competitive market economy. They form the demand for and supply of commodities cleared in the marketplace represented in the model, as the market clearing conditions or equilibrium. A brief description of IndoTERM is presented in Appendix 1.

IndoTERM was developed based on TERM (The Enormous Regional Model), an inter-regional model of the Australian economy (Horridge, Madden, & Wittwer, 2003). It was created to deal with highly disaggregated sub-national data, while providing quick simulations. Like the original version, IndoTERM is a “bottom-up” model that treats each provincial economy as a separate economy. Provinces are linked to each other through trade in commodities and through other factors. The national economy is an aggregation of the provincial economies. Unlike a “top-down” multi-regional CGE, the bottom-up model has different market clearing equations for each commodity in each provincial economy. Therefore, prices for each commodity will be differentiated across provinces. By combining the bottom-up feature with a detailed regional specification, IndoTERM is a useful tool for examining the impacts of province-specific investment and policy changes.

IndoTERM generates a year-on-year sequence of solutions. It produces annual results in terms of year-on-year growth through any desired simulation period. This feature allows policy shock to be introduced on an annual basis, in line with common policy practice.

Another feature of IndoTERM is its detailed treatment of the transport sector. The model includes all major elements of the transport subsector, such as road, sea, rail, and air transport. Services to transport, such as ports and airports, are treated as a separate industry. With this specification, the model can analyze the economy-wide impact of policy improvement in each transport subsector.

IndoTERM can be used to analyze both regional and economy-wide impacts of a regional project, such as port improvement, road development, and airport development, in any region in Indonesia. This innovative feature has been used to analyze both the regional and economy-wide effects of improving efficiency at Tanjung Priok port.

The development of IndoTERM is a collaborative effort of various institutions, including the Center for Economics and Development Studies (CEDS) at Padjadjaran University, Indonesia; Center of Policy Studies (CoPS) at Monash University, Australia, Asian Development Bank Indonesia Resident Mission, and the Indonesian Ministry of National Development Planning.
4. Policy simulations and results
IndoTERM analyzes policy change by using two simulations (Figure 2). The first is the baseline (business-as-usual) simulation, showing economic development in the absence of the policy under consideration. In generating the baseline, most macroeconomic variables were set exogenously to follow IMF forecasts. The second simulation includes all the features of the baseline simulation and also a one-off policy shock. For the purpose of illustration, the policy shock is introduced in 2014 in Figure 2. The new growth path would therefore diverge from the baseline, making it possible to evaluate the impact of the policy. Policy effects are reported as percent deviations endogenous variables from the baseline. This method is pioneered by Peter Dixon in MONASH model. An informative application of this method outside of Australia is presented in Dixon and Rimmer (2012) to analyze President Obama’s national export initiative using USAGE, a dynamic economy-wide model for the U.S.

Figure 2: Baseline and policy simulations

In considering solutions to the long container dwell time at Tanjung Priok port, we ran two policy simulations. The first simulation (SIM1) analyzed the government’s policy to increase the
port’s capacity by 2020. This will involve about a 20% increase in capital in Jakarta’s transport services industry. We therefore introduced a policy shock in SIM1 to increase investment in Jakarta’s transport services industry by 20% from 2016 to 2020.

The second simulation (SIM2) was to capture policy measures for improving soft infrastructure at Tanjung Priok to reduce port handling costs. We assume that these measures will gradually improve the port’s efficiency by 50% from 2015 to 2020. This will lead to a reduction of international trade costs through FOB prices for exports and CIF price for imports. The actual benefit will be divided between exporters and importers according to the degree of competition in international trade. For simplicity, for this study it is assumed that this benefit will be divided equally between exporters and importers.

Table 1: Impact of GDP at regional and national levels

<table>
<thead>
<tr>
<th>GDP in 2030</th>
<th>Sumatera</th>
<th>Jakarta</th>
<th>Other Java</th>
<th>Kalimantan</th>
<th>Sulawesi</th>
<th>East Indo.</th>
<th>National</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIM1 - Doubling port</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>capacity</td>
<td>0.06</td>
<td>0.35</td>
<td>0.21</td>
<td>0.10</td>
<td>0.14</td>
<td>0.06</td>
<td>0.17</td>
</tr>
<tr>
<td>SIM2 - Shipping cost</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>reduction</td>
<td>-0.18</td>
<td>3.98</td>
<td>0.80</td>
<td>-0.06</td>
<td>0.13</td>
<td>0.24</td>
<td>0.94</td>
</tr>
</tbody>
</table>

Source: IndoTERM simulations

The combined effect of the two policies is growth of around 4% in Jakarta’s gross domestic product from 2016 to 2030 (Table 1). It is interesting to note that the impact of SIM2 for Jakarta is almost four times that of SIM1. This is because SIM2 produces a direct and significant reduction of shipping costs, while SIM1 works through increased investment and its impact on shipping costs will not arrive until the port extension becomes operational. The combined impact of the two policies will account for around 1.1% of national GDP.

As expected, one of the main factors behind the positive growth will be improved export performance, particularly in motor vehicles, metals, and chemicals (Figure 3). Improved export performance also attracts new investment to these sectors.

The employment impact of the two simulations will be more jobs in manufacturing industries. Most of the jobs generated are in the Jakarta area, consistent with region-specific policy shocks introduced to the model.

Improved efficiency in Tanjung Priok will be positive for some regions in eastern Indonesia, which depend more on Jakarta for their goods and inputs. The impact on provinces competing with Jakarta in international ports will be negative. Increased efficiency in the port sector in
Jakarta will have a slight negative impact on Sumatra, reflecting its declining relative competitiveness.

**Figure 3: 10 Most benefited Industries in 2030 (% deviation from baseline)**

![Graph showing the 10 most benefited industries in 2030](image)

5. **Conclusion**

This paper analyzes the effects of high-profile investment and policy measures aimed at improving efficiency in Tanjung Priok port.

The study has two important findings. First, Tanjung Priok’s declining efficiency is mainly due to soft infrastructure, rather than its hard infrastructure. This implies that a large efficiency gain can be achieved by implementing quick reforms. These include measures to transparently increase the number of importers with priority status, enhance the existing INSW, and introduce an integrated physical inspection facility.

The study also found that efforts to improve efficiency in Tanjung Priok, through port expansion and policy measures to reduce dwell time, will have a significant economy-wide impact. By 2020, these efforts will contribute around 4% to GDP in Jakarta and 1.1% of GDP nationally, supported by improved growth of manufacturing sectors currently constrained by Tanjung Priok’s inefficiencies.

It is noteworthy that policy measures to reduce the upstream part of the dwell time will produce significantly bigger gains than capital investment to expand the capacity of the port. While this finding provides positive reassurance to accelerate the implementation of these measures, in practice, the two will need to go together to provide a sustainable and lasting solution to the port’s problems.
References


Appendix 1: Brief description of IndoTERM

IndoTERM is a multi-regional CGE model of Indonesia\(^1\) that includes two dynamic mechanisms. Firstly, capital accumulates over time via the change in net investment. Employment temporarily responds to changes in real wages. Via this second mechanism we move the labour market from a typical short-run environment (real wages fixed, employment variable) to a long-run environment (employment fixed, real wages flexible).

IndoTERM treats each region as a separate economy. A feature of TERM-style models is their ability to deal with highly disaggregated regional data without excessive computational cost. This is made possible by a number of simplifying assumptions that creates a compact data structure (Horridge et al., 2003). For example, IndoTERM assumes that all users of a particular commodity (fish products) in a particular region, source their fish from other regions according to common proportions. Horridge et al. (2003) noted that finer regional and sectoral detail is desirable for a number of reasons. Firstly, TERM-style models are very useful for countries such as Indonesia, which is characterized by a large number of diverse regions. These regions vary in resource endowment and in the pattern of economic activity: policy intervention may be needed to ensure that the benefits of economic growth are shared equitably between regions. TERM allows events such as natural disasters to be modeled in a specific region. Secondly, policy-makers concerned with unemployment or urban-rural policy desire more detailed regional results. Thirdly, environmental issues, such as turning forests into farmland, call for smaller regions that can allow for natural boundaries to be mapped more accurately. Finally, smaller regions give CGE models a greater sense of geographical realism.

Basic structure of the static IndoTERM model

Figure A1 represents the model’s input-output structure\(^2\). The rectangles indicate matrices of flows. Core matrices contained in the database are printed in bold while other matrices may be calculated from the core matrices. The dimensions of the matrices are indicated by indices corresponding to the sets listed at top right.

The matrices on the left-hand side of the diagram resemble (for each region) a conventional single-region input-output database.\(^3\) For example, the matrix USE at top left shows the delivered value of demand for each good (c in COM) whether domestic or imported (s in SRC) in each destination region (DST) for each user (USER, comprising the industries, IND, and 4 final demanders: households, investment, government, and exports). Some typical elements of USE might show:

- **USE("OilPalm","dom","EdibleOil","Sumatra"):** domestically-produced OilPalm used by the EdibleOil industry in Sumatra.

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1 IndoTERM is based on the TERM (The Enormous Regional Model) of the Australian economy.
2 This and the next subsection draw from Horridge et al. (2003).
3 The matrices in Figure 2 show the value of flows valued according to 3 methods:
   1) Basic values = Output prices (for domestically-produced goods), or CIF prices (for imports)
   2) Delivered values = Basic + Margins
   3) Purchasers’ values = Basic + Margins + Tax = Delivered + Tax
• USE("OilGas","dom","EXP","Kalimantan") : domestically-produced OilGas exported from a port in Kalimantan.

The TAX matrix of commodity tax revenues contains elements corresponding to each element of USE. Together with matrices of primary factor costs and production taxes, these add to the costs of production (or value of output) of each regional industry.

The MAKE matrix at the bottom of Figure A1 shows the value of output of each commodity by each industry in each region. A subtotal of MAKE, MAKE_I, shows the total production of each commodity c each region d.

The right hand side of A1 shows the regional sourcing mechanism. The key matrix is TRADE, which shows the value of inter-regional trade by sources (r in ORG) and destinations (d in DST) for each good (c in COM) whether domestic or imported (s in SRC). The diagonal of this matrix (r=d) shows the value of local usage which is sourced locally. For foreign goods (s="imp") the regional source subscript r (in ORG) denotes the port of entry. The matrix IMPORT, showing total entry of imports at each port, is simply an add-up (over d in DST) of the imported part of TRADE.

The TRADMAR matrix shows, for each cell of the TRADE matrix the value of margin good m (m in MAR) which is required to facilitate that flow. Adding together the TRADE and TRADMAR matrix gives DELIVRD, the delivered (basic + margins) value of all flows of goods within and between regions. Note that TRADMAR makes no assumption about where a margin flow is produced (the r subscript refers to the source of the underlying basic flow).

Matrix SUPPMAR shows where margins are produced (p in PRD). It lacks the good-specific subscripts c (COM) and s (SRC), indicating that, for all usage of margin good m used to transport any goods from region r to region d, the same proportion of m is produced in region p. Summation of SUPPMAR over the p (in PRD) subscript yields the matrix SUPPMAR_P which should be identical to the subtotal of TRADMAR (over c in COM and s in SRC), TRADMAR_CS. In the model, TRADMAR_CS is a CES aggregation of SUPPMAR: margins (for a given good and route) are sourced according to the price of that margin in the various regions (p in PRD).

IndoTERM assumes that all users of a given good (c,s) in a given region (d) have the same sourcing (r) mix. In effect, for each good (c,s) and region of use (d) there is a broker who decides for all users in d whence supplies will be obtained. Armington sourcing is assumed: the matrix DELIVRD_R is a CES composite (over r in ORG) of the DELIVRD matrix.

A balancing requirement of the IndoTERM database is that the sum over user of USE, USE_U, shall be equal to the sum over regional sources of the DELIVRD matrix, DELIVRD_R.
It remains to reconcile demand and supply for domestically-produced goods. In Figure A1 the connection is made by arrows linking the MAKE_I matrix with the TRADE and SUPPMAR matrices. For non-margin goods, the domestic part of the TRADE matrix must sum (over d in DST) to the corresponding element in the MAKE_I matrix of commodity supplies. For margin goods, we must take into account both the margins requirement SUPPMAR_RD and direct demands TRADE_D.

(a) At the moment, Indoterm distinguishes only 4 final demanders in each region:
(b) HOU: the representative household
(c) INV: capital formation, distinguished by sector of use
(d) GOV: government demand
(e) EXP: export demand.

The TRADMAR matrix shows, for each cell of the TRADE matrix the value of margin good $m$ ($m$ in MAR) which is required to facilitate that flow. Adding together the TRADE and TRADMAR matrix gives DELIVRD, the delivered (basic + margins) value of all flows of goods within and between regions. Note that TRADMAR makes no assumption about where a margin flow is produced (the $r$ subscript refers to the source of the underlying basic flow).

Matrix SUPPMAR shows where margins are produced ($p$ in PRD). It lacks the good-specific subscripts $c$ (COM) and $s$ (SRC), indicating that, for all usage of margin good $m$ used to transport any goods from region $r$ to region $d$, the same proportion of $m$ is produced in region $p$. Summation of SUPPMAR over the $p$ (in PRD) subscript yields the matrix SUPPMAR_P which should be identical to the subtotal of TRADMAR (over $c$ in COM and $s$ in SRC), TRADMAR_CS. In the model, TRADMAR_CS is a CES aggregation of SUPPMAR: margins (for a given good and route) are sourced according to the price of that margin in the various regions ($p$ in PRD).

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(f) At the moment, IndoTERM distinguishes only 4 final demanders in each region:

(g) HOU: the representative household
(h) INV: capital formation, distinguished by sector of use
(i) GOV: government demand
(j) EXP: export demand.

The IndoTERM sourcing mechanism

A2 illustrates the details of the IndoTERM system of demand sourcing. Note that this figure covers only the demand for a single commodity (Vegetables) by a single user (Households) in a single region (Sumatra). The same diagram would apply to other commodities, users and regions.
Figure A2: IndoTERM sourcing mechanisms
The diagram depicts a series of 'nests' indicating the various substitution possibilities allowed by the model. Down the left side of the figure, boxes with dotted borders show in upper case the value flows associated with each level of the nesting system. These value flows may also be located in Error! Reference source not found.. The same boxes show in lower case the price \((p....)\) and quantity \((x....)\) variables associated with each flow. The dimensions of these variables are critical both to the usefulness of the model and to its computational tractability; they are indicated by subscripts \(c, s, m, r, d\) and \(p\), as explained at top right of Error! Reference source not found.. Most key features of IndoTERM could be reconstructed from Error! Reference source not found. and Error! Reference source not found..

At the top level, households choose between imported (from another country) and domestic vegetables. A CES or Armington specification describes their choice—as pioneered by ORANI and adopted by most later CGE models. Demands are guided by user-specific purchasers' prices (the purchasers' values matrix \(\text{PUR}\) is found by summing the \(\text{TAX}\) and \(\text{USE}\) matrices of Figure A2).

Demands for domestic vegetables in a region are summed (over users) to give total value \(\text{USE}_U\) (the "\(U\)" suffix indicates summation over the user index \(u\)). The \(\text{USE}_U\) matrix is measured in "delivered" values—which include basic values and margins (trade and transport), but not the user-specific commodity taxes.

The next level treats the sourcing of \(\text{USE}_U\) between the various domestic regions. The matrix \(\text{DELIVRD}\) shows how \(\text{USE}_U\) is split between origin regions \(r\). Again a CES specification controls the allocation; substitution elasticities range from \(5\) (merchandise) to \(0.2\) (services). The CES implies that regions which lower production costs more than other regions will tend to increase their market share. The sourcing decision is made on the basis of delivered prices—which include transport and other margin costs. Hence, even with growers' prices fixed, changes in transport costs will affect regional market shares. Notice that variables at this level lack a user \((u)\) subscript—the decision is made on an all-user basis (as if wholesalers, not final users, decided where to source vegetables). The implication is that, in Sumatra, the proportion of vegetables which come from Bali is the same for households, intermediate, and all other users.

The next level shows how a "delivered" vegetable from, say, Bali, is a Leontief composite of basic vegetables and the various margin goods. The share of each margin in the delivered price is specific to a particular combination of origin, destination, commodity and source. For example, we should expect transport costs to form a larger share for region pairs which are far apart, or for heavy or bulky goods. The number of margin goods will depend on how aggregated is the model database. Under the Leontief specification we preclude substitution between Road and Retail margins, as well as between Road and Rail. For some purposes it might be worthwhile to construct a more elaborate nesting which accommodated Road/Rail switching.

The bottom part of the nesting structure shows that margins on vegetables passing to Sumatra from Bali could be produced in different regions. The figure shows the sourcing mechanism for the road margin. We might expect this to be drawn more or less equally from the origin (Bali), the destination (Sumatra) and regions between (Java). There would be some scope \((\sigma = 0.5)\) for substitution, since trucking firms
can relocate depots to cheaper regions. For retail margins, on the other hand, a larger share would be
drawn from the destination region, and scope for substitution would be less (σ = 0.1). Once again, this
substitution decision takes place at an aggregated level. The assumption is that the share of Java in
providing Road margins on trips from Bali to Sumatra, is the same whatever good is being transported.

Although not shown in Figure 7, a parallel system of sourcing is also modelled for imported vegetables,
tracing them back to port of entry instead of region of production.

Dynamic equations
There are three dynamic mechanisms in IndoTERM. They are:

- a stock-flow relation between investment and capital stock, which assumes a 1 year gestation lag.
- a positive relation between investment and the rate of profit.
- a relation between wage growth and employment.
For simplicity we have omitted industry and region subscripts in the details below.

Capital accumulation
Capital in each year grows by an amount equal to the rate of investment at the beginning of the period
minus depreciation on existing capital stock.

\[ K_1 = K_0 + I_0 - dK_0 \] (E.1)

Thus,

\[ \Delta K = I_0 - dK_0 \] (E.2)

where

- \( K_1, K_0, \Delta K \) is the capital stock at the end of period 1, capital stock at the start of the period and the
change in capital stock respectively;
- \( I_0 \) is the investment undertaken during the year;
- \( d \) is the depreciation rate.

Thus, a change in investment undertaken during year 1 affects the end-of-the-year capital stock and
therefore the growth rate of capital not in this period but in the next.

Investment allocation has two parts, namely:

- investment/capital ratios are positively related to expected rates of return; and
- expected rates of return converge to actual rates of return via a partial adjustment mechanism.

We define the investment/capital ratios as:

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4 This section relies on Horridge (2002).
\[ G = \frac{XINV}{XCAP} \quad \text{(percentage change is } gro = xinv - xcap) \]  

We define actual gross rate of return as:
\[ R = \frac{PCAP}{PINV} \quad \text{(ordinary change } \Delta gret = 0.01*GROR(pcap-pinv) \]  

where
\[ G \quad \text{capital growth rate in the next period} \]
\[ XINV \quad \text{investment} \]
\[ XCAP \quad \text{capital stock} \]
\[ R \quad \text{actual gross rate of return} \]
\[ PCAP \quad \text{unit rental price of capital} \]
\[ PINV \quad \text{investment price index} \]
\[ E \quad \text{expected rate of return for the next period} \]

Our theory that rates of growth of capital stock depend on expected rates of return may be expressed as:
\[ G = F(E) \quad \text{where } F_E > 0 \]  

Notice that both \( G \) and \( R \) (and by extension \( E \)) must be \( > 0 \). In the case of \( R \), this is guaranteed by other model equations — capital always earns a positive rent. For convenience, we have expressed \( E.5 \) in terms of gross rather than net rates of growth and return.

We also hypothesize that each industry has a long-run or normal rate of return \( R_{normal} \) and that when \( E \), the expected rate, is equal to \( R_{normal} \) then \( G = G_{trend} \) where \( G_{trend} \) is a normal or secular gross growth rate. That is,
\[ G_{trend} = F(R_{normal}) \]  

We choose a type of logistic curve for the function \( F \):
\[ G = QG_{trend}M^\alpha/(Q-1+M^\alpha) \quad \text{where} \]  

\[ M = E/R_{normal} \]  

if \( M = 1 \) then \( G = G_{trend} \)

if \( M \) is large then \( G = QG_{trend} = G_{max} \quad (Q = 5 \text{ in the database}) \)

if \( M \) is 0 then \( G = 0 \)
We postulate that end-of-period expected rates of return are an average of the initial (start-of-period) expected rate and the end-of-period actual rate of return. This implies that investors are both conservative and myopic—only past and current rates of return affect the expected rate for next period.

**Real wage adjustment mechanism**

In IndoTERM we allow for real wages to adjust to employment levels as follows: If end-of-period employment exceeds some trend level by x% then real wages will rise, during the period, by γ.x%. Since employment is negatively related to real wages, this mechanism causes employment to adjust towards the trend level, which may be thought of as the level of employment corresponding to NAIRU. We write this equation as:

\[
\Delta W/W_o = \gamma[(L_o/T_o)-1] + \gamma \Delta(L/T)
\]  

(E.9)

where

L \hspace{1cm} \text{actual employment}

T \hspace{1cm} \text{trend employment}

W \hspace{1cm} \text{real wage}

**Multi-regional database**

The key sources for the IndoTERM data are the BPS 2005 Indonesian national and inter-regional input-output tables, but several other sources have been used. Although the main IndoTERM database distinguishes 33 provinces and 179 sectors, simulations with this level of detail are slow to run. Hence for the simulations reported here, the data was aggregated to 6 regions and 32 sectors.