

Firm Entry and Exit and Growth

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 - ▶ continuing firms?
 - ▶ entry and exit of firms?

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- ▶ These studies are widely cited to justify assumptions that net entry (creative destruction) is unimportant/important.

Firm entry and aggregate growth: empirics

- ▶ How does firm entry and exit contribute to aggregate productivity growth?
 - ▶ During periods of rapid GDP growth
 - ▶ During periods of slow GDP growth

Firm entry and aggregate growth: empirics

- ▶ How does firm entry and exit contribute to aggregate productivity growth?
 - ▶ During periods of rapid GDP growth
 - ▶ During periods of slow GDP growth
- ▶ Plant-level data from Chile and Korea
- ▶ Review literature that uses identical decomposition
- ▶ Net entry is more important in periods of rapid growth
 - ▶ Average contribution, rapid growth: 54 percent
 - ▶ Average contribution, slow growth: 26 percent

Firm entry and aggregate growth: model

- ▶ Construct a model of firm entry and exit
 - ▶ Calibrate to the United States

Firm entry and aggregate growth: model

- ▶ Construct a model of firm entry and exit
 - ▶ Calibrate to the United States
- ▶ Use the calibrated model for policy analysis
 - ▶ Reduce entry barriers
 - ▶ Reduce barriers to technology adoption
- ▶ Quantitatively accounts for Chile and Korea data
- ▶ Entry and exit are crucial to understanding reform

data

Plan

- ▶ Decompose aggregate productivity growth
 - ▶ Terms related to entry and exit of firms
 - ▶ Terms related to growth in continuing firms
 - ▶ Follow Foster, Haltiwanger, and Krizan (2001)
- ▶ Use manufacturing plant data from Chile and Korea
 - ▶ Periods of rapid growth
 - ▶ Periods of slow growth
- ▶ Review comparable studies in the literature

Defining industry productivity

- ▶ Productivity of industry i :

$$\log Z_{it} = \sum_{e \in E_{it}} s_{et} \log z_{et}$$

- ▶ s_{et} : gross output share of plant e in time t in industry i
- ▶ z_{et} : TFP of plant e in time t in industry i
- ▶ Change in productivity (window defined by $t - 1, t$):

$$\Delta \log Z_{it} = \log Z_{it} - \log Z_{i,t-1}$$

Estimating plant productivity

- ▶ Plant e in industry i production function

$$\log y_{eit} = \log z_{eit} + \beta_k^i \log k_{eit} + \beta_\ell^i \log \ell_{eit} + \beta_m^i \log m_{eit}$$

- ▶ Following Foster et al. (2001)
 - ▶ β_j^i : average cost shares of input j in industry i
- ▶ Consider alternative methods to estimate z
 - ▶ Woolridge-Levinsohn-Petrin methods (Chile)
 - ▶ Generate similar productivity decompositions

Productivity decomposition of industry growth

$$\Delta \log Z_{it} = \Delta \log Z_{it}^{NE} + \Delta \log Z_{it}^C$$

- ▶ $\Delta \log Z_{it}^{NE}$: change due to entering/exiting plants
- ▶ $\Delta \log Z_{it}^C$: change due to continuing plants

Net entry

$$\Delta Z_{it}^{NE} = \underbrace{\sum_{e \in N_{it}} s_{et} (\log z_{et} - \log Z_{i,t-1})}_{\text{entering plants}} - \underbrace{\sum_{e \in X_{it}} s_{e,t-1} (\log z_{e,t-1} - \log Z_{i,t-1})}_{\text{exiting plants}}$$

N_{it} and X_{it} are sets of entering and exiting plants

- ▶ “entering plants” is positive if entrants have high productivity (compared to initial aggregate productivity)
- ▶ “exiting plants” is negative if exiting plants have low productivity

Continuing plants

$$\begin{aligned}\Delta Z_{it}^C &= \underbrace{\sum_{e \in C_{it}} s_{e,t-1} \Delta \log z_{et}}_{\text{within plant}} + \underbrace{\sum_{e \in C_{it}} (\log z_{e,t-1} - \log Z_{i,t-1}) \Delta s_{et}}_{\text{between plant}} \\ &+ \underbrace{\sum_{e \in C_{it}} \Delta \log z_{e,t} \Delta s_{et}}_{\text{covariance}}\end{aligned}$$

C_{it} is the set of continuing plants

- ▶ “within plant” is average within-plant productivity growth
- ▶ “between plant” is positive if relatively productive plants expand market share
- ▶ “covariance” is positive if plants that expand also increase their productivity

Productivity growth and aggregation

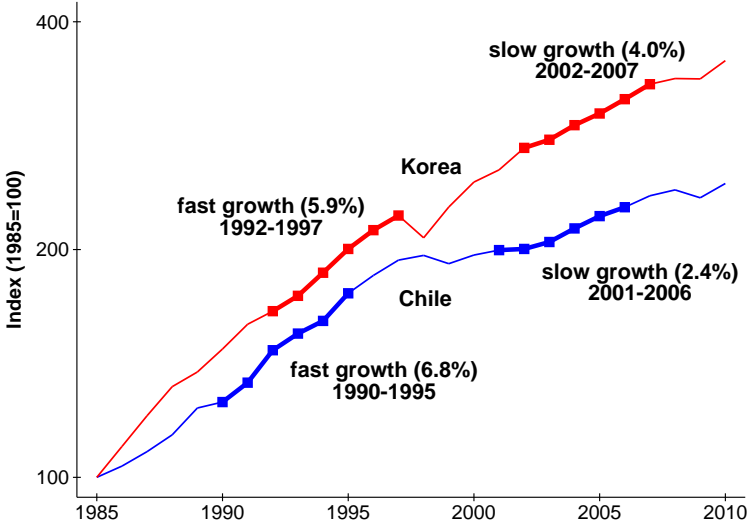
- ▶ At the industry-level we determine
 1. Productivity change
 2. Productivity change from entry/exit
 3. Productivity change from continuing plants

- ▶ To aggregate, weight each of these three components by gross output of industry (using average of beginning and end of window)

Decomposing productivity growth: Chile and Korea

- ▶ How does the net entry term change in Chile and Korea?
- ▶ Look within the same country at two windows
 - ▶ Avoids cross-country differences
 - ▶ Uses consistent datasets

Real GDP per working-age person



Plant-level manufacturing data

▶ Chile

- ▶ Encuesta Nacional Industrial Anual
- ▶ Collected by the Chilean national statistical agency
- ▶ Covers all plants with more than 10 employees
- ▶ 127 industries and 5,500 plants (2005)
- ▶ Two panels: 1986-1996 and 1995-2006

▶ Korea

- ▶ Survey of Mining and Manufacturing
- ▶ Collected by the Korean national statistical agency
- ▶ Covers all plants with more than 10 employees
- ▶ 104 industries and 8,300 plants
- ▶ Panel: 1992, 1997, 2002, and 2007

The relative importance of net entry

Country	Period	GDP WAP growth (percent)	Window	Effect of net entry (percent)
Chile	1990-1995	6.8	5 years	85
Chile	2001-2006	2.4	5 years	35
Korea	1992-1997	5.9	5 years	44
Korea	2002-2007	4.0	5 years	39

Other empirical studies

- ▶ Existing studies with identical methodology
 - ▶ Slow growth: Portugal, U.K., U.S.
 - ▶ Rapid growth: China, Korea, Chile

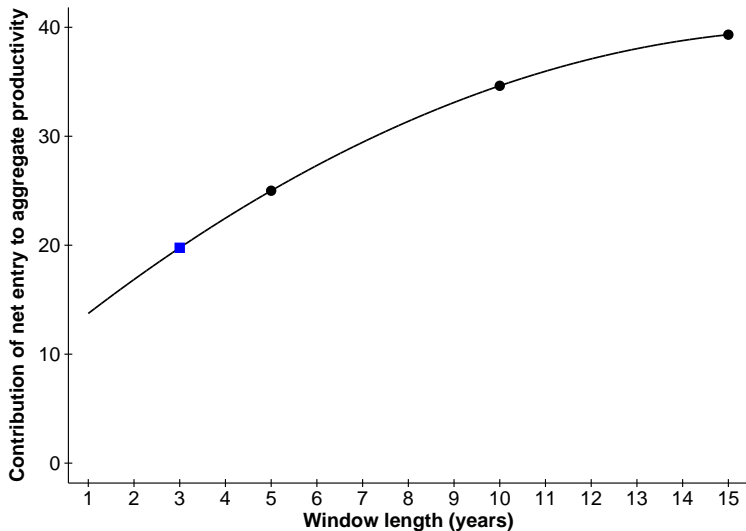
Other empirical studies

- ▶ Existing studies with identical methodology
 - ▶ Slow growth: Portugal, U.K., U.S.
 - ▶ Rapid growth: China, Korea, Chile
- ▶ Problem: Studies use different length time windows
 - ▶ Makes comparisons difficult
- ▶ Solution: Use calibrated model to make adjustments

Use model to make window adjustments

- ▶ Solve the baseline equilibrium for the U.S.
- ▶ Decompose model output using 5, 10, 15 year windows
- ▶ Fit a quadratic to contribution of net entry to productivity growth for the 3 windows

Net entry under various windows in the model



Use model to make window adjustments

- ▶ Portugal: 3-year window, 15 percent net entry contribution
- ▶ In the calibrated model
 - ▶ 5 year window generates 25 percent contribution
 - ▶ 3 year window generates 20 percent contribution
- ▶ Adjust proportionally
- ▶ Adjustment: $15 \times 25/20 = 19$ (5-year window equivalent)

Contribution of net entry

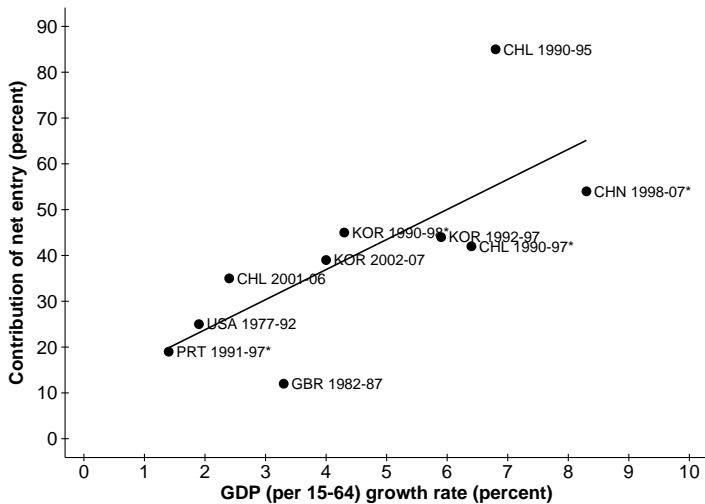
Net entry more important during periods of fast growth

Country	Period	GDP growth 15–64	Window	Effect of net entry	5 year equiv.
US	1977–1992	1.9	5 years*	25	25
UK	1982–1987	3.3	5 years	12	12
Portugal	1991–1997	1.4	3 years*	15	19
Chile	2001–2006	2.4	5 years	35	35
Korea	2002–2007	4.0	5 years	39	39
Average		2.6			26
China	1998–2007	8.3	9 years	72	54
Chile	1990–1997	6.4	7 years	49	42
Korea	1990–1998	4.3	8 years	57	45
Chile	1990–1995	6.8	5 years	85	85
Korea	1992–1997	5.9	5 years	44	44
Average		6.3			54

Sources: U.S.: Foster et al. (2002); U.K.: Disney et al. (2005); Portugal: Carreira and Teixeira (2008); China: Brandt et al. (2012); Chile (1990–97): Bergoeming and Repetto (2006); Korea (1990–98) Ahn et al. (2005)

* Average over multiple windows

Net entry important for fast-growth economies



*adjusted to 5 year windows using elasticities generated by model

model

Model

- ▶ We develop a model in which
 - ▶ Potential entrants draw from frontier efficiency distribution, which improves by growth factor g_e
 - ▶ Efficiency of continuing firms grows, by $g_c < g_e$
 - ▶ Endogenous entry/exit of firms
- ▶ Easy to characterize balanced growth path

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 - ▶ Efficiency of continuing firms grows, by $g_c < g_e$
 - ▶ Endogenous entry/exit of firms
- ▶ Easy to characterize balanced growth path
- ▶ Implications:
 - ▶ BGP growth factor g_e
 - ▶ Level is determined by barriers to entry, technology adoption
- ▶ Purpose of model: Investigate policy reforms

Household problem

- ▶ Representative household solves

$$\max_{C_t, B_{t+1}} \sum_{t=0}^{\infty} \beta^t \log C_t$$

subject to

$$P_t C_t + q_{t+1} B_{t+1} = w_t + D_t + B_t$$

$$C_t \geq 0, \text{ No Ponzi condition, } B_0 \text{ given}$$

D_t : aggregate dividends

- ▶ Normalize $P_t = 1, \forall t$

Firm dynamics

- ▶ Based on Hopenhayn (1992)
- ▶ Continuum of perfectly competitive firms
 - ▶ A firm in the model is a plant in the data
- ▶ Heterogenous in efficiency x
 - ▶ Productivity depends on efficiency
- ▶ Pay κ to draw initial efficiency, f to operate
- ▶ Exogenous exit probability δ and endogenous exit

Fixed costs paid by firms

- ▶ Potential entrants pay $\kappa_t = \kappa Y_t$ to draw efficiency x

$$\kappa = \kappa^T + \kappa^P$$

- ▶ Paid in consumption/investment good
- ▶ κ^T is the technological cost, common across countries
- ▶ κ^P is the policy induced cost

Fixed costs paid by firms

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$$\kappa = \kappa^T + \kappa^P$$

- ▶ Paid in consumption/investment good
- ▶ κ^T is the technological cost, common across countries
- ▶ κ^P is the policy induced cost
- ▶ Firms pay fixed cost of operating, $f_t = fY_t$, or exit
- ▶ $\kappa_t + f_t$ is the capital of a firm in t

Firms face two decisions

1. Entry/exit decision
2. Conditional on operating: maximize profits

Firm's static problem

- ▶ Conditional on operating, firm with efficiency x solves

$$\pi_t(x) = \max_{l_t(x)} x l_t(x)^\alpha - w_t l_t(x) - f_t$$

- ▶ Solution is

$$l_t(x) = \left(\frac{w_t}{\alpha x} \right)^{\frac{1}{\alpha-1}}$$

- ▶ More efficient firms are larger

Firm's dynamic problem

- ▶ Firms with efficiency x choose to exit or continue to solve

$$V_t(x) = \max \{ \pi_t(x) + q_{t+1}(1 - \delta)V_{t+1}(g_{c,t+1}x), 0 \}$$

- ▶ Efficiency grows at g_c

Operating firm efficiency growth

- ▶ Efficiency of existing firms grow by

$$g_{ct} = \bar{g}g_t^\varepsilon$$

- ▶ \bar{g} is constant
- ▶ g_t is average efficiency growth
- ▶ ε measures the degree of spillovers

Operating firm efficiency growth

- ▶ Efficiency of existing firms grow by

$$g_{ct} = \bar{g}g_t^\varepsilon$$

- ▶ \bar{g} is constant
- ▶ g_t is average efficiency growth
- ▶ ε measures the degree of spillovers
- ▶ Quantitatively, but not qualitatively important
 - ▶ Further discussion in calibration

New entrant's problem

- ▶ Potential entrants draw efficiency from

$$F_t(x) = 1 - \left(\frac{\varphi x}{g_e^t} \right)^{-\gamma}, \quad x \geq \frac{g_e^t}{\varphi}$$

- ▶ Mean grows by growth factor g_e
- ▶ Barrier to technology adoption, φ (Parente-Prescott 1994)
- ▶ Mass of potential entrants, μ_t , from costly entry condition:

$$E_x [V_t(x)] = \kappa_t$$

- ▶ Firm enters if and only if $x \geq \hat{x}_t$

Measure of firms

- ▶ Measure of firms of age j in operation

$$\eta_{jt} = \mu_{t-j+1}(1 - \delta)^{j-1} \left[1 - F_{t-j+1} \left(\frac{\hat{x}_t}{\prod_{s=1}^{j-1} g_{c,t-s+1}} \right) \right]$$

- ▶ Convert age- j efficiency to initial efficiency

$$\prod_{s=1}^{j-1} g_{c,t-s+1}$$

- ▶ Total measure of operating firms

$$\eta_t = \sum_{i=1}^{\infty} \eta_{it}$$

Equilibrium definition

Given initial conditions, an equilibrium is

- ▶ Household consumption and bond plans
- ▶ Allocations and entry/exit thresholds for firms
- ▶ Measure of potential entrants for firms
- ▶ Prices and aggregate dividends

Equilibrium definition

such that

- ▶ Household maximizes lifetime utility
- ▶ Firms maximize discounted dividends
- ▶ Costly entry condition binds
- ▶ Goods, labor, and bond markets clear
- ▶ Dividends satisfy

$$D_t = \Pi_t - \mu_t \kappa_t$$

Existence of balanced growth path

Economy converges to a balanced growth path in which

1. Entry and exit thresholds grow by g_e
2. Real consumption, output, wages, and dividends grow by g_e
3. Masses of potential entrants and operating firms are constant

Characterizing BGP: growth

$$\begin{aligned}\hat{x}_t &= \frac{g_e^t}{\varphi} \left(\frac{\omega}{\eta} \mu \right)^{\frac{1}{\gamma}} \\ w_t &= \alpha \left(\frac{1-\alpha}{f} \right)^{1-\alpha} \hat{x}_t \\ Y_t &= \left(\frac{1-\alpha}{f} \right)^{1-\alpha} \hat{x}_t \\ \mu &= \frac{\xi}{\gamma \kappa \omega} \\ \eta &= \frac{\gamma(1-\alpha) - 1}{\gamma f}\end{aligned}$$

Economy grows by g_e

Characterizing BGP: levels

$$\mu = \frac{\xi}{\gamma \kappa \omega}$$

$$\hat{x}_t = \frac{g_e^t}{\varphi} \left(\frac{\omega}{\eta} \mu \right)^{\frac{1}{\gamma}}$$

$$w_t = \alpha \left(\frac{1 - \alpha}{f} \right)^{1 - \alpha} \hat{x}_t$$

$$Y_t = \left(\frac{1 - \alpha}{f} \right)^{1 - \alpha} \hat{x}_t$$

$$\eta = \frac{\gamma(1 - \alpha) - 1}{\gamma f}$$

- ▶ As κ decreases
 - ▶ More potential entrants pay to draw efficiency
 - ▶ More-efficient firms enter and aggregate income increases

quantitative exercise

Entry cost reform

1. Calibrate model to U.S. (high BGP)
 - ▶ No policy distortions in entry costs
 - ▶ $\kappa_{US} = \kappa^T$
2. Model a distorted country on a lower balanced growth path
 - ▶ Income level is 15 percent lower than U.S.
 - ▶ $\kappa_D = \kappa^T + \kappa^P$
 - ▶ $\kappa_D = 5 \times \kappa_{US}$
3. Reform entry costs in distorted country to U.S. level
 - ▶ Solve for transition to higher balanced growth path

Measuring capital

- ▶ Fixed costs (κ, f) are investments (new approach)
- ▶ How are they accounted for
 - ▶ In the firm's accounts?
 - ▶ In the national accounts?

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- ▶ How are they accounted for
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 - ▶ In the national accounts?
- ▶ Aggregate investment = $\mu_t \kappa_t + \eta_t f_t$
- ▶ Depreciation is the sum of
 - ▶ Capital of firms that die or exit
 - ▶ κ_t of potential entrants that do not enter
 - ▶ f_t minus costs of upgrading capital for continuing firms

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 - ▶ f_t minus costs of upgrading capital for continuing firms
- ▶ Aggregate capital stock = $\eta_t (\kappa_t + f_t)$
- ▶ Depreciation rate constant on BGP, not in transition

Measuring capital

- ▶ Alternatives we are considering
- ▶ In the model
 - ▶ κ_t, f_t scale with g_e^t rather than Y_t
 - ▶ Policy distortions are ad valorem, $\kappa^T + \kappa^P = \tau \kappa^T$
- ▶ In the accounting
 - ▶ Some parts of κ and f are intermediate inputs
 - ▶ Expensed, rather than counted as investment

Measuring productivity

- ▶ Need model measurement consistent with data measurement
- ▶ Productivity z of firm with efficiency x

$$\begin{aligned}\log(z_t(x)) &= \log(y_t(x)) - \alpha \log(\ell_t(x)) - \alpha_{kt} \log(k_t) \\ &= \log(x) - \alpha_{kt} \log(k_t)\end{aligned}$$

- ▶ Capital share is given by

$$\alpha_{kt} = \frac{R_t K_t}{Y_t}$$

where $R_t = \frac{1}{q_t} - 1 + \delta_{kt}$

Calibration

Calibrate model to match size distribution of plants as well as effect of net entry on aggregate productivity growth.

Calibrated parameters

- ▶ Model period is 5 years
- ▶ Data from United States

Parameter	Value	Target
Operating cost f	0.32×5	average establishment size = 16.0
Entry cost κ	0.26	entry cost / fixed cost* = 0.82
Pareto parameter γ	10.08	establishment size s.d. = 91.2
Firm growth $\bar{g}^{1/(1-\varepsilon)}$	$(1.017)^5$	effect of net entry on growth [†] = 25%
Death rate δ	$1 - (0.97)^5$	exiting plant employment share [‡] = 17.7%
Entrant productivity g_e	$(1.02)^5$	BGP growth factor = 1.02
Discount factor β	$(0.98)^5$	4 percent real interest rate
Returns to scale α	0.8	Atkeson and Kehoe (2005)

*Survey in Barseghyan and DiCecio (2011); [†]Foster et al. (2001); [‡]Dunne et al. (1989)

Technological spillovers

- ▶ Take logs of equation that characterizes spillovers

$$\log g_{ct} = \log \bar{g} + \varepsilon \log g_t$$

- ▶ We estimate this equation as follows

$$\log g_{ct,i} = \beta_0 + \varepsilon \log g_{it} + v_{it}$$

- ▶ $g_{ct,i}$ is weighted productivity growth of continuing plants in i
- ▶ g_{it} is weighted productivity growth of entire industry i
- ▶ Estimate using Chile and Korea data (would like U.S. data)
- ▶ Average estimate: $\varepsilon = 0.52$

Solving for transition path

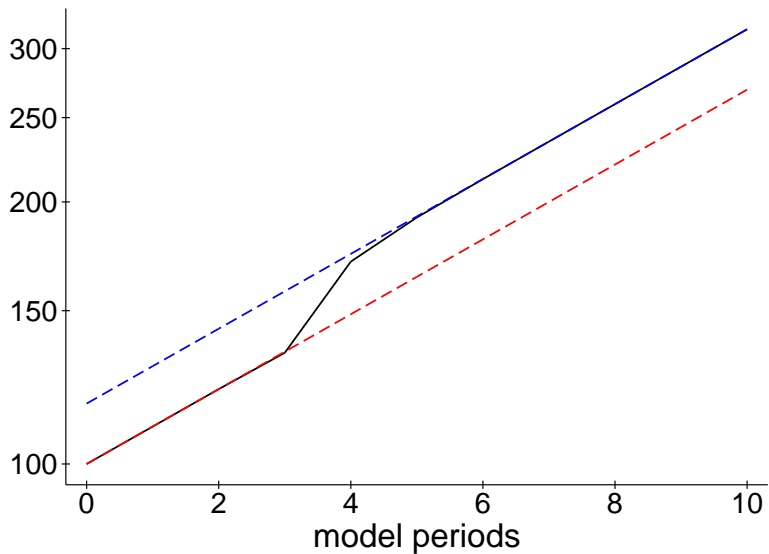
- ▶ Unanticipated reform at $t = t_0$: $\kappa_D = \kappa_{us}$
- ▶ System of $2T$ equations and $2T$ unknowns for large T
 - ▶ Labor market clearing

$$\hat{x}_t^\gamma = \frac{g_e^{\gamma t}}{\eta} \sum_{i=1}^N \varphi_{t-i+1}^{-\gamma} \mu_{t-i+1} (1-\delta)^{i-1} g_e^{\gamma(1-i)} \prod_{s=1}^{i-1} g_{c,t-s+1}^\gamma$$

- ▶ Costly entry condition

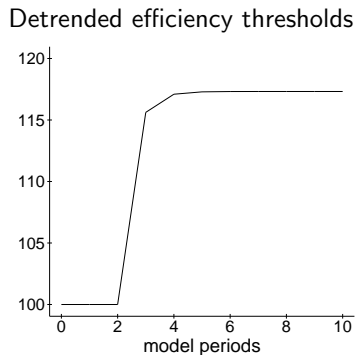
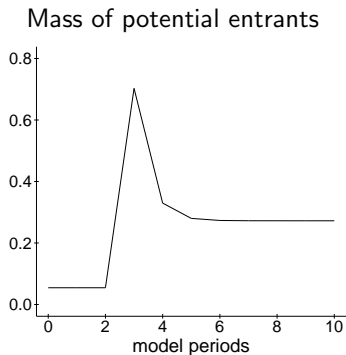
$$\kappa_t = \frac{g_e^{\gamma t}}{\gamma \eta} \varphi_t^{-\gamma} \sum_{i=1}^N (1-\delta)^{i-1} \left(\prod_{s=1}^{i-1} q_{t+s} g_{c,t+s}^\gamma \right) \frac{w_{t+i-1}}{\alpha} \hat{x}_{t+i-1}^{-\gamma}$$

Output per worker



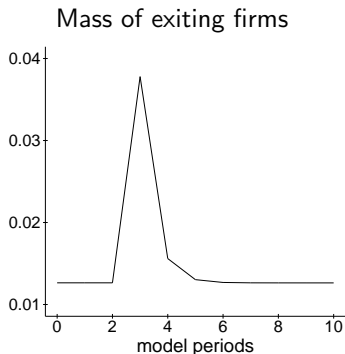
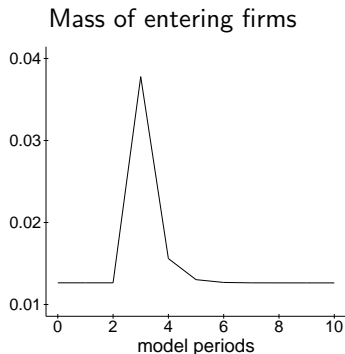
Transition: more potential entrants

- ▶ More potential entrants increases efficiency thresholds



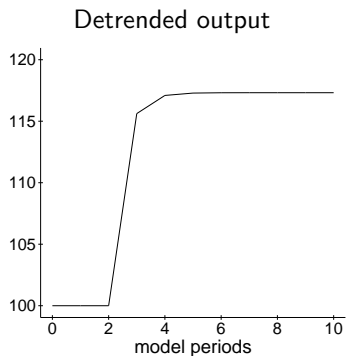
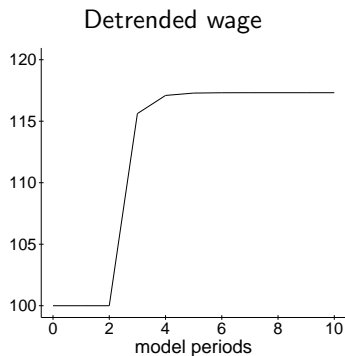
Transition: more entry and exit

- ▶ Efficient firms enter, inefficient firms exit
- ▶ Total mass of firms is constant



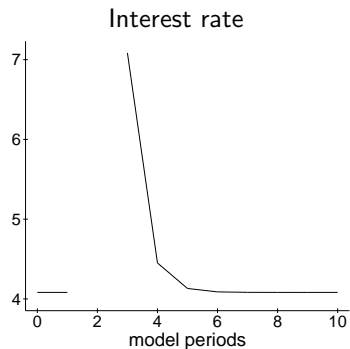
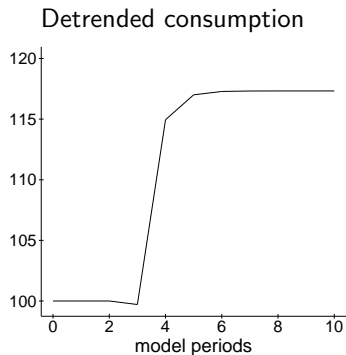
Transition: wages and output

- ▶ Higher wages increase efficiency thresholds
- ▶ More efficient firms increase output



Transition: consumption and interest rates

- ▶ More attractive investment opportunities



Productivity growth decompositions

Model periods (5 years)	Entry Cost	Output growth (%, annualized)	Contribution of net entry (%)
0-2	1.32	2.0	25.0
3 (reform)	0.26	5.0	78.3
4	0.26	2.3	33.5
5	0.26	2.0	26.3
6+	0.26	2.0	25.0

Net entry and productivity in model and data

- ▶ Model generates quantitatively reasonable numbers

	Model reform	Data rapid	Model BGP	Data slow
GDP/WAP growth (%)	5.0	6.3	2.0	2.6
Contribution of net entry (%)	78.3	54.0	25.0	26.0

- ▶ Calibration and experiment need further work

Reforming barriers to technology adoption

- ▶ A reform that does not involve entry costs
- ▶ Potential entrants draw efficiency from

$$F_t(x) = 1 - \left(\frac{\varphi x}{g_e^t} \right)^{-\gamma}, \quad x \geq \frac{g_e^t}{\varphi}$$

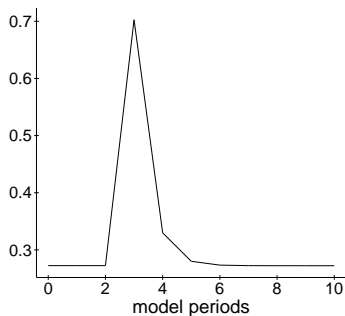
$\varphi \geq 1$: policy-induced barriers to technology adoption

- ▶ Set φ so that distorted BGP is 15 percent lower than U.S.
- ▶ Reform φ to generate a transition to higher BGP

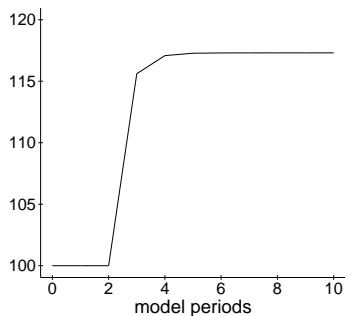
Transition: more potential entrants

- ▶ More potential entrants only in the transition
- ▶ Efficiency thresholds increase

Mass of potential entrants

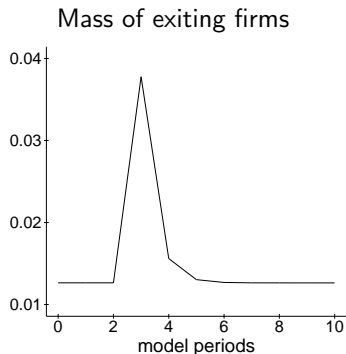
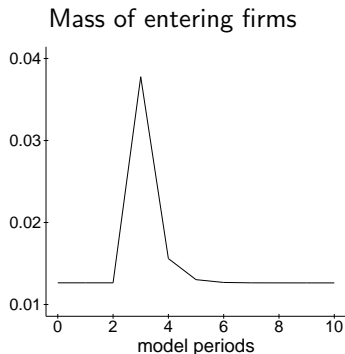


Detrended efficiency thresholds



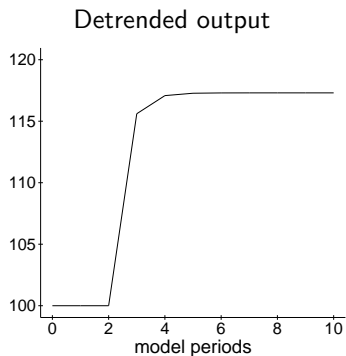
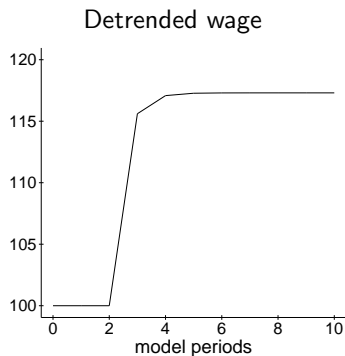
Transition: more entry and exit

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- ▶ Total mass of firms is constant



Transition: wages and output

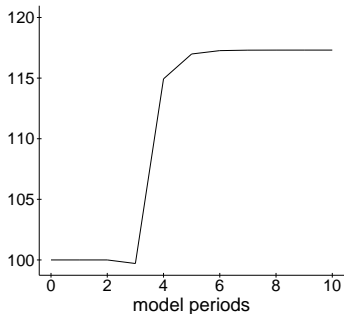
- ▶ Higher wages increase efficiency thresholds
- ▶ More efficient firms increase output



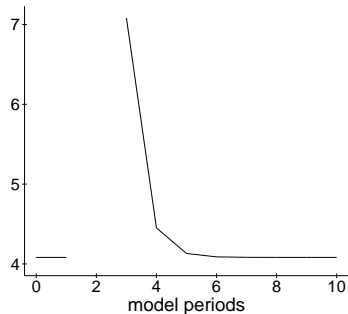
Transition: consumption and interest rates

- ▶ More attractive investment opportunities

Detrended consumption



Interest rate



Productivity growth decompositions

Model periods (5 years)	Barrier to tech. adoption	Productivity growth (%, annualized)	Contribution of net entry (%)
0-2	1.17	2.0	25.0
3 (reform)	1.00	5.0	78.2
4	1.00	2.3	33.5
5	1.00	2.0	26.2
6+	1.00	2.0	25.0

- ▶ Almost identical to reform in entry cost

Reform and growth

- ▶ Reforms that increase aggregate productivity
 - ▶ Increase entry and exit in the transition
 - ▶ Increase the contribution of net entry
- ▶ Need models of entry and exit to understand productivity