How Destructive is Innovation?

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Literature

- Polar models in the endogenous growth literature:
  - Creative destruction
    - Grossman & Helpman (1991), Aghion & Howitt (1992)
  - Creation of new varieties
    - Romer (1990)
  - Own-variety improvements
    - Lucas (1988), Acemoglu (2009)

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- Empirical literature with accounting decompositions:
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- We consider **all three channels** in an exogenous growth model and try to infer their contribution from **data on U.S. manufacturing plants**

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- Why do we care?
  - optimal innovation policy depends on knowledge spillovers vs. business stealing, which differ across channels.

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- Data: U.S. Census of manufacturing plants (1963-2002)
- To infer the forces driving plant growth, match model and data moments:
  - growth rate of aggregate TFP
  - exit rate by age
  - employment by age
  - growth in the number of plants
  - exit rate by size (employment)
  - distribution of employment growth
  - distribution of employment

Main findings

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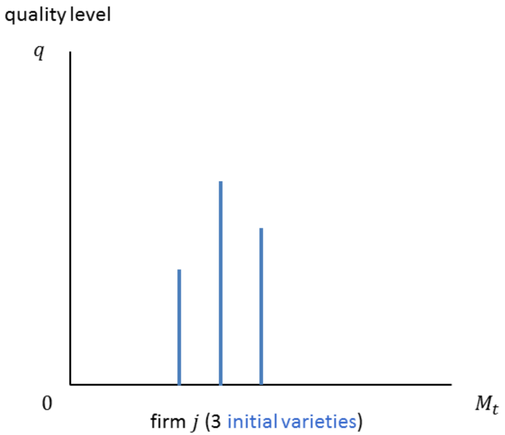
  1. incumbents $\gg$ entrants
  2. quality improvements $\gg$ new varieties
  3. own innovation $>$ creative destruction

Model: innovation channels



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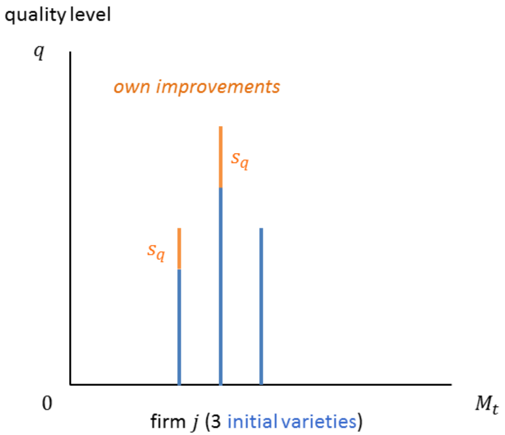

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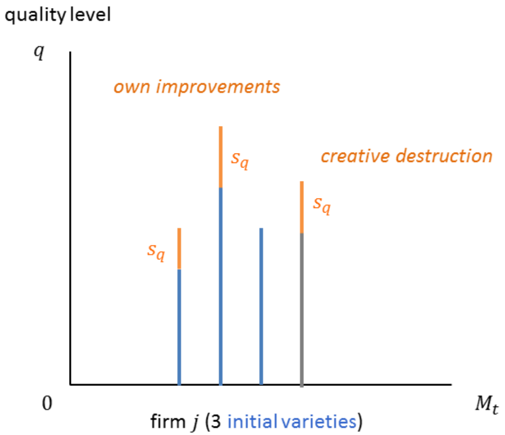

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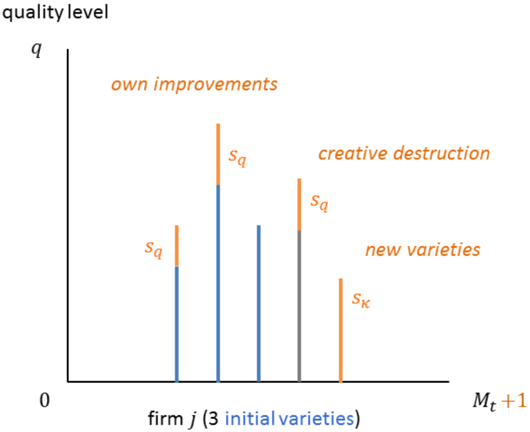

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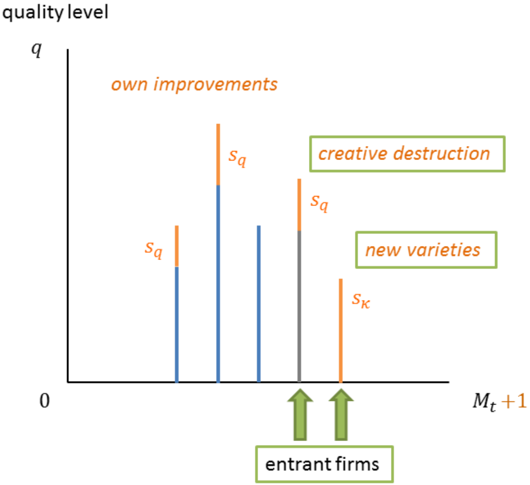

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  - Undirected innovation by entrants and incumbents
  - Only factor of production is labor
  - Monopolistic competition, CES σ
    $\Rightarrow$ employment, profits and revenues proportional to sum of $q^{\sigma-1}$ for a firm
    $\Rightarrow$ **employment growth is proportional to innovation**

Model: production

- Variety-level:

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- Firm-level:

$$Y_f = \frac{\sum_{j=1}^{M_f} p_j \, y_j}{P}$$

- Aggregate:

$$Y = \left[\sum_{j=1}^{M} (q_j \, y_j)^{1-1/\sigma} \right]^{\frac{\sigma}{\sigma-1}}$$

Model: innovation channels

- We add creation of new varieties and own-variety improvements:

channel	probability	step size
own-variety improvements by incumbents	λ_i	$s_\lambda \geq 1$
creative destruction by entrants	δ_e	$s_\delta \geq 1$
creative destruction by incumbents	δ_i	$s_\delta \geq 1$
new varieties from entrants	κ_e	s_κ
new varieties from incumbents	κ_i	s_κ

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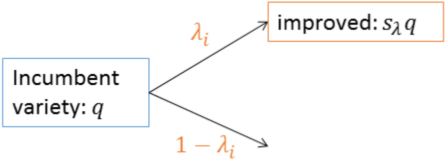
Note 2: For stationarity, potentially directed creative destruction (ρ_i and ρ_e).

Model: innovation channels

Incumbent
variety: q

Model: innovation channels



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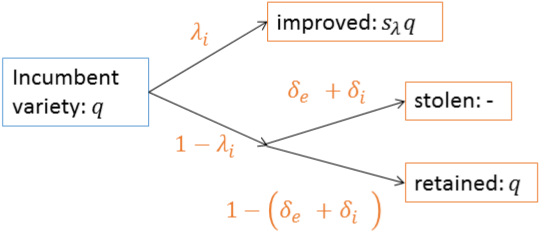

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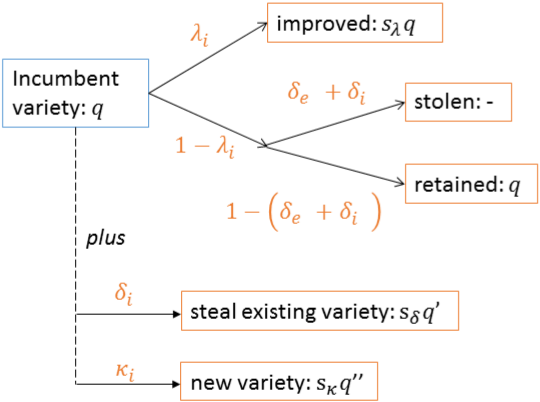

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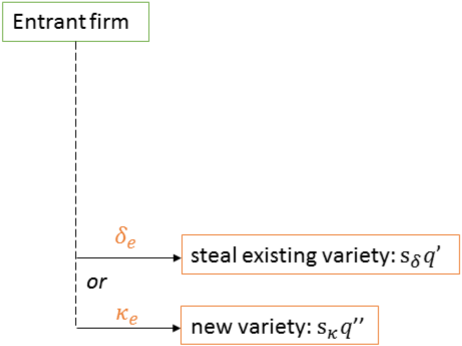

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3. Iterate until the size distribution converges to a steady state
4. Iterate on parameter values to minimize distance between the simulated moments and the data moments

Results: parameters

channel	probability	step size
own-variety improvements by incumbents	29.0%	1.058
creative destruction by entrants	6.2%	1.010
creative destruction by incumbents	76.6%	1.010
new varieties from entrants	0.5%	1.000
new varieties from incumbents	0.0%	1.000

Model: contributions to growth

- Aggregate Productivity:

$$Y_t/L_t = M_t^{\frac{1}{\sigma-1}} \left[\frac{\sum_{j=1}^{M_t} q_{j,t}^{\sigma-1}}{M_t} \right]^{\frac{1}{\sigma-1}}$$

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- Aggregate growth rate:

$$1 + g_{Y/L} = \left[(1 + \kappa_e + \kappa_i)(1 + g_q) \right]^{\frac{1}{\sigma-1}}$$

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where

$$1 + g_q = \frac{s_\kappa^{\sigma-1}\kappa_e + s_\kappa^{\sigma-1}\kappa_i + 1 + \left(s_q^{\sigma-1} - 1\right)\lambda_i + \left(s_q^{\sigma-1} - 1\right)(1 - \lambda_i)(\rho_e\delta_e + \delta_i)}{1 + \kappa_e + \kappa_i}$$

Results: contributions to growth

	entrants	incumbents	
creative destruction	2.6%	34.1%	36.7%
creation of new varieties	9.5%	0.0%	9.5%
own-variety improvements	-	53.8%	**53.8%**
	12.1%	**87.9%**	

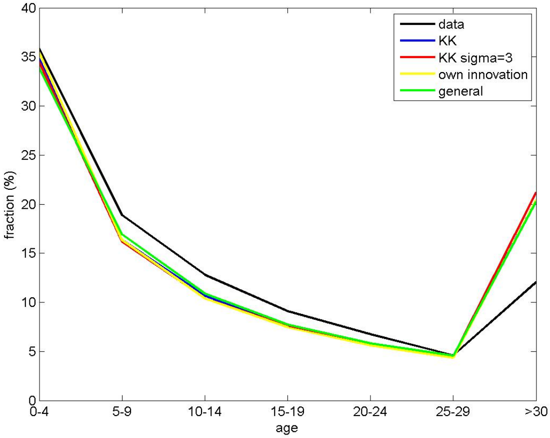
Simulated models

- Sequentially depart from KK to arrive at general model:

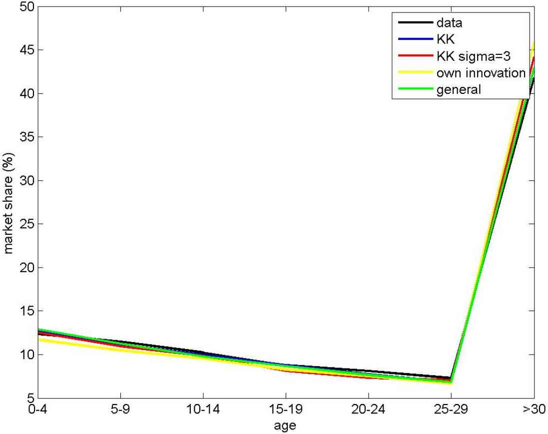
	KK	**KK 3**	**New Varieties**	**Own Innov.**	**General**
σ	1	3	3	3	3
creative destruction by entrants	$\surd$	$\surd$	$\surd$	$\surd$	$\surd$
creative destruction by incumb.	$\surd$	$\surd$	$\surd$	$\surd$	$\surd$
new varieties from entrants			$\surd$	$\surd$	$\surd$
new varieties from incumb.			$\surd$	$\surd$	$\surd$
own-variety improvements by incumb.				$\surd$	$\surd$
(partially) directed innovation					$\surd$

parameters in other models

Model fit: fraction of firms by age



Model fit: employment share by age



Model exit rate

A firm with a single variety exits if all of these things happen:

- does not improve its own variety
- loses its own variety to another incumbent or to an entrant
- does not create a brand new variety
- does not creatively destroy another firm's variety

$$(1-\lambda_i)(\delta_e+\delta_i)(1-\kappa_i)(1-\delta_i(1-\lambda_i))$$

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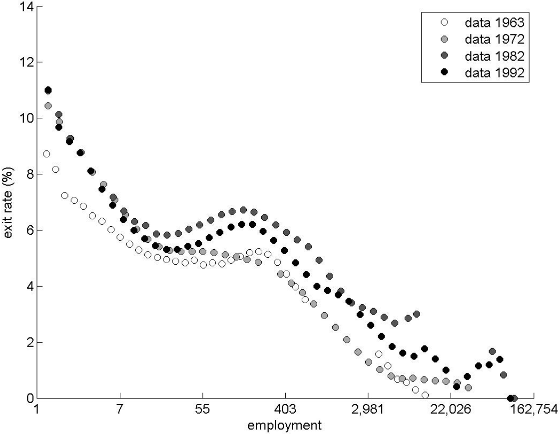
$$(1-\lambda_i)(\delta_e+\delta_i)(1-\kappa_i)(1-\delta_i(1-\lambda_i))$$

or

- current profits go below the overhead cost

Model fit: exit by size



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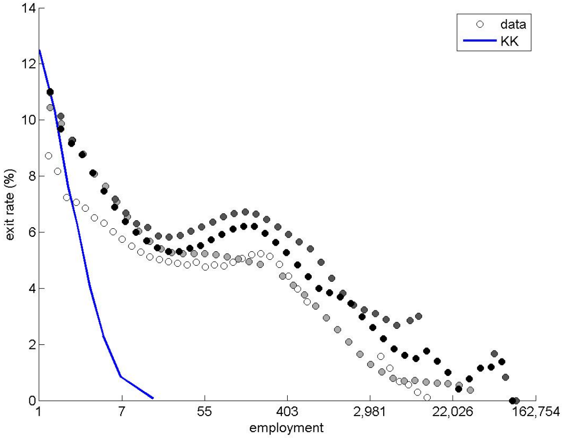

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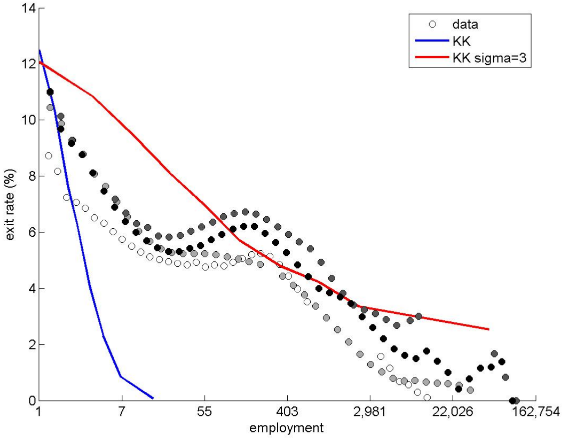

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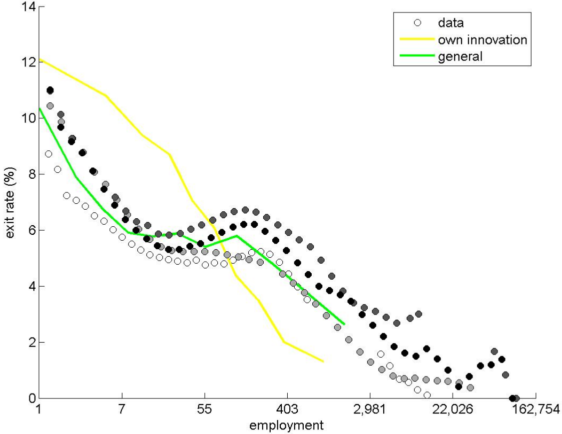
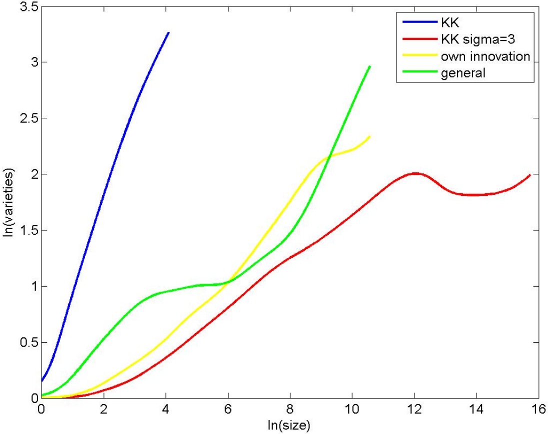
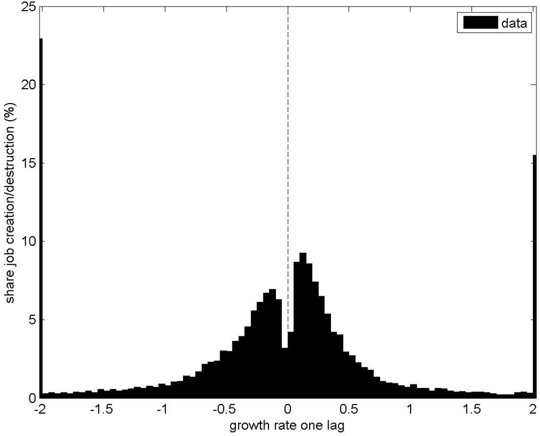


Model variety vs. size



Data: distribution of employment growth



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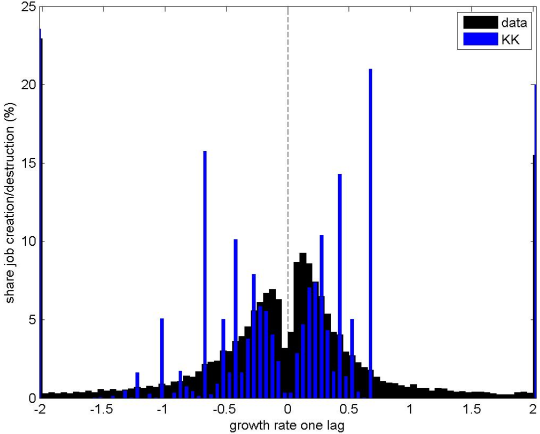

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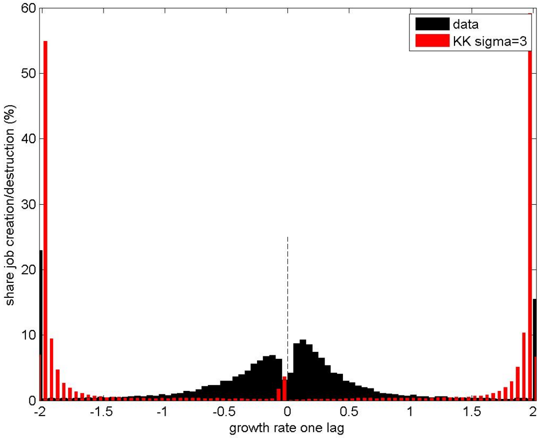

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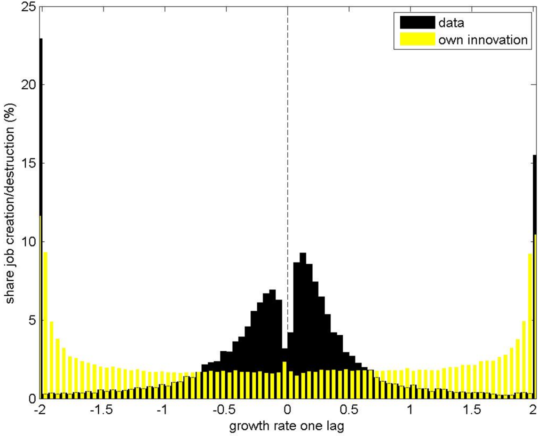

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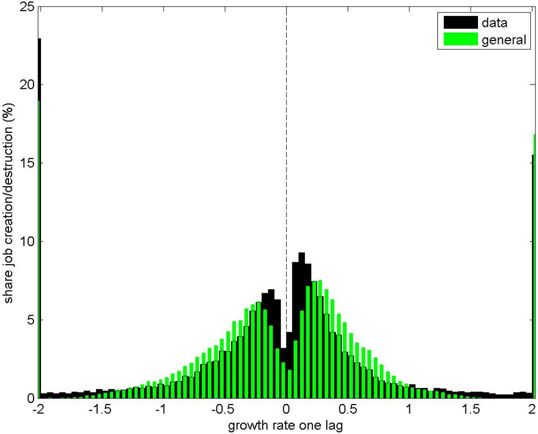
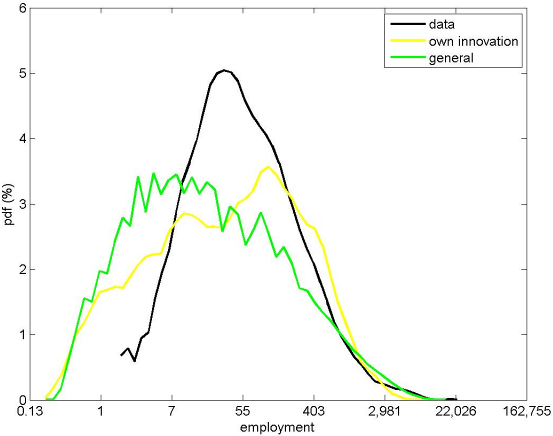


Model fit: distribution of firm size



Recap of main findings

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Work to be done

- Measure variety using the number of product categories
  - elasticity between 0.15 and 0.40 wrt *firm* size. Plants?
- Robustness to different specifications
  - correlated exit of varieties for each firm?
  - adjustment costs (especially for entrants)
- Repeat the estimation with data from China and India
  - Bigger contribution from entrants? More creative destruction?
  - In China: massive entry of private firms and exit of SOEs
- Repeat the estimation with data from other U.S. sectors
  - e.g. retail trade (Wal-Mart and Amazon)

Parameter values

	KK	KK 3	New varieties	Own innovation	General
λ_i	-	-	-	35.5%	43.0%
δ_e	2.4%	2.3%	1.9%	3.3%	3.6%
δ_i	41%	41%	41%	41.6%	47.0%
s_q	1.058	1.057	1.051	1.035	1.032
κ_e	-	-	0.5%	0.5%	0.5%
κ_i	-	0.001%	0.001%	0.001%	0.001%
s_κ	-	1	1.051	0.980	0.980

back to slide