

Hysteresis and Full Employment in a Small Open Economy

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Abstract

We simulate a small open economy Two Agent New Keynesian (TANK) model featuring 'learning by doing' in production whereby changes in employment generate hysteresis in productivity and output. Credit constraints and hysteresis amplify the efficacy of fiscal stimulus in a small open economy with a floating exchange rate and inflation-targeting central bank such that output multipliers can exceed unity; welfare multipliers can be positive; and the degree of hysteresis, output and employment multipliers match empirical evidence well. Fiscal stimulus helps reverse output hysteresis, and price-level targeting provides superior macroeconomic stabilisation compared to other simple monetary rules combined with fiscal stimulus.

- This paper presents a small open-economy extension of a Two-agent New Keynesian (TANK) model
- A key ingredient of the model is 'learning by doing' in the production technology which generates hysteresis (Chang et al., 2002)
 - Basically, changes in employment affect human capital formation and aggregate productivity
- A Global Financial Crisis (GFC) scenario is simulated with the domestic economy representing Australia
- Output, employment and welfare multipliers are evaluated
- Monetary-fiscal policy interactions are evaluated under alternative simple monetary rules including inflation targeting, NGDP level and growth targeting rules, and a form of price-level targeting.

- **Ongoing debates concerning the effects of fiscal policy following the GFC...**
 - Emerging cross-country evidence predicts output multipliers > 1 , particularly when there is economic slack (e.g. IMF, 2012; Auerbach and Gorodnichenko, 2012a and 2012b; Fazzari et al., 2015; and Riera-Crichton et al., 2015), even in very small open economies (see Auerbach et al., 2020)
 - Benchmark contemporary small open economy NK DSGE models (i.e. Gali and Monacelli, 2005; Lubik and Schorfheide, 2007; and Justiano and Preston, 2010) predict output multipliers < 1
- **Debate concerning the relevance of the zero lower bound (ZLB) for fiscal multipliers**
 - An increase in government consumption can probably only have a multiplier > 1 at the ZLB (Ramey, 2019; Christiano et al., 2011; Eggertsson, 2011; and Woodford, 2011)
 - Multipliers may be > 1 in a broader range of circumstances (see Ramey, 2011; Auerbach and Gorodnichenko, 2012a and 2012b; and Fazzari et al., 2015)

- **Ongoing debate concerning the optimal central bank reaction function following the GFC...**
 - The Federal Reserve (Powell, 2020) adopts a 'flexible form of average inflation targeting' in August 2020
 - Limited academic support for this strategy (see Gianonni, 2014; and Eo and Lie, 2019)
 - No academic coverage in the (small) open economy literature
- **Alternate simple rules** that have been advocated include:
 - Increasing weight on output gap in the reaction function (e.g. Yellen, 2016; Blanchard et al., 2015)
 - Nominal income level targeting (Eggertson et al., 2020; Woodford, 2012 and 2013; Sumner, 2012)
 - Nominal income growth targeting (McCallum, 2015)
 - Temporary price-level targeting (Bernanke, 2017; Bernanke et al., 2019)

- **Empirical evidence in support of the hysteresis hypothesis...**
 - Even **demand driven recessions can have highly persistent, or even permanent effects, on the level of output and TFP** (total factor productivity): See Ball (2014); Bianchi et al., (2019); Blanchard et al., (2015); Cerra and Saxena, (2005), Cerra et al., (2013), Cerra and Saxena, (2017), and Cerra et al., (2020); Fatás and Summers, (2018); Jorda et al., (2020); and Furceri et al., (2021)
- **Limited consideration of macroeconomic policy implications of hysteresis**
 - **Fiscal policy:** Engler and Tervala (2018); and D'Alessandro et al. (2019)
 - **Monetary policy:** Reifschneider et al. (2015); Moran and Queralto (2018); Acharya et al. (2019); Bianchi et al. (2019); Garga and Singh (2019); and Jordà et al. (2020)
 - **No consideration of monetary-fiscal interactions**

Motivation and background

• Hysteresis in output...

- Deviation of output following business cycle peaks relative to the Blanchard et al. (2015) trend indicates no tendency of output to recover to its pre-recession growth path following each recession

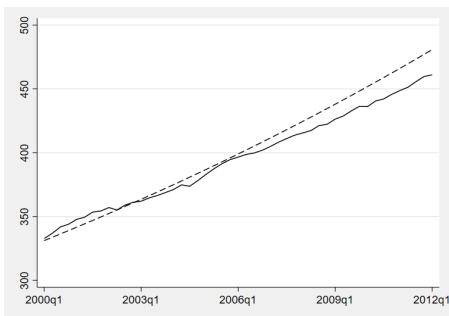
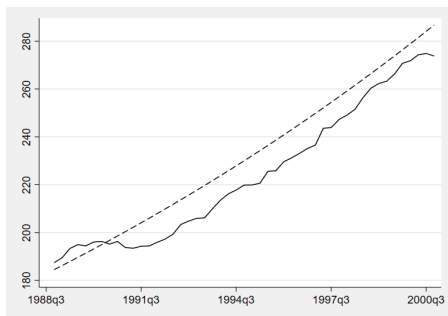


Figure: Real GDP (solid) relative to trend (dashed), \$A billion seasonally adjusted, source: ABS 5206.0

Motivation and background

- **but not employment**

- Employment displays a tendency to recover both in absolute terms, and relative to its pre-recession stochastic trend similar to evidence concerning other advanced economies presented by Jordà et al. (2020)

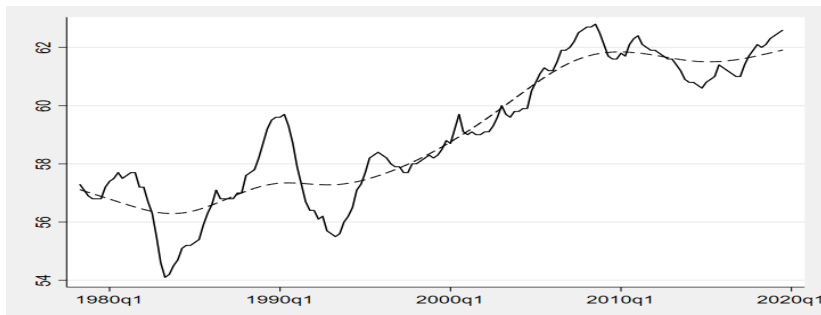


Figure: Employment to population ratio, seasonally adjusted (solid); HP trend, $\lambda = 10,000$ (dashed), source: ABS 6202.0

Workers

- **Utility**

$$U_t(z) = E_t \sum_{s=t}^{\infty} \beta^{s-t} \epsilon_s^{TP} \left[\log C_s - \frac{(I_s(z))^{1+1/\varphi}}{1+1/\varphi} + \varrho \log G_s \right] \quad (1)$$

- **Ricardian workers** smooth consumption over time, receive dividends from firms and pay a lump-sum tax to the government, with budget constraint:

$$\frac{B_t}{1-\lambda} = \frac{(1+i_{t-1})}{1-\lambda} B_{t-1} + w_t I_{R,t} - P_t C_{R,t} + \frac{v_t}{1-\lambda} - P_t T_{R,t} \quad (2)$$

- **Non-Ricardian workers** earn income from labour, and do not smooth consumption over time or own firms with budget constraint:

$$P_t C_{N,t} = w_t I_{N,t} - P_t T_{N,t} \quad (3)$$

Private consumption index

$$C_{i,t} = [(\alpha n)^{1/\psi} (C_{i,t}^h)^{\frac{\psi-1}{\psi}} + (1 - \alpha n)^{1/\psi} (C_{i,t}^f)^{\frac{\psi-1}{\psi}}]^{\frac{\psi}{\psi-1}} \quad (4)$$

- where $i = N, R$
- $C_{i,t}^h$ and $C_{i,t}^f$ are indexes of domestically and foreign produced goods;
- $n\alpha$ is the share of domestic goods in the consumption basket ($\alpha > 1$ captures the degree of home bias in consumption and $0 < n\alpha < 1$); and
- $\psi > 0$ is the Armington elasticity, the elasticity of substitution between domestic and foreign goods.

Firms

- **Production technology:** $a_t(z)$ = total factor productivity (TFP)

$$y_t(z) = a_t(z)l_t(z) \quad (5)$$

- **TFP accumulation:** a learning-by-doing process: the level of employment in the current period affects the level of productivity in the next period with elasticity η

$$\hat{a}_t(z) = \phi \hat{a}_{t-1}(z) + \eta \hat{l}_{t-1}(z) \quad (6)$$

- Hatted variables represent deviations from the initial steady state

Policy

- **Monetary policy**

- Taylor style rule where the central bank targets the deviation of output from its initial level, not the output gap

$$\hat{i}_t = \mu_1 \hat{i}_{t-1} + (1 - \mu_1)(\mu_2 \Delta \hat{P}_t + \mu_3 \hat{Y}_t) + \epsilon_t^i \quad (7)$$

- **Fiscal policy**

- Balanced budget government budget constraint

$$P_t T_t = P_t G_t \quad (8)$$

- where $T_t \equiv \lambda T_{N,t} + (1 - \lambda) T_{R,t}$
- Defining $\hat{g}_t \equiv (G_t - G)/Y$ and $\hat{t}_t \equiv (T_t - T)/Y$, the government budget constraint is:

$$\hat{g}_t = \hat{t}_t \quad (9)$$

- And government spending evolves according to:

$$\hat{g}_t = \rho^g \hat{g}_{t-1} + \epsilon_t^g \quad (10)$$

Human capital formation

- FOCs for labour imply that real wages are driven by productivity.
 - Under 'learning by doing', productivity can be represented as a moving average of past employment

$$\hat{w}_t - \hat{p}_t = \hat{a}_t(z) = \eta \sum_{k=0}^{\infty} \phi^k \hat{l}_{t-1-k}(z) \quad (11)$$

- Invoking Wold's Representation Theorem, equation (12) provides a model consistent real wage equation that can be simply estimated via non-linear least squares

$$\hat{w}_t - \hat{p}_t = \sum_{j=1}^4 \beta_j (\hat{w}_{t-j} - \hat{p}_{t-j}) + \eta \sum_{k=0}^4 \phi^k \hat{l}_{t-1-k} + \varepsilon_t \quad (12)$$

- Where $0 < \eta < 1$, $0 < \phi < 1$, and $\sum_{j=1}^4 \beta_j$ are constrained to unity, $\eta \sum_{k=0}^4 \phi^k \hat{l}_{t-1-k} = 0$, and the real wage equation retains theoretical consistency with our structural model.

Table: Human capital accumulation

	(1)	(2)	(3)	(4)
	Employment	Employment to population ratio	Hours worked	Hours worked per worker
β_1	0.94*** (0.66, 1.21)	0.91*** (0.58, 1.15)	0.93*** (0.63, 1.23)	0.92*** (0.57, 1.26)
β_2	0.11 (-0.24, 0.46)	0.15 (-0.24, 0.54)	0.13 (-0.27, 0.53)	0.13 (-0.28, 0.55)
β_3	-0.22* (-0.49, 0.03)	-0.26* (-0.52, 0.01)	-0.25* (-0.54, 0.04)	-0.23* (-0.50, 0.04)
$\exp(\phi)$	0.93 (0.78, 1.10)	0.91** (0.84, 0.99)	0.94 (0.83, 1.07)	0.90 (0.72, 1.13)
$\exp(\eta)$	0.20** (0.13, 0.31)	0.27*** (0.18, 0.42)	0.23*** (0.15, 0.34)	0.30*** (0.16, 0.56)
R^2	0.44	0.47	0.45	0.45
BG LM test (pr.)	0.26	0.00	0.26	0.14
Harvey test (pr.)	0.32	0.43	0.08	0.26
Chow test (pr.)	0.36	0.44	0.15	0.12

Notes: ***, **, * represent statistical significance at the 0.01, 0.05 and 0.1 significance levels respectively. 95 per cent confidence intervals reported in brackets. Estimation period is 1998Q3 to 2019Q4. All variables expressed in log deviation from Hodrick-Prescott Filter trend ($\lambda = 1600$). Estimates for ϕ and η are exponentiated to facilitate direct comparison to the structural model $A_t(z) = A_{t-1}^\phi(z)L_{t-1}^\eta(z)$. BG LM test is a fourth order Breusch (1978) - Godfrey (1978) LM test with null of no serial correlation. Harvey test is the Harvey (1976) heteroskedasticity test with null of homoskedastic errors. The Chow test is the Chow (1960) break point test with assumed break date of 2009Q2, and null hypothesis of no structural break.

Table: Baseline parameter values

Domestic		Foreign		Universal	
β	0.99	β^*	0.99	α	46.5
φ	1	φ^*	1	n	0.017
θ	6	θ^*	6	ψ	1
γ	0.85	γ^*	0.75	ρ^{TP}	0.96
μ_1	0.85	μ_1^*	0.79	ω	0.001
μ_2	1.5	μ_2^*	1.5		
μ_3	0.2	μ_3^*	0.5		
ρ^g	0.9	ρ^{g^*}	0.75		
λ	0.27	λ^*	0.3		
ϕ	0.93	ϕ^*	0.96		
η	0.2	η^*	0.13		

- **GFC scenario**

- A combination of demand shocks:
 - **A common global time preference shock:** 14 per cent of initial level of consumption- consistent with falls in consumer and market confidence internationally in October 2008 (month after Lehmann's collapse)
 - **Fiscal Shocks:** 5.6 per cent of GDP for domestic region (Australia), and 1.2 of world GDP to capture combined value of G20 economy stimulus programs announced in 2008-09
 - **Monetary Shocks:** 425 basis points for domestic region (Australia), and 250 basis points for the world (halfway between 200 basis point cut from the Fed, and 300 basis point reduction from the ECB)

Results: Domestic output dynamics

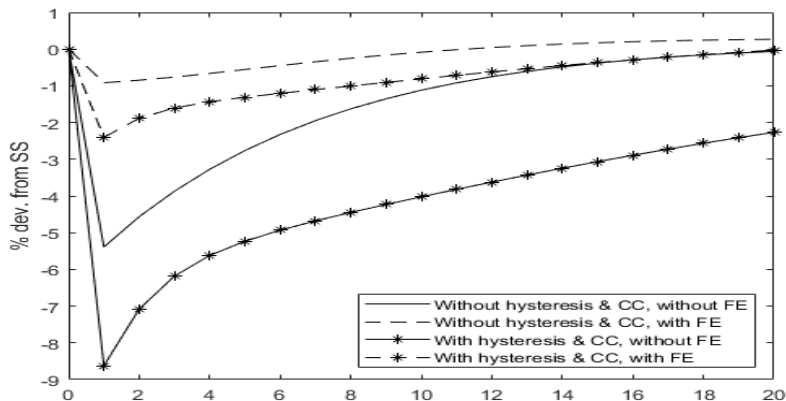


Figure: Domestic output dynamics with and without hysteresis and credit constraints (CC), with and without coordinated fiscal expansion (FE), quarterly

Results: Domestic employment dynamics

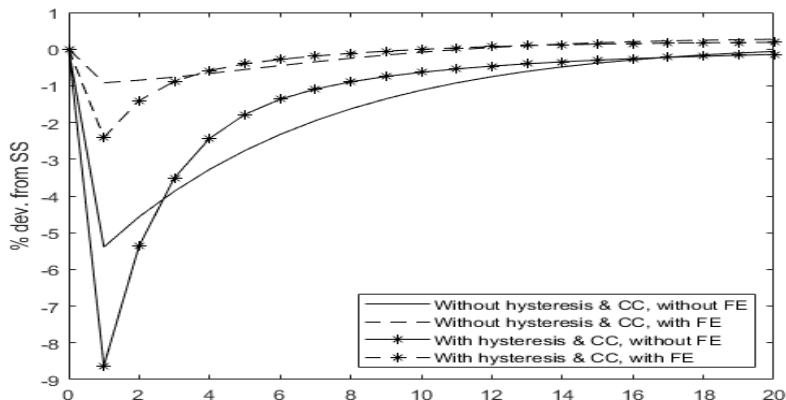


Figure: Domestic employment dynamics with and without hysteresis and credit constraints (CC), with and without coordinated fiscal expansion (FE), quarterly

Results: Output and employment multipliers

Table: Output and employment multipliers

		Output		Employment
Hys.	CC	CM	NPVM	CM
No	No	0.59	0.60	0.59
No	Yes	0.72	0.73	0.72
Yes	Yes	1.28	1.27	0.50

- **High output multipliers in the presence of hysteresis:** Consistent with cross-country evidence showing high GFC-era multipliers from Auerbach and Gorodnichenko (2012a); IMF (2012); Riera-Crichton et al., (2015); Fazzari et al. (2015); Auerbach et al. (2019); and Li and Spencer (2016) in the Australian context
 - Output multipliers can be > 1 even in a small open economy where the ZLB does not bind
- **Employment multipliers roughly half magnitude of output multipliers:** Consistent with evidence from Auerbach et al. (2019); Ball et al. (2017); and Monacelli et al. (2010)

Table: Welfare multipliers

Welfare multipliers				
Hys.	CC	$\rho = 0$	$\rho = 0.4$	$\rho = 1$
No	No	-0.76	-0.51	-0.01
No	Yes	-0.75	-0.50	-0.02
Yes	Yes	0.08	0.31	0.75

- **Welfare multipliers** are defined as the consumption equivalent change in welfare associated with a unit increased in government spending
 - They are **positive only under hysteresis**
 - Consistent with Rendahl (2016) and Engler and Tervala (2018)
 - Negative welfare multipliers without hysteresis consistent with Sims and Wolff (2018), and Ergas and Robson (2009) in the Australian context.

Results: Degree of hysteresis

- **Ratio of peak fall in TFP relative to output** is 0.39
 - Furceri et al. (2021) find 0.42 for 18 advanced economies between 1970 and 2014
- **Degree of hysteresis** (ratio of fall in output relative to equilibrium output) is 0.19 in the model after four years
 - Kienzler and Schmid (2014) suggest a range of 0.2 to 0.3 for OECD economies between 1955-2012
 - Delong and Summers (2012) suggest between 0 to 0.2 as 'plausible values' for the US
 - The degree of hysteresis falls to zero midway through the fifth year consistent with evidence for Australia from Rawdonwicz (2014).
 - Relatively modest degrees of hysteresis can be important for policy, and fiscal stimulus helps reverse hysteresis!

Table: Parameter robustness

Parameter	Output		Emp.	Welfare multipliers		
	CM	NPVM	CM	$\varrho = 0$	$\varrho = 0.4$	$\varrho = 1$
Baseline	1.28	1.27	0.50	0.08	0.31	0.75
$\varphi = \varphi^* = 0.5$ (1)	1.29	1.29	0.49	0.05	0.25	0.66
$\varphi = \varphi^* = 2$ (1)	1.32	1.31	0.53	0.12	0.34	0.78
$\eta = \eta^* = 0.11$ (0.2,0.13)	1.08	1.07	0.59	-0.15	0.08	0.28
$\eta = \eta^* = 0.3$ (0.2,0.13)	1.44	1.42	0.43	0.24	0.45	0.86
$\phi = \phi^* = 0.8$ (0.93,0.96)	1.03	1.02	0.56	-0.33	-0.08	0.39
$\phi = \phi^* = 0.99$ (0.93,0.96)	1.54	1.51	0.48	0.72	0.93	1.35
$\lambda = \lambda^* = 0.20$ (0.27, 0.30)	1.25	1.23	0.49	0.07	0.31	0.77
$\lambda = \lambda^* = 0.50$ (0.27, 0.30)	1.42	1.42	0.54	0.09	0.23	0.51

Would a change in monetary framework have improved outcomes?

Three alternative simple policy rules considered for the domestic region:

- 1 **Nominal income level targeting:** Equal weight on output and price level deviations from initial levels (1.5)
- 2 **Nominal income growth targeting:** Equal weight on annualised growth in price level and output relative to initial levels (1.5) in line with McCallum (2015)
- 3 **Price level targeting:** As per baseline inflation targeting rule except replacing the deviation of annualised inflation from initial level with the price level consistent with Bernanke (2017) and Bernanke et al. (2019)

Would a change in monetary framework have improved outcomes?

Table: Multipliers under alternative simple monetary policy rules

Policy Rule	Output		Employment	Welfare multipliers		
	CM	NPVM	CM	$\varrho = 0$	$\varrho = 0.4$	$\varrho = 1$
Baseline	1.28	1.27	0.50	0.08	0.31	0.75
NGDPGT	1.30	1.28	0.51	0.09	0.32	0.75
NGDPLT	1.12	1.11	0.45	0.04	0.30	0.80
PLT	1.34	1.33	0.54	0.13	0.40	0.92

Why are geographic cross-sectional multipliers so large?

- Leduc and Wilson (2013) and Nakamura and Steinsson (2014) develop DSGE models that generate large geographic cross-sectional output multipliers using Greenwood, Hercowitz, and Huffman (GHH, 1988) preferences
- Auclert and Rognlie (2017): Under GHH preferences and non-distortionary labour income taxes, fiscal multipliers equate to the elasticity of substitution between intermediate goods
 - Difficult to see how this parameter would influence multiplier size in the real world
 - Therefore, a theoretical challenge remains how to motivate sizeable geographic cross-sectional fiscal multipliers without resorting to GHH (1988) preferences

Extension: Motivating large geographic cross-sectional multipliers

Models

- Two region open economy DSGE models:
 - ① Average SA4 and Rest-of-Nation economy
 - ② National and RoW economy
- TANK: Fraction of households are assumed to be liquidity constrained as in Galí et al. (2007)
- Learning-by-doing in the production technology generates output persistence (hysteresis): Arrow (1962) and Chang et al. (2002)
- Private and public investment
- National Monetary Policy: Standard Taylor type rule
- National Fiscal Policy: Deficit financed government spending. Distortionary income and consumption taxes. Fiscal rule uses income taxes to stabilise government debt. Spending instruments include consumption, investment, transfers and wage subsidies

Building the Education Revolution (BER) Output Multipliers (Watson, 2021)

Table: BER Output Multipliers

	2009	2010	2011	2012	Cumulative
Average SA4					
Model simulation	5.82	4.74	6.68	9.88	27.11
Empirical	6.55	4.70	3.85	11.00	26.10
National					
Model simulation	1.58	3.34	4.77	5.28	14.96
Empirical	4.14	2.00	2.71	6.12	14.96

Notes: The average SA4 empirical model is the preferred employment model including controls for geographic spillovers. The national empirical model is the preferred employment model estimated using probability weights based on SA4 working age population and allowing for geographic spillovers. Output multipliers are then calculated using the method of Chodorow-Reich (2019).

Conclusions

- With hysteresis and credit constraints, fiscal policy can help reverse hysteresis effects, even in a small open economy with an inflation targeting central bank
 - Output multipliers can be greater than one and employment multipliers are around half the size of output multipliers
 - The degree of hysteresis, output and employment multipliers match empirical evidence well
 - Hysteresis implies that the welfare effects of fiscal stimulus are positive
- Multipliers are larger under price-level targeting compared to other monetary policy frameworks
 - Support for the Federal Reserve's adoption of a 'flexible form of average inflation targeting' (Powell, 2020)
 - Also suggests a temporary price level target is worth considering as a form of forward guidance in the present circumstances in Australia
 - **Key lesson for current policy:** Recovery of (un)employment to pre-recession trend does not imply that output and incomes will too
- Hysteresis and credit constraints can also generate (very) large cross-sectional fiscal multipliers without reliance on GHH (1988) preferences