Treasury Industry Model (TIM)

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Context

- Treasury’s purpose is

  “to support and implement informed decisions on policies for the good of the Australian people, consistent with achieving strong sustainable economic growth and fiscal settings”
Context

• The production side of economy is complex

• Treasury’s objectives imply we should be able to provide advice on policy where production complexity needs to be considered.

• Treasury needs to harness approaches consistent with mainstream macroeconomic theory.
TIM project

- We are developing and using a multisector dynamic general equilibrium model, called the Treasury Industry Model (TIM).

- TIM will provide insight into the effects of industry policy on:
  - Economic activity, government budget, welfare
  - Short, medium and long-run effects of policy
Approach

• Part of a fit-for purpose broader model development programme
  – TIM (representative agent model of the Australian economy for industry policy analysis) – January 2018
  – OLGA (overlapping generations model of the Australian economy for fiscal policy analysis) – April 2016

• Ongoing development through modules
  – Today we will present Version 1.0

• Ongoing consultation

• Sustainable staff capability
TIM Overview

- Based on mainstream macroeconomic theory (neoclassical growth model)
- A multi (114) sector dynamic general equilibrium model
TIM Overview (cont.)

- **Households**
  - One utility-maximising infinitely-lived representative household.
  - Makes forward looking decisions on consumption, leisure/labour and saving to maximise lifetime utility.

- **Firms**
  - Each industry is a modelled representative firm.
  - Produce using intermediate inputs, labour, variable capital and land/minerals.
  - Make forward looking decision on investment, output and production inputs to maximise their cum dividend value of equity.
TIM Overview (cont.)

• Government
  – Levies taxes
  – Exogenous spending

• Rest of the World
  – Perfect capital mobility
    ▪ Foreign investor is the marginal investor
  – Differentiated exports and imports
TIM Overview (cont.)

- A lot of detail
  - 11 margin goods.
  - Foreign ownership by industry
  - Sales tax, excise, duties, 4 production taxes, CIT and LIT.
  - Industry specific investment goods.

- Calibrated to Australian data

- Captures responses to anticipated policy changes

- Internally consistent welfare measure
Scenarios

• To illustrate the properties/details of TIM we provide some results from hypothetical scenarios.
• Show industry linkages and forward looking dynamics.
• Indicates models ability to analyse industry specific policy questions.
Economy-wide LATP increase

• Permanent level increase in labour-augmenting technical progress (LATP) of 1 per cent
  – 100 workers now equivalent to 101 workers before increase (working same time)

• To all industries

• Do not capture cost of productivity increase
What we expect

- **Households:**
  - Wage $\uparrow$ -> Labour supply $\uparrow$
  - Income $\uparrow$ -> Labour supply $\downarrow$, consumption $\uparrow$,
  - Labour supply $\uparrow$, welfare $\uparrow$

- **Firms:**
  - Effective labour $\uparrow$ -> output, profits $\uparrow$ -> investment $\uparrow$ -> long run capital $\uparrow$ -> long run output $\uparrow$

- **In a simple model (Swan-Solow)**
  - In short run 1% $\uparrow$ LATP -> 0.6% $\uparrow$ output (labour ~60% value add)
  - In long run 1% $\uparrow$ LATP -> 1% $\uparrow$ output
Real GDPE contributions by components
development from baseline (%)
Anticipated LATP increase

• In year 1 everyone realises mining productivity will permanently increase in year 6
• Productivity increase same size as previously
• In anticipation we expect:
  – Higher future profits: investment ↑
  – Cheaper future investment goods: investment ↓
  – Increased lifetime income: Consumption ↑, N ↓
Mining sector LATP increase

- LATP increase only impacts the mining sector
- To make results comparable productivity increase is 27% (mining 4% of labour use)
Real GDPP contributions by sector
deviation from baseline (%)
Real GDPE contributions by components
deviation from baseline (%)
Construction sector LATP increase

- Construction sector LATP increases 12% (8% of labour use)
Real GDPE contributions by components
development from baseline (%)
Conclusion

TIM is a powerful tool for analysis of policy questions with industry detail.

- Captures much Australian industry detail.
- Forward looking model useful for considering dynamic aspects of policy.
- Consistent with mainstream macroeconomic approaches.
- Part of Treasury’s model development programme.
Back pocket
Real GDPE contributions by components
development from baseline (%)
## Scenario comparison

<table>
<thead>
<tr>
<th>Scenario</th>
<th>GDP</th>
<th>Labour</th>
<th>Consumption</th>
<th>Welfare (Consumption equivalent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economy wide</td>
<td>0.79</td>
<td>-0.15</td>
<td>1.00</td>
<td>1.10</td>
</tr>
<tr>
<td>Mining</td>
<td>0.81</td>
<td>-0.14</td>
<td>0.64</td>
<td>0.74</td>
</tr>
<tr>
<td>Construction</td>
<td>1.05</td>
<td>-0.14</td>
<td>0.99</td>
<td>1.07</td>
</tr>
</tbody>
</table>
Household’s Problem

- Households maximise expected lifetime utility

\[ U_t = \sum_t \beta^t \left( \frac{u_t}{1 - \sigma^u} \right) \]

- Gives inter-temporal allocation of utility

\[ u_t = \left( \frac{P_u^{t+1}}{\beta (1 + r_d^{t+1}) P_t^u} \right)^{\frac{1}{\sigma^u}} u_{t+1} \]

where

\[ P^u = \left( (P^C)^{1-\sigma^{CL}} \alpha^{CL} + (P^L)^{1-\sigma^{CL}} (1 - \alpha^{CL}) \right)^{\frac{1}{1-\sigma^{CL}}} \]

and

\[ P^C = \left( \sum_{i \in I} \alpha_i^{C} (P_i^{C})^{1-\sigma^{C}} \right)^{\frac{1}{1-\sigma^{C}}} \]
Firms’ Problems

- Firms maximise cum-dividend share price

\[
V_{i,t} = DIV_{i,t} + P_{i,t}^F = \sum_{t=t_0}^{\infty} \frac{DIV_{i,t}}{\prod_{s=t_0+1}^{t} (1 + r_s)(1 + \gamma)^{-1}}
\]

- Gives the following condition for the marginal product of capital

\[
r_{t+1} = \frac{(1-\tau^k)P_{t+1}^{KS} \omega^k + P_{t+1}^I \tau^k \delta + P_{t+1}^Y 5\psi(1-\tau^k) \left(\frac{I_{t+1}}{K_{t+1}}\right)^2 - (\gamma + \delta)^2}{P_t^I + P_t^Y \psi(1-\tau^k) \left(\frac{I_t}{K_t} - \delta - \gamma\right)}
\]

\[
+ (1-\delta) \left(\frac{P_{t+1}^I + P_{t+1}^Y \psi(1-\tau^k) \left(\frac{I_{t+1}}{K_{t+1}} - \delta - \gamma\right)}{P_t^I} - P_t^I - P_t^Y \psi(1-\tau^k) \left(\frac{I_t}{K_t} - \delta - \gamma\right)\right)
\]

\[
P_t^I + P_t^Y \psi(1-\tau^k) \left(\frac{I_t}{K_t} - \delta - \gamma\right)
\]

\[
, \quad P_t^I + P_t^Y \psi(1-\tau^k) \left(\frac{I_t}{K_t} - \delta - \gamma\right)
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- Gives the following condition for the marginal product of capital

\[
\begin{align*}
\text{Required return } r_{t+1} &= \frac{\text{Investment cost current period} \left( P^I_t + P^Y_t \psi(1 - \tau^k) \left( \frac{I_{t+1}}{K_{t+1}} - \delta - \gamma \right) \right) + \text{Investment cost future period} \left( 1 - \delta \right) \left( P^I_{t+1} + P^Y_{t+1} \psi(1 - \tau^k) \left( \frac{I_{t+1}}{K_{t+1}} - \delta - \gamma \right) \right)}{	ext{Benefit of extra capital on adjustment cost} \left( 1 - \tau^k \right) P^{KS}_{t+1} \omega^k + P^I_{t+1} \tau^k \delta + P^Y_{t+1} \cdot 5\psi (1 - \tau^k) \left( \frac{I_{t+1}}{K_{t+1}} \right)^2 - (\gamma + \delta)^2} \\
&\text{MPK-tax} \quad \text{dep-allow} \quad \text{Benefit of extra capital on adjustment cost}
\end{align*}
\]