Endogenous Technology Adoption and R&D as Sources of 
Business Cycle Persistence 
Online Appendix 

Diego Anzoategui 
Rutgers 
Mark Gertler 
NYU and NBER 

Diego Comin 
Dartmouth, NBER and CEPR 
Joseba Martinez 
LBS
1 Final Good Producers

Final good producers use the following CES aggregator to produce.

\[ Y_t^i = \left( \int_0^{A_t} (Y_m^j)^{\frac{1}{\varphi}} \frac{dj}{\varphi} \right)^{\varphi} \]  

(1.1)

Let \( p_{mt} \) be the real price of intermediate goods. Cost minimization determines the following real marginal cost,

\[ MC_t = \frac{p_{mt}}{A_t^{\varphi-1}} \]

Let \( P_i^t \) be the nominal price of final good \( i \) and \( P_t \) the nominal price level. The demand curve facing each final good producer is:

\[ Y_t^i = \frac{P_i^t}{P_t} \left( \frac{1}{\mu_t/(\mu_t-1)} \right)^{-\mu_t/(\mu_t-1)} Y_t \]  

(1.2)

where the price index is given by:

\[ P_t = \left( \frac{1}{\int_0^1 (P_i^t)^{-1/(\mu_t-1)} \frac{di}{\mu_t-1}} \right)^{-1/(\mu_t-1)} \]  

(1.3)

We assume Calvo pricing with indexing. Let \( 1 - \xi_p \) be the i.i.d probability that a firm is able to re-optimize its price and let \( \pi_t = P_t/P_{t-1} \) be the inflation rate. Firms that are unable to re-optimize during the period adjust their price according to the following indexing rule:

\[ P_i^t = P_i^{t-1} \pi_{t-1}^{1-t_p} \pi^{1-t_p} \]  

(1.4)

where \( \pi \) is the steady state inflation rate and \( t_p \) reflects the degree of indexing to lagged inflation.

For firms able to re-optimize, the optimization problem is to choose a new reset price \( P_t^* \) to maximize expected discounted profits until the next re-optimization, given by

\[ E_t \sum_{\tau=0}^{\infty} \xi_p^\tau \Lambda_{t,t+\tau} \left( \frac{P_t^*}{P_{t+\tau}} \Gamma_{t,t+\tau} - MC_{t+\tau} \right) Y_{t+\tau}^i \]  

(1.5)
subject to the demand function (1.2) and where

\[ \Gamma_{t,t+\tau} \equiv \prod_{k=1}^{\tau} \pi_{t+k-1}^{t-\tau} \pi^{1-\tau} \]  

(1.6)

The first order condition for \( P_t^* \) is

\[ 0 = E_t \sum_{\tau=0}^{\infty} \xi_p^T \Lambda_{t,t+\tau} \left[ \frac{P_t^* \Gamma_{t,t+\tau}}{P_{t+\tau}} - \mu_{t+\tau} MC_{t+\tau} \right] Y_{t+\tau}^i \]

replacing \( Y_{t+\tau}^i = \left[ \frac{P_t^* \Gamma_{t,t+\tau}}{P_{t+\tau}} \right]^{1-\mu_{t+\tau}} \pi_{t+\tau} \)

\[ 0 = E_t \sum_{\tau=0}^{\infty} \xi_p^T \Lambda_{t,t+\tau} \left[ \frac{P_t^* \Gamma_{t,t+\tau}}{P_{t+\tau}} - \mu_{t+\tau} MC_{t+\tau} \right] \left[ \frac{P_t^* \Gamma_{t,t+\tau}}{P_{t+\tau}} \right]^{1-\mu_{t+\tau}} Y_{t+\tau} \]  

(1.7)

The price index that relates \( P_t \) to \( P_t^*, P_{t-1} \) and \( \pi_{t-1} \) is then:

\[ P_t = \left[ (1 - \xi_p) (P_t^*)^{-1/(\mu_{t-1})} + \xi_p (\pi_{t-1}^{1-\tau} P_{t-1})^{-1/(\mu_{t-1})} \right]^{-(\mu_{t-1})} \]  

(1.8)

Equations (1.7) and (1.8) jointly determine inflation. In the loglinear equilibrium, current inflation is a function of current real marginal cost \( MC_t \), expected future inflation, and lagged inflation.

2 Employment Agencies and Wage Adjustment

The household is a monopolistically competitive supplier of labor. Think of the household as supplying its labor to form a labor composite. Firms then hire the labor composite. The only difference from the standard DSGE model with wage rigidity, is that households now supply two types of labor, skilled and unskilled.

Let \( X_t = \{L_t, L_{st}\} \) denote a labor composite. As is standard, we assume that \( X_t \) is the following CES aggregate of the differentiated types of labor that households provide

\[ X_t = \left[ \int_0^1 X_t^h \frac{1}{\mu_{wt}} dh \right]^{\mu_{wt}} \]  

(2.1)

where \( \mu_{wt} > 1 \) obeys an exogenous stochastic process\(^1\).

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\(^1\)In estimating the model we introduce wage markup shocks to the wage setting problem of unskilled labor only, so the markup for skilled labor is constant at its steady state level.
Let $W_{xt}$ denote the wage of the labor composite and let $W_{xt}^h$ be the nominal wage for labor supplied by household $h$. Then profit maximization by competitive employment agencies yields the following demand for type $x$ labor:

$$X_t^h = \left( \frac{W_{xt}^h}{W_{xt}} \right)^{-\mu_{wt}/(\mu_{wt} - 1)} X_t, \quad (2.2)$$

with

$$W_{xt} = \left[ \int_0^1 W_{xt}^h \frac{1}{\mu_{wt}-\tau} d\tau \right]^{-1/(\mu_{wt} - 1)}. \quad (2.3)$$

As with price setting by final goods firms, we assume that households engage in Calvo wage setting with indexation. Each period a fraction $1 - \xi_w$ of households re-optimize their wage. Households who are not able to re-optimize adjust according to the following indexing rule:

$$W_{xt} = W_{xt-1}^{1 - \xi_w} \pi_{t-1}^{1-\xi_w} (1 + \gamma_y) \quad (2.4)$$

where $(1 + \gamma_y)$ is the steady state growth rate of labor productivity.

The remaining fraction of households choose an optimal reset wage $W_t^*$ by maximizing

$$E_t \left\{ \sum_{\tau=0}^\infty \xi_w^{\tau} \beta^\tau \left[ -v_x \left( X_{t+\tau}^h \right)^{1+\varphi} + u'(C_{t+\tau}) \frac{W_{xt}^* \Gamma_{wt,t+\tau}}{P_{t+\tau}} X_{t+\tau}^h \right] \right\} \quad (2.5)$$

subject to the demand for type $h$ labor and where $v_x = \{v, v_s\}$ and the indexing factor $\Gamma_{wt,t+\tau}$ is given by

$$\Gamma_{wt,t+\tau} \equiv \prod_{k=1}^{\tau} \pi_{t+\tau-k}^{1-\xi_w} \pi_{t+\tau}^{1-\xi_w} (1 + \gamma_y) \quad (2.6)$$

The first order condition for the re-set wage and the equation for the composite wage index as a function of the reset wage, inflation and the lagged wage are given, respectively, by

$$E_t \left\{ \sum_{\tau=0}^\infty \xi_w^{\tau} \Lambda_{t,\tau} \left[ \frac{W_{xt}^* \Gamma_{wt,t+\tau}}{P_{t+\tau}} - \mu_{wt} \left( \frac{W_{xt}^* \Gamma_{wt,t+\tau}}{W_{xt+\tau}} \right)^{-\varphi} \right] \left[ \frac{W_{xt}^* \Gamma_{wt,t+\tau}}{W_{xt+\tau}} \right]^{-\mu_{wt} \pi^{1-\varphi} W_{xt+\tau}} X_{t+\tau}^h \right\} = 0 \quad (2.7)$$

$$W_{xt} = \left[ (1 - \xi_w) (W_{xt}^*)^{-1/(\mu_{wt} - 1)} + \xi_p \left( (1 + \gamma_y) \pi_{t-1}^{1-\xi_w} W_{xt-1} \right)^{-1/(\mu_{wt} - 1)} \right]^{-1/(\mu_{wt} - 1)} \quad (2.8)$$
3 Aggregation

We aggregate equations related to individual intermediate good producer using the CES aggregator in (1.1) and the fact that up to a first order approximation $Y^i_t = Y_t$. Define aggregate labor demand, aggregate capital, average capital utilization rate as,

\[ L_t = A_t L^j_t \]
\[ K_t = A_t K^j_t \]
\[ U_t = U^j_t \]

In the last two expressions we are using the fact that all intermediate producers are symmetric. Given this symmetry, note the following relationship between intermediate output and aggregate final output.

\[ Y_t = \left( \int_0^{A_t} (Y^j_{mt})^{\frac{1}{\vartheta}} dj \right)^{\vartheta} = A_t^{\vartheta} Y^j_{mt} = A_t^{\vartheta-1} \theta_t(U^j_tK^j_t)^\alpha (L^j_t)^{1-\alpha} \]

where the last step uses the intermediate goods production function $Y^j_{mt} = \theta_t(U^j_t K^j_t)^\alpha (L^j_t)^{1-\alpha}$.

Given the information above we can express the factor demands from intermediate good producers in aggregate terms.

\[ \frac{\alpha p_m Y^j_{mt}}{K^j_t} = \varsigma [D_t + \delta(U^j_t)Q_t] \]
\[ \frac{\alpha p_m Y^j_{mt}}{U^j_t} = \varsigma \delta'(U^j_t)Q_tK^j_t \]
\[ (1 - \alpha) \frac{p_m Y^j_{mt}}{L^j_t} = \varsigma w_t \]

Applying the CES aggregator to the FOCs we get,

\[ \alpha \frac{p_m A^{\vartheta} Y^j_{mt}}{K_t} = \varsigma A^{\vartheta}_t [D_t + \delta(U^j_t)Q_t] \]
\[
\alpha p_m A^{\psi \psi} t^j Y^j_{mt} = \varsigma A^\psi t \delta(U^j_t)Q_t K^j_t \\
(1 - \alpha)\frac{p_m A^{\psi \psi} t^j Y^j_{mt}}{L^j_t} = A^\psi t \varsigma w_t
\]

Replacing to get the FOCs in terms of aggregate variables and real marginal cost of final producers we get

\[
\alpha MC_t Y_t = \varsigma [D_t + \delta(U_t)Q_t] \\
\alpha MC_t Y_t = \varsigma \delta'(U_t)Q_t K_t \\
(1 - \alpha) MC_t Y_t = \varsigma w_t
\]

The value of an adopted technology can also be expressed in terms of aggregate output and final good producer real marginal cost. That value is defined as

\[
V_t = \Pi_{mt} + \phi E_t \{ A_{t,t+1} V_{t+1} \} \\
= (\varsigma - 1) \frac{p_m}{\varsigma} Y_{mt} + \phi E_t \{ A_{t,t+1} V_{t+1} \} \\
= \left( \frac{\varsigma - 1}{\varsigma} \right) MC_t A_t^{\psi - 1} Y_{mt} + \phi E_t \{ A_{t,t+1} V_{t+1} \}
\]

Multiplying both terms by \( A_t \) we get,

\[
V_t A_t = \left( \frac{\varsigma - 1}{\varsigma} \right) MC_t A_t Y_t + \phi E_t \{ A_{t,t+1} V_{t+1} A_t \frac{A_t}{A_{t+1}} \}
\]

Renaming \( V_t A_t = V_t^A \)

\[
V_t^A = \left( \frac{\varsigma - 1}{\varsigma} \right) MC_t A_t Y_t + \phi E_t \{ A_{t,t+1} V_{t+1}^A \frac{A_t}{A_{t+1}} \}
\]

We can modify the value of unadopted technologies to incorporate \( V_t^A \). Scaling \( J_t \) by \( Z_t \)

\[
J_t Z_t = -w_{st} L_{sat} Z_t + \phi E_t \{ \lambda_t V_{t+1} A_{t+1} \frac{Z_t}{A_{t+1}} + (1 - \lambda_t) J_{t+1} Z_{t+1} \frac{Z_t}{Z_{t+1}} \}
\]
Defining $J_tZ_t \equiv J_t^Z$ and $L_{\text{sat}}^Z \equiv L_{\text{sat}}Z_t$

$$J_t^Z = -w_{st}I_{\text{sat}}^Z + \phi E_t \left\{ \Lambda_{t, t+1} \left[ \lambda_t V_{t+1} Z_t A_{t+1} + (1 - \lambda_t) J_t^Z \frac{Z_t}{Z_{t+1}} \right] \right\}$$

We also modify the $R&D$ and adoption FOCs accordingly.

$$E_t \left\{ \Lambda_{t, t+1} J_{t+1}^Z \frac{Z_t}{Z_{t+1}} I_{\text{sat}}^{\rho_{st}} \right\} = w_{st}$$

$$\rho_\lambda \Lambda_{t, t+1} \phi E_t \left\{ \Lambda_{t, t+1} \left[ V_{t+1} A_{t+1} Z_t + J_{t+1} \frac{Z_t}{Z_{t+1}} \right] \right\} = w_{st} I_{\text{sat}}^Z$$

### 4 Model Equations

The basic model consists of 35 equations related to 35 variables (27 endogenous and 8 shock processes). The variables are described in the following table.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$MC_t$</td>
<td>Real marginal cost final good prod</td>
</tr>
<tr>
<td>$D_t$</td>
<td>Ex depreciation dividends</td>
</tr>
<tr>
<td>$Q_t$</td>
<td>Price of capital</td>
</tr>
<tr>
<td>$U_t$</td>
<td>captial utilization</td>
</tr>
<tr>
<td>$K_t$</td>
<td>Captial stock</td>
</tr>
<tr>
<td>$Y_t$</td>
<td>Real Aggregate Output</td>
</tr>
<tr>
<td>$w_t$</td>
<td>Real wage unskilled labor</td>
</tr>
<tr>
<td>$w_{st}$</td>
<td>Real wage skilled labor</td>
</tr>
<tr>
<td>$L_t$</td>
<td>Unskilled Labor</td>
</tr>
<tr>
<td>$A_t$</td>
<td>Stock of adopted technologies</td>
</tr>
<tr>
<td>$C_t$</td>
<td>Consumption</td>
</tr>
<tr>
<td>$R_t$</td>
<td>Real risk free interest rate</td>
</tr>
<tr>
<td>$\Lambda_{t, t+1}$</td>
<td>Stoch Discount Factor</td>
</tr>
<tr>
<td>$I_t$</td>
<td>Investment</td>
</tr>
<tr>
<td>$R_{nt}$</td>
<td>Nominal Interest Rate</td>
</tr>
<tr>
<td>$\pi_t$</td>
<td>Gross inflation rate</td>
</tr>
<tr>
<td>$Z_t$</td>
<td>Stock of technologies</td>
</tr>
<tr>
<td>$L_{srt}$</td>
<td>Skilled labor demand: R&amp;D sector</td>
</tr>
</tbody>
</table>
\( L_{st} \)  
Skilled labor supply

\( L_{sat} \)  
Skilled labor demand: adoption sector, scaled by \( Z_t (L_{sat} Z_t) \)

\( J_t^Z \)  
Value unadopted good scaled by \( Z_t (J_t Z_t) \)

\( V_t^A \)  
Value adopted good scaled by \( A_t (V_t A_t) \)

\( \lambda_t \)  
Adoption probability

\( p_t^* \)  
optimal relative price \((P_t^*/P_{t-1})\)

\( w_t^* \)  
optimal real wage \((W_t^*/P_t)\) unskilled labor

\( w_{st}^* \)  
optimal real wage \((W_{st}^*/P_t)\) skilled labor

\( u_{ct} \)  
Marginal utility consumption

\( G_t \)  
Government Spending

\( \theta_t \)  
Productivity Shock

\( \mu_t \)  
Mark up shock

\( \mu_{wt} \)  
Wage mark up shock

\( p_{kt} \)  
Price of capital shock

\( r_{t}^m \)  
Taylor rule shock

\( \chi_t \)  
R&D productivity shock

\( \zeta_t \)  
Liquidity demand shock

---

The model equations are the following,

\[
\begin{align*}
\alpha \frac{MC_t Y_t}{K_t} &= \varsigma [D_t + \delta(U_t)Q_t] \quad (4.1) \\
\alpha \frac{MC_t Y_t}{U_t} &= \varsigma \delta'(U_t)Q_t K_t \quad (4.2) \\
(1 - \alpha) \frac{MC_t Y_t}{L_t} &= \varsigma w_t \quad (4.3) \\
Y_t &= \left[A_t^{\theta - 1} \theta_t \right] (U_t K_t)^\alpha (L_t)^{1-\alpha} \quad (4.4) \\
u_{ct} &= \frac{1}{C_t - bC_{t-1}} - \beta E_t \frac{b}{C_{t+1} - bC_t} \quad (4.5) \\
1 &= E_t \{ \Lambda_{t,t+1} R_t \} + \zeta_t \quad (4.6) \\
1 &= E_t \left\{ \Lambda_{t,t+1} \frac{D_{t+1} + Q_{t+1}}{Q_t} \right\} \quad (4.7) \\
\Lambda_{t,t+1} &= \beta E_t \frac{u_{ct+1}}{u_{ct}} \quad (4.8)
\end{align*}
\]
\[
\frac{Q_t}{p_{kt}} = 1 + f \left( \frac{I_t}{(1 + \gamma_y)I_{t-1}} \right) + \frac{I_t}{(1 + \gamma_y)I_{t-1}} f' \left( \frac{I_t}{(1 + \gamma_y)I_{t-1}} \right) - E_t \Lambda_{t,t+1} \left( \frac{I_{t+1}}{(1 + \gamma_y)I_t} \right)^2 f' \left( \frac{I_{t+1}}{(1 + \gamma_y)I_t} \right) \]

\[
K_{t+1} = I_t + (1 - \delta(U_t))K_t
\]

\[
R_{nt} = r^m_t \left( \left( \frac{\pi_t}{\pi} \right)^{\phi_n} \left( \frac{L_{t}}{L_{sat}^s} \right)^{\phi_u} R_n \right)^{1-\rho} (R_{nt-1})^{\rho} R_{nt-1}
\]

\[
R_{nt} = R_t E_t \pi_{t+1}
\]

\[
Z_{t+1} = \chi_t Z_t \rho_{st} + \phi Z_t
\]

\[
E_t \left\{ \Lambda_{t,t+1} J_{t+1}^Z \frac{Z_t}{Z_{t+1}} \right\} = w_{st}
\]

\[
J_{t}^Z = -w_{st}L_{sat}^s + \phi E_t \left\{ \Lambda_{t,t+1} \left[ \lambda_t V^A_{t+1} \frac{Z_t}{A_{t+1}} + (1 - \lambda_t) J_{t+1}^Z \frac{Z_t}{Z_{t+1}} \right] \right\}
\]

\[
\lambda_t = \kappa \lambda (L_{sat}^s)^{\rho \lambda}
\]

\[
A_{t+1} = \lambda_t \phi [Z_t - A_t] + \phi A_t
\]

\[
V^A_t = \left( \frac{\xi - 1}{\xi} \right) MC_t Y_t + \phi E_t \left\{ \Lambda_{t,t+1} V^A_{t+1} \frac{A_t}{A_{t+1}} \right\}
\]

\[
\rho \lambda \lambda_t \phi E_t \left\{ \Lambda_{t,t+1} \left[ \frac{Z_t}{A_{t+1}} - J_{t+1}^Z \frac{Z_t}{Z_{t+1}} \right] \right\} = w_{st} L_{sat}^s
\]

\[
0 = E_t \sum_{\tau=0}^{\infty} C_t \Lambda_{t,t+\tau} \left[ \frac{p^t_{+} \Gamma_{t+\tau}}{\prod_{k=0}^{t} \pi^t_{t+k}} - \mu_{wt+\tau} MC_{t+\tau} \right] \left[ \frac{p^t_{+} \Gamma_{t+\tau}}{\prod_{k=0}^{t} \pi^t_{t+k}} \right]^{\frac{\mu}{\mu + 1}} Y_{t+\tau}
\]

\[
\pi_t = \left[ (1 - \xi_p) (p^t_{+})^{-1/\mu_t} + \xi_p \left( \prod_{t-1}^{t} \pi^t_{t+k} \right)^{-1/\mu_t} \right]^{(\mu_t - 1)}
\]

\[
E_t \left\{ \sum_{\tau=0}^{\infty} C_t \Lambda_{t,t+\tau} \left[ \frac{w^t_{+} \Gamma_{w,t+\tau}}{\prod_{k=1}^{t} \pi^t_{t+k}} - \mu_{wt} u \left( \frac{w^t_{+} \Gamma_{w,t+\tau}}{\prod_{k=1}^{t} \pi^t_{t+k}} \right) \frac{L^\varphi_{t+\tau}}{u^t(C_{t+\tau})} \right] \frac{\mu_{wt}}{\mu_{wt} + 1} L_{t+\tau} \right\} = 0
\]

\[
w_t = \left[ (1 - \xi_w) (p^t_{+})^{-1/\mu_{wt} - 1} + \xi_p \left( \frac{1 + \gamma_y}{\pi^t_{t-1}} \right)^{-1/\mu_{wt} - 1} \right]^{-(\mu_{wt} - 1)}
\]

\[
E_t \left\{ \sum_{\tau=0}^{\infty} C_t \Lambda_{t,t+\tau} \left[ \frac{w^t_{+} \Gamma_{w,t+\tau}}{\prod_{k=1}^{t} \pi^t_{t+k}} - \mu_{wt} u \left( \frac{w^t_{+} \Gamma_{w,t+\tau}}{\prod_{k=1}^{t} \pi^t_{t+k}} \right) \frac{L^\varphi_{st+\tau}}{u^t(C_{t+\tau})} \right] \frac{\mu_{wt}}{\mu_{wt} + 1} L_{st+\tau} \right\} = 0
\]
\[
\begin{align*}
    w_{st} &= \left(1 - \xi_w \right) \left( w_{st}^\ast \right)^{-1/(\mu_w - 1)} + \xi_p \left(1 + \gamma_y \right) \pi_{t-1}^w \pi_w \left( w_{st-1} \right)^{-1/(\mu_w - 1)} \right)^{-1/(\mu_w - 1)} (4.25) \\
    Y_t &= C_t + p_{kt} \left[ 1 + f \left( \frac{I_t}{(1 + \gamma_y) I_{t-1}} \right) \right] I_t + G_t (4.26) \\
    L_{st} &= \left[ 1 - \frac{A_t}{\bar{Z}_t} \right] L_{st}^Z + L_{srt} (4.27) \\
    \log(G_t/(1 + \gamma_y)^t) &= (1 - \rho_g) \bar{g} + \rho_g \log(G_{t-1}/(1 + \gamma_y)^{t-1}) + \sigma_g \epsilon_t^g (4.28) \\
    \log(\theta_t) &= \rho_g \log(\theta_{t-1}) + \sigma_g \epsilon_t^g (4.29) \\
    \log(\mu_t) &= (1 - \rho_\mu) \mu + \rho_\mu \log(\mu_{t-1}) + \sigma_\mu \epsilon_t^\mu (4.30) \\
    \log(\mu_{wt}) &= (1 - \rho_{\mu_w}) \mu_w + \rho_{\mu_w} \log(\mu_{wt-1}) + \sigma_{\mu_w} \epsilon_t^{\mu_w} (4.31) \\
    \log(p_{kt}) &= \rho_{pk} \log(p_{kt-1}) + \sigma_{pk} \epsilon_t^{pk} (4.32) \\
    \log(r_{tm}) &= \rho_{rm} \log(r_{tm-1}) + \sigma_{rm} \epsilon_t^{rm} (4.33) \\
    \log(\chi_t) &= (1 - \rho_\chi) \log(\chi) + \rho_\chi \log(\chi_{t-1}) + \sigma_\chi \epsilon_t^\chi (4.34) \\
    \zeta_t &= (1 - \rho_\zeta) \bar{\zeta} + \rho_\zeta \zeta_{t-1} + \sigma_\zeta \epsilon_t^\zeta (4.35)
\end{align*}
\]

5 Stationarizing the Model

The model presented in section 4 is non-stationary. In fact, it is straightforward to see that if there is positive skilled labor in equilibrium \(A_t\) and \(Z_t\) grow at a rate \(1 + \gamma_a\) in steady state. Moreover, \(Y_t, C_t, K_t, I_t, G_t\), real wages and values \(V_t^A\) and \(J_t^Z\) grow at a rate \(1 + \gamma_y \equiv \left(1 + \gamma_a\right)^{\frac{\alpha - 1}{\alpha}}\) in steady state.

Hence, we stationarize variables dividing by either \((1 + \gamma_y)^t\) or \((1 + \gamma_a)^t\) depending on the case. In particular, define

\[
    \tilde{X}_t = \frac{X_t}{(1 + \gamma_j)^t}
\]

for \(j = \{y, a\}\) depending on the steady state growth rate of the variable. Applying the normalization to the model described in 4 we get the following

\[
    \alpha \frac{MC_t \tilde{Y}_t}{K_t} = \zeta [D_t + \delta(U_t)Q_t] (5.1)
\]
\[
\alpha \frac{MC_t \tilde{Y}_t}{U_t} = \varsigma \delta'(U_t) Q_t \tilde{K}_t \\
(1 - \alpha) \frac{MC_t \tilde{Y}_t}{L_t} = \varsigma \tilde{w}_t
\]

(5.2)

\[
\tilde{Y}_t = \tilde{A}^{\alpha-1} \theta(U_t) \tilde{K}_t \alpha (L_t)^{1-\alpha}
\]

(5.3)

\[
\tilde{u}_{ct} = (1 + \gamma_y)' u_{ct} = \frac{(1 + \gamma_y)}{(1 + \gamma_y) C_t - b C_{t-1}} - \beta \bar{E}_t \frac{b}{(1 + \gamma_y) C_{t+1} - b C_t}
\]

(5.4)

\[
1 = E_t \left\{ \tilde{\Lambda}_{t,t+1} + \frac{D_{t+1} + Q_{t+1}}{Q_{t-1}} \right\}
\]

(5.5)

\[
\Lambda_{t,t+1} = \beta E_t \tilde{u}_{ct+1} \Rightarrow \Lambda_{t,t+1} = \tilde{\Lambda}_{t,t+1} \frac{1}{1 + \gamma_y}
\]

(5.6)

\[
\frac{Q_t}{p_{kt}} = 1 + f \left( \frac{I_t}{I_{t-1}} \right) + \frac{I_t}{I_{t-1}} f' \left( \frac{I_t}{I_{t-1}} \right) - E_t \Lambda_{t,t+1} \left( \frac{I_{t+1}}{I_t} \right)^2 f' \left( \frac{I_{t+1}}{I_t} \right)
\]

(5.7)

\[
(1 + \gamma_y) \tilde{K}_{t+1} = \tilde{I}_t + (1 - \delta(U_t)) \tilde{K}_t
\]

(5.8)

\[
R_{nt} = r_m \left( \frac{\pi_t}{\pi_0} \right)^{\phi_y} \left( \frac{L_t}{L^s} \right)^{\phi_y} R_n \left( R_{nt-1}^R \right)^{R^R}
\]

(5.9)

\[
\tilde{\Lambda}_{t,t+1} = \beta E_t \tilde{u}_{ct+1} \Rightarrow \Lambda_{t,t+1} = \tilde{\Lambda}_{t,t+1} \frac{1}{1 + \gamma_y}
\]

(5.10)

\[
\tilde{Z}_{t+1} = \chi_t \tilde{Z}_t L_{sat}^{\rho_s} + \phi \tilde{Z}_t
\]

(5.11)

\[
E_t \left\{ \tilde{\Lambda}_{t,t+1} \tilde{Z}_{t+1} \lambda_t \tilde{Z}_t \tilde{Z}_{t+1} (1 + \gamma_a) \right\} = \tilde{w}_s t
\]

(5.12)

\[
\tilde{J}_{t+1}^Z = -\tilde{w}_s t Z_{sat} + \phi E_t \left\{ \tilde{\Lambda}_{t,t+1} \tilde{Z}_t \tilde{Z}_{t+1} + (1 - \lambda_t) \tilde{J}_{t+1}^Z \tilde{Z}_t \right\}
\]

(5.13)

\[
\lambda_t = \kappa_A (L_{sat}^{\rho_s})^{\rho_s}
\]

(5.14)

\[
(1 + \gamma_a) \tilde{A}_{t+1} = \lambda_t \phi [\tilde{Z}_t - \tilde{A}_t] + \phi \tilde{A}_t
\]

(5.15)

\[
\tilde{v}_t^A = \left( \frac{\varsigma - 1}{\varsigma} \right) MC_t \tilde{Y}_t + \phi E_t \left\{ \tilde{\Lambda}_{t,t+1} \tilde{v}_t^A \frac{\tilde{A}_t}{\tilde{A}_{t+1} (1 + \gamma_a)} \right\}
\]

(5.16)
\[ \rho \lambda t \phi E_t \left\{ \frac{\tilde{t}_{t,t+1}}{1 + \gamma t} \left[ \tilde{Y}_{t+1} - \tilde{Z}_{t+1} \right] \right\} = \tilde{w}_{st} L_{st} \]  
(5.19)

\[ 0 = E_t \sum_{\tau=0}^{\infty} \xi_p^t \tilde{t}_{t,t+\tau} \left[ \frac{p_t^\tau}{t_{k=0} \pi_t^{k+1}} - \mu_{t+\tau} M C_{t+\tau} \right] \left[ \frac{p_t^\tau}{t_{k=0} \pi_t^{k+1}} \right]^{\frac{\mu t}{\mu t - 1}} \tilde{Y}_{t+\tau} \]  
(5.20)

\[ \pi_t = \left( 1 - \xi_p \right) \left( p_t^\tau \right)^{-1/(\mu t - 1)} + \xi_p \left( \pi_{t-1}^{p t} \pi_t^{1-p t} \right)^{-1/(\mu t - 1)} \]  
(5.21)

\[ E_t \sum_{\tau=0}^{\infty} \xi_s^t \tilde{t}_{t,t+\tau} \left[ \frac{\tilde{w}_s^t \Gamma_{w,t+\tau}}{t_{k=1} \pi_t^{k+1}(1 + \gamma_s)^{\tau}} - \mu_{w,t} \left( \frac{\tilde{w}_s^t \Gamma_{w,t+\tau}}{t_{k=1} \pi_t^{k+1}(1 + \gamma_s)^{\tau}} \right) \right] \]  
(5.22)

\[ \tilde{w}_t = \left( 1 - \xi_w \right) \left( \tilde{w}_t^w \right)^{-1/(\mu w - 1)} + \xi_p \left( \pi_{t-1}^{1-w} \pi_t^{1-w} \tilde{w}_{t-1} \right)^{-1/(\mu w - 1)} \]  
(5.23)

\[ E_t \sum_{\tau=0}^{\infty} \xi_s^t \tilde{t}_{t,t+\tau} \left[ \frac{\tilde{w}_s^t \Gamma_{w,t+\tau}}{t_{k=1} \pi_t^{k+1}(1 + \gamma_s)^{\tau}} - \mu_{w,t} \left( \frac{\tilde{w}_s^t \Gamma_{w,t+\tau}}{t_{k=1} \pi_t^{k+1}(1 + \gamma_s)^{\tau}} \right) \right] \]  
(5.24)

\[ \tilde{w}_{st} = \left( 1 - \xi_w \right) \left( \tilde{w}_{st}^w \right)^{-1/(\mu w - 1)} + \xi_p \left( \pi_{t-1}^{1-w} \pi_t^{1-w} \tilde{w}_{st-1} \right)^{-1/(\mu w - 1)} \]  
(5.25)

\[ \tilde{Y}_t = \tilde{C}_t + p_{kt} \left[ 1 + f \left( \frac{\hat{t}_t}{\tilde{t}_{t-1}} \right) \right] \tilde{I}_t + \tilde{G}_t \]  
(5.26)

\[ L_{st} = \left[ 1 - \tilde{A}_t \right] L_{sat} + L_{srt} \]  
(5.27)

\[ \log(\tilde{G}_t) = (1 - \rho g) \tilde{g} + \rho g \log(\tilde{G}_{t-1}) + \sigma_g \epsilon_t^g \]  
(5.28)

\[ \log(\theta_t) = \rho \log(\theta_{t-1}) + \sigma_\theta \epsilon_t^\theta \]  
(5.29)

\[ \log(\mu_t) = (1 - \rho \mu) \mu + \rho \mu \log(\mu_{t-1}) + \sigma_\mu \epsilon_t^\mu \]  
(5.30)
\[
\log(\mu_{wt}) = (1 - \rho_{\mu_w})\mu_w + \rho_{\mu_w} \log(\mu_{wt-1}) + \sigma_{\mu_w} \epsilon_t^{\mu_w} \quad (5.31)
\]
\[
\log(p_{kt}) = \rho_{p_k} \log(p_{kt-1}) + \sigma_{p_k} \epsilon_t^{p_k} \quad (5.32)
\]
\[
\log(r_{mt}) = \rho_{r_m} \log(r_{mt-1}) + \sigma_{r_m} \epsilon_t^{r_m} \quad (5.33)
\]
\[
\log(\chi_t) = (1 - \rho_{\chi}) \log(\bar{\chi}) + \rho_{\chi} \log(\chi_{t-1}) + \sigma_{\chi} \epsilon_t^{\chi} \quad (5.34)
\]
\[
\zeta_t = (1 - \rho_{\zeta}) \bar{\zeta} + \rho_{\zeta} \zeta_{t-1} + \sigma_{\zeta} \epsilon_t^{\zeta} \quad (5.35)
\]

6 Steady State

We log-linearize the equilibrium around a steady state where output grows at a rate 
\((1 + \gamma_a)^{\frac{q - 1}{1 - \alpha}}\), that is,

\[
1 + \gamma_y = (1 + \gamma_a)^{\frac{q - 1}{1 - \alpha}}
\]

where \(1 + \gamma_a\) is the gross growth rate of \(A_t\) in steady state. Assuming, capital depreciation is given by,

\[
\delta(U) = \delta - \frac{d_1}{1 + \omega} + d_1 \frac{U^{1+\omega}}{1 + \omega}
\]

Where \(\delta\) is the steady state depreciation rate and \(d_1\) is calibrated such that \(U = 1\) in steady state. For a given steady state output growth rate \(1 + \gamma_y\) and inflation rate \(\pi\) we compute the steady state in the following steps.

From the definition \(1 + \gamma_y\)

\[
1 + \gamma_a = (1 + \gamma_y)^{\frac{1 - \alpha}{q - 1}}
\]

From (5.6), (5.8), (5.9) and (5.7)

\[
R = \frac{(1 + \gamma_y)(1 - \tilde{\zeta})}{\beta}
\]
\[
\tilde{\Lambda} = \beta
\]
\[
Q = 1
\]
\[
D = R - 1
\]

Setting \(U = 1\), from (5.1) and (5.2)
\( d_1 = R - 1 + \delta \)

From (5.20), (5.21) and (5.12)

\[
MC = \frac{1}{\mu} \\
p^* = \pi \\
R_n = R\pi
\]

From (5.1), (5.3) and (5.4)

\[
\tilde{K} Y = \alpha \mu \varsigma \left( R - 1 + \delta \right) \\
\tilde{w} L Y = \frac{1 - \alpha}{\mu \varsigma}
\]

From (5.10)

\[
\tilde{I} Y = (\delta + \gamma_y) \tilde{K} Y
\]

For a given government consumption/ GDP ratio \( G/Y \) and using (5.26)

\[
\tilde{C} Y = 1 - \tilde{I} Y - \frac{G}{Y}
\]

From (5.5)

\[
\tilde{Y} \tilde{u}_c = \frac{1}{C/Y} \frac{1 + \gamma_y - \beta b}{1 + \gamma_y - b}
\]

From (5.22), by setting \( L = 1 \) we can calibrate the unskilled labor disutility parameter \( \upsilon \)

\[
\upsilon = \frac{\tilde{w} L}{\tilde{Y}} \left( \tilde{Y} \tilde{u}_c \right) \frac{1}{\mu \upsilon}
\]

Now from (5.4), normalizing \( \tilde{A} = 1 \) in steady state and using \( L = 1 \)

\[
\tilde{Y} = \left( \frac{\tilde{K}}{\tilde{Y}} \right)^{\frac{\alpha}{1-\upsilon}} = \left( \frac{\alpha}{\mu \varsigma (R - 1 + \delta)} \right)^{\frac{\alpha}{1-\upsilon}}
\]

Given the calculations up to this point, we are also able to compute \( \tilde{K}, \tilde{w}, \tilde{I}, \tilde{C} \) and \( \tilde{u}_c \).
Now from (5.18)

\[ \tilde{V}^A = \left( \frac{1 + \gamma_a}{1 + \gamma_a - \phi \beta} \right) \left( \frac{\varsigma - 1}{\varsigma \mu} \right) \tilde{V} \]

Given a value for steady state adoption probability \( \lambda \) and that \( \tilde{A} = 1 \), (5.17) implies

\[ \tilde{Z} = \frac{1 + \gamma_a - \phi}{\lambda \phi} + 1 \]

From (5.15) and (5.19)

\[ \tilde{J}^Z = \frac{(1 - \rho \lambda) \lambda \phi \beta}{1 + \gamma_a - (1 - \lambda + \rho \lambda) \phi \beta} \tilde{V}^A \tilde{Z} \]

And going back to (5.19) we get,

\[ \tilde{w}_s L^{Z}_{sa} = \frac{\rho \lambda \phi \beta}{1 + \gamma_a} \left[ \tilde{V}^A \tilde{Z} - \tilde{J}^Z \right] \]

From (5.13) and (5.14)

\[ \tilde{w}_s L^{sr} = \beta \frac{\tilde{J}^Z (1 + \gamma_a - \phi)}{1 + \gamma_a} \]

Using (5.27)

\[ \tilde{w}_s L_s = \left[ 1 - \frac{1}{\tilde{Z}} \right] \tilde{w}_s L^{Z}_{sa} + \tilde{w}_s L^{sr} \]

Now going to (5.24), we can calibrate \( \upsilon_s \) to set \( L_s = 1 \)

\[ \upsilon_s = \frac{(\tilde{w}_s L_s) \tilde{u}_c}{\mu_{w} \phi} \]

Given that \( L_s = 1 \), we can get from the last expressions \( \tilde{w}_s \), \( L^{sr} \) and \( L^{Z}_{sa} \). Lastly, we calibrate the values for R&D productivity \( \chi \) and \( \kappa_\lambda \) to make the growth rates \( \gamma_a \) (or \( \gamma_y \)) and adoption probability \( \lambda \) in steady state consistent with the model. From (5.16) and (5.13)

\[ \kappa_\lambda = \frac{\lambda}{(L^{Z}_{sa})^{\rho \lambda}} \]

\[ \chi = \frac{1 + \gamma_a - \phi}{L^{\upsilon}_s} \]

Note that from equation (5.23) and (5.25) in steady state \( \tilde{w} = \tilde{w}^* \) and \( \tilde{w}_s = \tilde{w}_s^* \).
7 Log-linearized model

We loglinearize the stationary model and estimate parameters using Dynare. The log-linearized equations are shown below. Lower case and hatted variables are log-deviations from the non-stochastic steady state.

\[
\alpha \beta \left[ \hat{m}c_t + \hat{y}_t - \hat{k}_t \right] = \frac{\zeta \mu K}{Y} (1 + \gamma_y - \beta) \hat{d}_t + \alpha \beta \hat{u}_t + \frac{\beta \zeta \mu K}{Y} \delta \hat{q}_t \tag{7.1}
\]

\[
\hat{m}c_t + \hat{y}_t = (1 + \omega) \hat{u}_t + \hat{q}_t + \hat{k}_t \tag{7.2}
\]

\[
\hat{m}c_t + \hat{y}_t - \hat{\ell}_t = \hat{w}_t \tag{7.3}
\]

\[
\hat{y}_t = (\vartheta - 1) \hat{a}_t + \hat{d}_t + \alpha \hat{k}_t + \alpha \hat{u}_t + (1 - \alpha) \hat{\ell}_t \tag{7.4}
\]

\[
(1 + \gamma_y - b) (1 + \gamma_y - \beta b) \hat{u}_{ct} = - \left[ (1 + \gamma_y)^2 + \beta b^2 \right] \hat{c}_t - (1 + \gamma_y) b \hat{c}_{t-1} \tag{7.5}
\]

\[
0 = \hat{\Lambda}_{t,t+1} + \hat{r}_t + \hat{\zeta}_t \tag{7.6}
\]

\[
0 = (1 + \gamma_y) \hat{\Lambda}_{t,t+1} - (1 + \gamma_y) \hat{q}_t + (1 + \gamma_y - \beta) \hat{d}_{t+1} + \beta \hat{q}_{t+1} \tag{7.7}
\]

\[
\hat{\Lambda}_{t,t+1} = \hat{u}_{ct+1} - \hat{u}_{ct} \tag{7.8}
\]

\[
\hat{q}_t - \hat{p}_k t = \left( 1 + \frac{\beta}{\gamma_y + 1} \right) \psi \hat{i}_t - \psi \hat{i}_{t-1} - \frac{\psi \beta}{1 + \gamma_y} \hat{i}_{t+1} \tag{7.9}
\]

\[
\beta (1 + \gamma_y) \frac{K}{Y} \hat{k}_{t+1} = \frac{\beta}{\gamma_y + 1} \hat{i}_t + \beta (1 - \delta) \frac{K}{Y} \hat{k}_t - (1 + \gamma_y (1 - \beta (1 - \delta)) \frac{K}{Y} \hat{u}_t \tag{7.10}
\]

\[
\hat{r}_{nt} = (1 - \rho^R) \left[ \phi_\pi \hat{x}_t + \phi_\eta \hat{I}_t \right] + \rho^R \hat{r}_{nt-1} + \hat{r}_t \tag{7.11}
\]

\[
\hat{r}_{nt} = \hat{r}_t + \hat{\pi}_{t+1} \tag{7.12}
\]

\[
(1 + \gamma_a) \hat{z}_{t+1} = (1 + \gamma_a - \phi) \left( \hat{x}_t + \rho_2 \hat{I}_{srt} \right) + (1 + \gamma_a) \hat{z}_t \tag{7.13}
\]

\[
\hat{\Lambda}_{t,t+1} + \hat{j}_t^Z + \hat{\chi}_t + \hat{z}_t - \hat{z}_{t+1} + (\rho_z - 1) \hat{I}_{srt} = \hat{w}_{st} \tag{7.14}
\]

\[
\hat{j}_t^Z \hat{j}_t^Z = -\tilde{w}_z L_{sa}^Z \left( \hat{w}_{st} + \hat{i}_{sat}^Z \right) + \frac{\phi \beta}{1 + \gamma_a} \left[ \lambda \hat{V}^A \hat{Z} + (1 - \lambda) \hat{j}_t^Z \right] \hat{\Lambda}_{t,t+1} - \frac{\phi \beta}{1 + \gamma_a} (1 - \lambda) \hat{j}_t^Z \hat{z}_{t+1} + \frac{\phi \beta}{1 + \gamma_a} \left[ \lambda \hat{V}^A \hat{Z} - \hat{j}_t^Z \right] \hat{\lambda}_t + \frac{\phi \beta}{1 + \gamma_a} \lambda \hat{V}^A \hat{Z} \left( \hat{a}_{t+1}^A - \hat{a}_{t+1} \right) \tag{7.15}
\]
\[ \hat{\lambda}_t = \rho^\lambda \hat{Z}_{sat} \]  
\[ (1 + \gamma_a) \hat{a}_{t+1} = (1 + \gamma_a - \phi) \hat{\lambda}_t + \lambda \phi \hat{Z}_t - (\lambda - 1) \phi \hat{a}_t \]  
\[ \tilde{V}^A \hat{t}_t = \left( \frac{\zeta - 1}{\zeta \mu} \right) \left( \hat{m}_c + \hat{y}_t \right) + \frac{\phi \beta}{1 + \gamma_a} \frac{\tilde{V}^A}{Y} \left( \hat{\lambda}_{t+1} + \hat{t}_{t+1} + \hat{a}_t - \hat{a}_{t+1} \right) \]  
\[ \tilde{w}_s L^Z_{sa} \left( \hat{w}_{st} + \hat{l}_{sat} - \hat{\lambda}_t - \hat{\Lambda}_{tt+1} \right) = \rho \lambda \frac{\phi \beta}{1 + \gamma_a} \tilde{V}^A \hat{Z} \left( \hat{t}_{t+1} + \hat{z}_t - \hat{a}_{t+1} \right) \]  
\[ - \rho \lambda \frac{\phi \beta}{1 + \gamma_a} \tilde{J} \hat{Z} \left( \hat{j}_{tt+1} + \hat{z}_t - \hat{z}_{t+1} \right) \]  

From (5.20) and (5.21) we get the price Phillips Curve,
\[ \hat{\pi}_t = \frac{1 - \xi_p}{1 + \beta(1 - \xi_p)} \left( \hat{\mu}_t + \hat{m}_c \right) + \frac{\beta}{1 + \beta(1 - \xi_p)} \]  

From (5.22) and (5.23) we get the wage Phillips Curve,
\[ (1 + \kappa_w) \hat{w}_t = \frac{1}{1 + \beta} \left( \hat{w}_{t-1} + \mu \hat{\pi}_{t-1} - (1 + \beta \mu) \hat{\pi}_t \right) + \left( \varphi \hat{l}_t - \hat{u}_ct \right) \kappa_w \]  
\[ + \frac{\beta}{1 + \beta} \left( \hat{\pi}_{t+1} + \hat{w}_{t+1} \right) + \kappa_w \hat{\mu}_w t \]  

where
\[ \kappa_w \equiv \frac{1 - \xi_w(1 - \xi_w)}{(1 - \varphi/(1 + \mu) + 1) \xi_w (1 + \beta)} \]  

From (5.24) and (5.25) we get the skilled labor wage Phillips Curve,
\[ (1 + \kappa_w) \hat{w}_{st} = \frac{1}{1 + \beta} \left( \hat{w}_{st-1} + \mu \hat{\pi}_{st-1} - (1 + \beta \mu) \hat{\pi}_t \right) + \left( \varphi \hat{l}_{st} - \hat{u}_{ct} \right) \kappa_w \]  
\[ + \frac{\beta}{1 + \beta} \left( \hat{\pi}_{t+1} + \hat{w}_{st+1} \right) \]  

Goods and Skilled labor market clearing conditions,
\[ \hat{y}_t = \frac{\hat{C}}{Y} \hat{c}_t + \frac{\hat{I}}{Y} \left( \hat{p}_{kt} + \hat{\pi}_t \right) + \frac{\hat{G}}{Y} \hat{g}_t \]  
\[ \hat{Z} L \hat{z}_{st} = L^Z_{sa} \left( \hat{z}_t - \hat{a}_t \right) + \left[ \hat{Z} - 1 \right] L^Z_{sa} \hat{i}_{sat} + \hat{Z} L_{sr} \hat{i}_{srt} \]  

Shocks processes,
\[ \hat{g}_t = \rho_g \hat{g}_{t-1} + \sigma_g \epsilon_t^g \]
\[ \hat{\theta}_t = \rho \hat{\theta}_{t-1} + \sigma \theta \epsilon_t^\theta \] (7.26)

\[ \hat{\mu}_t = \rho \mu \hat{\mu}_{t-1} + \sigma \mu \epsilon_t^\mu \] (7.27)

\[ \hat{\mu}_{wt} = \rho \mu_w \hat{\mu}_{wt-1} + \sigma \mu_w \epsilon_t^{\mu_w} \] (7.28)

\[ \hat{p}_{kt} = \rho p_k \hat{p}_{kt-1} + \sigma p_k \epsilon_t^{p_k} \] (7.29)

\[ \hat{r}_t^m = \rho r_m \hat{r}_{t-1}^m + \sigma r_m \epsilon_t^{r_m} \] (7.30)

\[ \hat{\chi}_t = \rho \chi \hat{\chi}_{t-1} + \sigma \chi \epsilon_t^\chi \] (7.31)

\[ \hat{\zeta}_t = \rho \zeta \hat{\zeta}_{t-1} + \sigma \zeta \epsilon_t^\zeta \] (7.32)

### 8 $\rho_\lambda$ Robustness Check

Figure 1 plots the evolution of $A_t$ for the baseline value of $\rho_\lambda$ (0.925) and a lower value (0.85) (see Section 4.7 in the paper for a discussion of the effect of varying $\rho_\lambda$).

**Figure 1:** Estimated time series for stock of adopted technologies $A_t$ for baseline and alternative calibrations of $\rho_\lambda$
9 More IRFs

Figure 2: Impulse Response to 1 std. dev. Money Shock
Figure 3: Impulse Response to 1 std. dev. R&D Productivity Shock
10 Additional Tables

As a check of the fit of the estimated model, Table 2 presents the theoretical standard deviations of the observable variables generated by the model and compares them with the data in our sample. Roughly speaking the model is in line with the actual volatilities of the key variables.

Table 2: Comparison of Standard Deviations

<table>
<thead>
<tr>
<th>Variable</th>
<th>Data</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output Growth</td>
<td>0.55</td>
<td>0.63</td>
</tr>
<tr>
<td>Consumption Growth</td>
<td>0.51</td>
<td>0.71</td>
</tr>
<tr>
<td>Investment Growth</td>
<td>1.54</td>
<td>1.52</td>
</tr>
<tr>
<td>Inflation</td>
<td>0.23</td>
<td>0.36</td>
</tr>
<tr>
<td>Nominal R</td>
<td>0.60</td>
<td>0.55</td>
</tr>
<tr>
<td>Hours (level)</td>
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<td>1.53</td>
</tr>
<tr>
<td>R&amp;D Expenditure Growth</td>
<td>4.00</td>
<td>6.83</td>
</tr>
</tbody>
</table>

Table 3: Prior and Posterior Distributions of Shock Processes

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Distr</th>
<th>Prior</th>
<th>Posterior</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>St. Dev.</td>
<td>Mean</td>
</tr>
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<td>Inv. Gamma</td>
<td>0.10</td>
<td>2.00</td>
</tr>
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<td>2.00</td>
</tr>
<tr>
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<td>Govt. exp.</td>
<td>Inv. Gamma</td>
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<td>2.00</td>
</tr>
<tr>
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<td>Inv. Gamma</td>
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<td>2.00</td>
</tr>
<tr>
<td>$\sigma_\mu$</td>
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<td>Inv. Gamma</td>
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<td>2.00</td>
</tr>
<tr>
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<td>2.00</td>
</tr>
<tr>
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<td>Inv. Gamma</td>
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<td>0.20</td>
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<tr>
<td>$\rho_\theta$</td>
<td>TFP</td>
<td>Beta</td>
<td>0.50</td>
<td>0.20</td>
</tr>
<tr>
<td>$\rho_{\mu_w}$</td>
<td>Wage markup</td>
<td>Beta</td>
<td>0.50</td>
<td>0.20</td>
</tr>
</tbody>
</table>