# A THEORY OF COUNTERCYCLICAL

# GOVERNMENT MULTIPLIER

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## GOVERNMENT MULTIPLIER IS COUNTERCYCLICAL

- US evidence:
  - Auerbach & Gorodnichenko [2012]
  - Candelon & Lieb [2013]
  - Fazzari, Morley, & Panovska [2015]
- international evidence:
  - Auerbach & Gorodnichenko [2013]
  - Jorda & Taylor [2016]
  - Holden & Sparrman [2018]

## EXISTING EXPLANATION: ZERO LOWER BOUND

- multiplier is large in bad times because of the zero lower bound
  - Eggertsson [2011]
  - Christiano, Eichenbaum, & Rebelo [2011]
  - Eggertsson & Krugman [2012]
- but evidence of countercyclical multipliers is obtained away from the zero lower bound

# THIS PAPER'S EXPLANATION: LABOR MARKET SLACK

- multiplier  $\equiv$  additional number of employed workers when 1 worker is hired in the public sector
- multiplier doubles when unemployment rises from 5% to 8%
  - irrespective of the zero lower bound
- mechanism based on the matching model of the labor market from Michaillat [2012]
  - unemployment = rationing + frictional

#### IMPORTANCE OF PUBLIC EMPLOYMENT

- public employment = 63% of government consumption expenditures in the US, 1947–2011
  - even more if purchase of services (contractors) are included
- stimulus packages often raise public employment
  - Great Depression [Neumann, Fishback, & Kantor 2010]

## MECHANISM: CROWDING OUT

- public employment crowds out private employment
  - because government and firms compete for the same jobseekers
- formally: an increase in public employment raises labor market tightness
  - $\rightsquigarrow$  raises recruiting costs
  - → reduces private employment

### MECHANISM: BAD TIMES VS. GOOD TIMES

- bad times: labor demand is low so unemployment is high and competition for workers is weak
  - $\rightsquigarrow$  weak crowding out
- good times: labor demand is high so unemployment is low and competition for workers is strong
  - $\rightsquigarrow$  strong crowding out
- procyclical crowding out  $\leadsto$  countercyclical multiplier

# MATCHING MODEL

# WITH PUBLIC EMPLOYMENT

## PUBLIC EMPLOYMENT

- the government employs g<sub>t</sub> workers
  - public employment is financed by an income tax
- public and private jobs are identical
  - same wage w
  - same job-separation rate s
- unemployed workers indiscriminately apply to public and private jobs
- public and private vacancies compete for the same unemployed workers

#### MATCHING FUNCTION



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# WORKER FLOWS: JOB CREATION & SEPARATION

1 -  $u_t$  employed workers

*u*<sup>*t*</sup> unemployed workers

# WORKER FLOWS: JOB CREATION & SEPARATION



# WORKER FLOWS: JOB CREATION & SEPARATION



#### LABOR SUPPLY

- labor supply = workers' employment rate when labor market flows are balanced
- balanced flows:  $E \rightarrow U = U \rightarrow E$

$$- s \cdot n = f(\theta) \cdot u = f(\theta) \cdot [1 - n + s \cdot n]$$

expression for labor supply:

$$n^{s}(\theta) = \frac{f(\theta)}{s + (1 - s) \cdot f(\theta)}$$

- equivalent to the Beveridge curve

#### **REPRESENTATIVE FIRM**

- hires  $l_t (1 s) \cdot l_{t-1}$  new workers by posting vacancies
  - cost per vacancy:  $r \cdot a$
  - vacancy-filling probability:  $q(\theta_t)$
- employs l<sub>t</sub> workers paid w
- production function:  $y_t = a \cdot l_t^{\alpha}$ 
  - a: level of technology
  - $\alpha \in (0, 1]$ : marginal returns to labor

# FIRM'S PROBLEM

• given wage and tightness {w,  $\theta_t$ }, the firm chooses employment { $l_t$ } to maximize discounted profits



#### PRIVATE LABOR DEMAND

• first-order condition with respect to *l* in steady state:



 given θ and w, the private labor demand is firms' desired employment rate in steady state:

$$l^{d}(\underline{\theta}, \underline{w}) = \left[\frac{1}{\alpha} \cdot \left\{\frac{w}{a} + \left[1 - \beta \cdot (1 - s)\right] \cdot \frac{r}{q(\theta)}\right\}\right]^{\frac{-1}{1 - \alpha}}$$

- there are mutual gains from matching
- many wage schedules are consistent with equilibrium
- we assume a simple wage schedule:  $w = \omega \cdot a^{\gamma}$ 
  - $\gamma$  = 0: fixed wage (unresponsive to *a*)
  - $\gamma$  = 1: flexible wage (proportional to *a*)
  - $\gamma \in$  (0, 1): partially rigid wage (subproportional to *a*)

#### AGGREGATE LABOR DEMAND

 using the wage schedule, we rewrite the private labor demand as a function of θ and a:

$$l^{d}(\underset{-}{\theta},\underset{+}{a}) = \left[\frac{1}{\alpha} \cdot \left\{\omega \cdot a^{\gamma-1} + \left[1 - \beta \cdot (1-s)\right] \cdot \frac{r}{q(\theta)}\right\}\right]^{\frac{-1}{1-\alpha}}$$

aggregate labor demand:

$$n^{d}(\underset{-}{\theta},\underset{+}{a},\underset{+}{g}) = l^{d}(\theta,a) + g$$

# STEADY-STATE EQUILIBRIUM

tightness equalizes labor supply and demand:

$$n^{s}(\underline{\theta}) = n^{d}(\underline{\theta}, \underline{a}, \underline{g})$$

- recession: low technology a
- expansion: high technology a
- stimulus: high public employment g
- note: in matching models, the convergence to steady state is almost immediate [Hall 2005]

## EQUILIBRIUM DIAGRAM



# **PROPERTIES OF THE MULTIPLIER**

## DEFINITION OF THE MULTIPLIER

- the multiplier is  $\lambda \equiv dn/dg$ 
  - additional number of employed workers when 1 worker is hired in the public sector
- another expression:  $\lambda = 1 + dl/dg$ 
  - 1: mechanical effect of public employment
  - *dl/dg* < 0: crowding out of private employment by public employment</li>
  - weaker crowding out  $\Rightarrow$  larger multiplier

# ASSUMPTIONS FROM MICHAILLAT [2012]

- α < 1: diminishing marginal returns to labor in production</li>
  → in (n, θ) plane: n<sup>d</sup>(θ, a, q) is downward-sloping
- $\gamma$  < 1: partial wage rigidity
  - $\rightarrow$  in  $(n, \theta)$  plane:  $n^d(\theta, a, g)$  shifts inward when a rises

# MULTIPLIER PROPERTIES WHEN lpha < 1 and $\gamma$ < 1

- multiplier < 1</li>
  - there is crowding out of private employment by public employment
- but multiplier > 0
  - crowding out is less than one-for-one
- multiplier is larger when *a* is lower
  - higher unemployment → weaker crowding out → larger multiplier









## COUNTERCYCLICAL MULTIPLIER



## COUNTERCYCLICAL MULTIPLIER



# INTUITION FOR THE MECHANISM

- when unemployment is high:
  - government hires unemployed workers who would not have been hired otherwise
  - → public employment does not affect private employment much
- but when unemployment is low:
  - government hires workers that would have been hired by the private sector otherwise
  - ~~ public employment heavily crowds out private employment

### WHAT HAPPENS IF $\alpha = 1$ ?

- $\alpha$  = 1: linear production function
  - standard assumption [Pissarides 2000; Hall 2005]
- in  $(n, \theta)$  plane: labor demand is horizontal
- $\rightsquigarrow$  a change in g does not change  $\theta$
- $\rightsquigarrow$  crowding out is one-for-one
- $\rightarrow$  multiplier = 0

# WHAT HAPPENS IF $\gamma = 1$ ?

- $\gamma$  = 1: flexible wage
  - as with Nash bargaining
- in  $(n, \theta)$  plane: labor demand is independent of a
- $\rightsquigarrow \theta$  is independent of *a*
- → crowding out is independent of *a*
- $\rightsquigarrow$  multiplier is acyclical

# NEW KEYNESIAN MODEL

## STANDARD FEATURES

- fluctuations arise from technology shocks
- representative large household
  - works for intermediate-good firms
  - consumes final good
  - saves using nominal bonds
- representative final-good firm
  - uses intermediate goods as input
  - sells output on perfectly competitive market

## STANDARD FEATURES

- intermediate-good firms
  - use labor as input
  - sell output on monopolistically competitive market to final-good firm
  - set price subject to a price-setting friction
- monetary policy
  - interest-rate rule (Taylor rule)

#### NONSTANDARD FEATURES

- labor market with matching structure from Michaillat [2012]
  - instead of perfect/monopolistic competition
- quadratic price-adjustment cost from Rotemberg [1982]
  - instead of Calvo [1983] pricing
- government consumption is public employment
  - instead of purchase of goods

#### **9 ENDOGENOUS VARIABLES**

• exogenous variables:

 $\{a_t,g_t\}_{t=0}^{+\infty}$ 

endogenous variables:

$$\left\{ \theta_t, n_t, l_t, w_t, \Lambda_t, c_t, y_t, R_t, \pi_t \right\}_{t=0}^{+\infty}$$

#### LABOR MARKET EQUATIONS

equation #1: wage schedule

$$w_t = \omega \cdot a_t^{\gamma}, \ \gamma < 1$$

equation #2: labor supply

$$n_t = (1 - s) \cdot n_{t-1} + f(\theta_t) \cdot [1 - (1 - s) \cdot n_{t-1}]$$

equation #3: public-employment policy

$$n_t = l_t + g_t$$

#### **PRODUCTION EQUATIONS**

equation #4: production function

$$y_t = a_t \cdot l_t^{\alpha}, \ \alpha < 1$$

equation #5: resource constraint

$$y_t - \frac{r \cdot a_t}{q(\theta_t)} \cdot \left[ n_t - (1 - s) \cdot n_{t-1} \right] = c_t \cdot \left[ 1 + \frac{\Phi}{2} \cdot \pi_t^2 \right]$$

#### BOND MARKET EQUATIONS

equation #6: Euler equation

$$1 = \beta \cdot \mathbb{E}_t \left( \frac{R_t}{1 + \pi_{t+1}} \cdot \frac{c_t}{c_{t+1}} \right)$$

• equation #7: Taylor rule

$$R_t = \frac{1}{\beta} \cdot (1 + \pi_t)^{\mu_{\pi} \cdot (1 - \mu_R)} \cdot (\beta \cdot R_{t-1})^{\mu_R}$$

#### FIRM EQUATIONS

equation #8: optimal pricing decision

$$\pi_t \cdot (\pi_t + 1) = \frac{1}{\Phi} \cdot \frac{y_t}{c_t} \left[ \epsilon \cdot \Lambda_t - (\epsilon - 1) \right] + \beta \cdot \mathbb{E}_t (\pi_{t+1} \cdot (\pi_{t+1} + 1))$$

equation #9: optimal employment decision

$$\Lambda_t \cdot \alpha \cdot l_t^{\alpha - 1} = \frac{w_t}{a_t} + \frac{r}{q(\theta_t)} - \beta \cdot (1 - s) \cdot \mathbb{E}_t \left( \frac{c_t}{c_{t+1}} \cdot \frac{a_{t+1}}{a_t} \cdot \frac{r}{q(\theta_{t+1})} \right)$$

# Steady state $(n, \theta)$ with zero inflation

equation #2: labor supply

$$n^{s}(\theta) = \frac{f(\theta)}{s + (1 - s) \cdot f(\theta)}$$

• equation #8: 
$$\Lambda$$
 = ( $\epsilon$  – 1)/ $\epsilon$ 

- equation #1:  $w = \omega \cdot a^{\gamma}$
- equation #9: firms' labor demand

$$\frac{\epsilon - 1}{\epsilon} \cdot \alpha \cdot \left[ l^{d}(\theta, \alpha) \right]^{\alpha - 1} = \omega \cdot \alpha^{\gamma - 1} + (1 - \beta \cdot (1 - s)) \cdot \frac{r}{q(\theta)}$$

# SIMULATIONS

## SIMULATION METHOD

- simulate nonlinear model under perfect foresight using shooting algorithm
- scenario #1: public employment without stimulus
  - value of  $g: \hat{g}_t = \overline{g}$
  - value of any  $x: \hat{x}_t$
  - solid blue lines in graphs
- scenario #2: public employment with stimulus
  - value of  $g: g_t^* > \overline{g}$
  - value of any  $x: x_t^*$
  - dashed red lines in graphs

## COMPUTATION OF THE MULTIPLIER

instantaneous multiplier in a simulation:

$$\frac{n_t^* - \hat{n}_t}{g_t^* - \hat{g}_t}$$

• cumulative multiplier in a simulation:

$$\frac{\sum_{t=0}^{T} n_t^* - \hat{n}_t}{\sum_{t=0}^{T} g_t^* - \hat{g}_t}$$

 cumulative multipliers are parametrized by the peak of the unemployment rate in the simulation

#### **RESPONSE TO POSITIVE TECHNOLOGY SHOCK**



#### MULTIPLIER AFTER POSITIVE SHOCK



#### **RESPONSE TO NEGATIVE TECHNOLOGY SHOCK**



#### MULTIPLIER AFTER NEGATIVE SHOCK



#### COUNTERCYCLICAL CUMULATIVE MULTIPLIER



#### COUNTERCYCLICAL CUMULATIVE MULTIPLIER



# CONCLUSION

#### SUMMARY

- this paper proposes a New Keynesian model in which the government multiplier doubles when unemployment rises from 5% to 8%
- mechanism behind countercyclical multiplier:
  - multiplier = 1– crowding out
  - crowding out of private employment by public employment is much weaker when unemployment is higher

### APPLICATIONS

- the same mechanism explains the procyclicality of the macroelasticity of unemployment with respect to unemployment insurance
  - see Landais, Michaillat, & Saez [2018]
- the same mechanism applies to the product market
  - see Michaillat & Saez [2019]
- the multiplier determines optimal stimulus spending
  - see Michaillat & Saez [2019]