Heterogeneous Innovation and Intertemporal Productivity Choice

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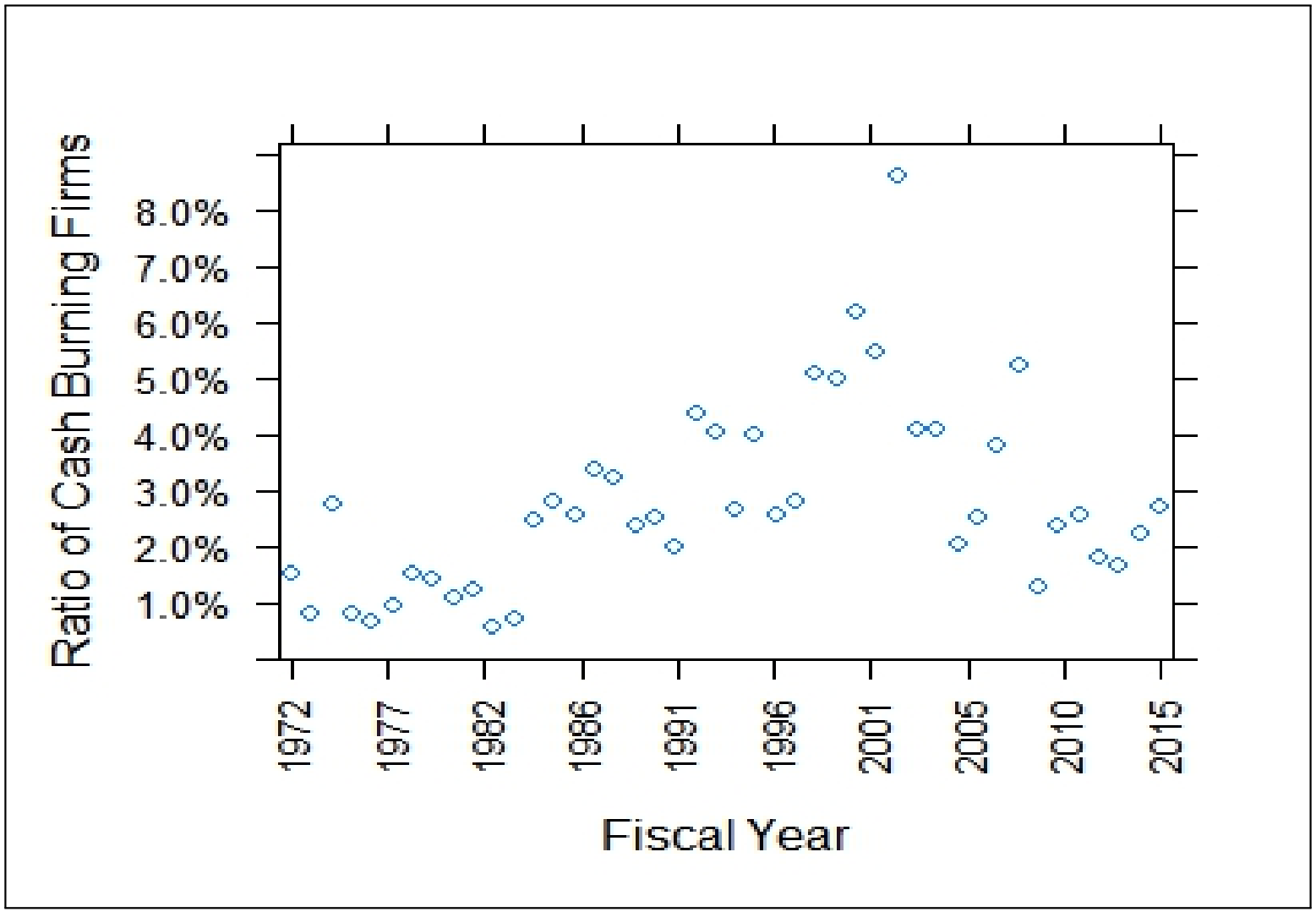
Research Motivation

Since the rebirth of endogenous growth in mid-2000s, literature became richer:

- Classics: Romer (1990), Grossman and Helpman (1991), Aghion and Howitt (1992);
- Micro-data renewal: Klette and Kortum (2004), Lentz and Mortensen (2008);
- Current state of the art: Acemoglu et al. (2013), Akcigit and Kerr (2016).

$\Rightarrow$ We now account for creative destruction/turnover, R&D spillover, imitation, incumbents' innovation, firm heterogeneity...but...

Research Motivation



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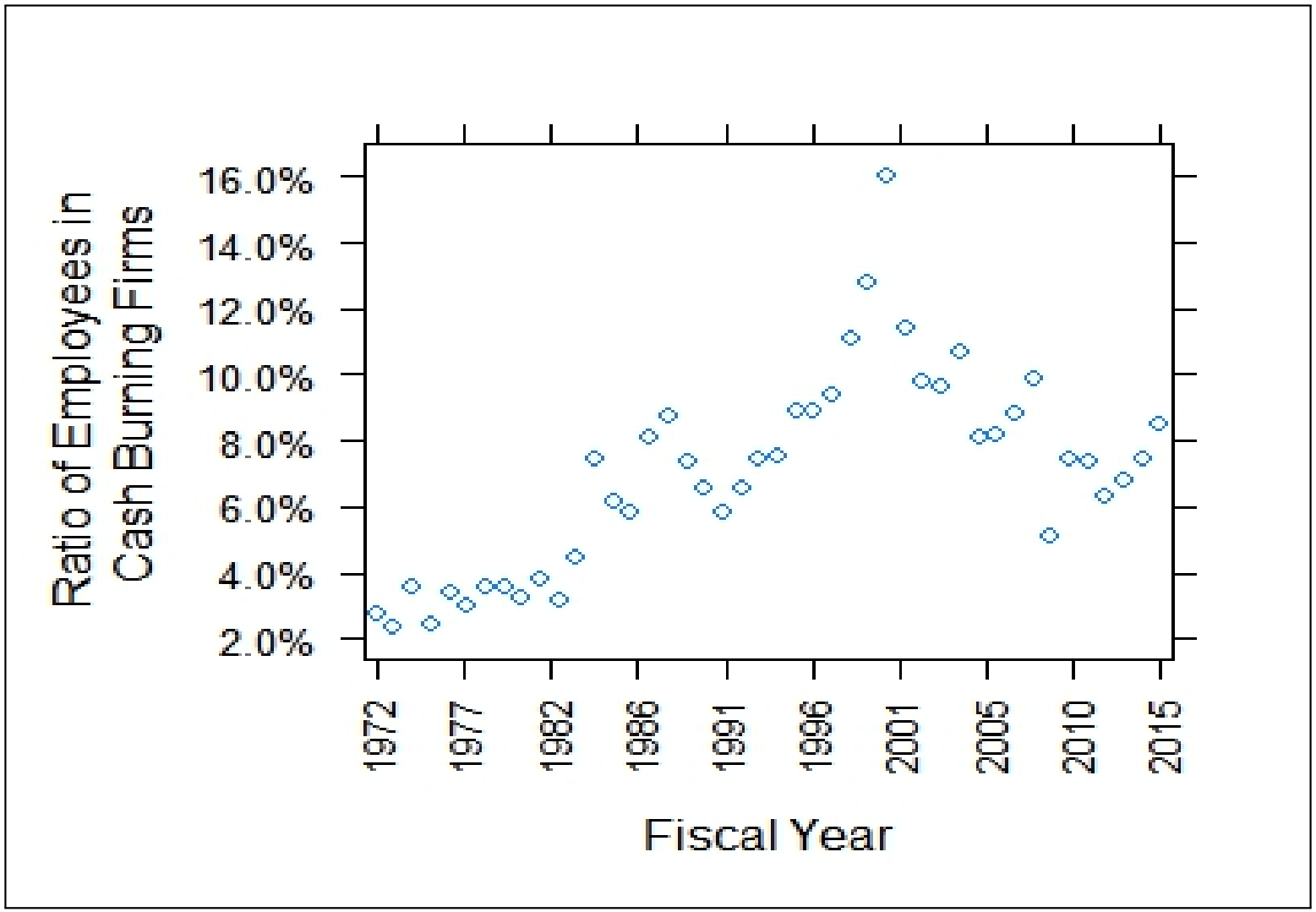


Research Motivation

TFP Distribution Test Results (Non-parametric Wilcoxon Test)

Distribution	Median	p-value
TFP Level		
Positive profits	3.205	2.241e-10
by sic	3.149	4.129e-11
Retail	3.485	1.366e-11
Weighted by employment		
by sic	3.145	1.116e-06
Industry	3.126	1.337e-04

Research Motivation

Questions:

- What's the impact of intertemporal TFP choice on aggregate TFP?
- What are the implications to the innovation strategy of firms?
- How long does it take to "get TFP back"?

Why is it interesting?

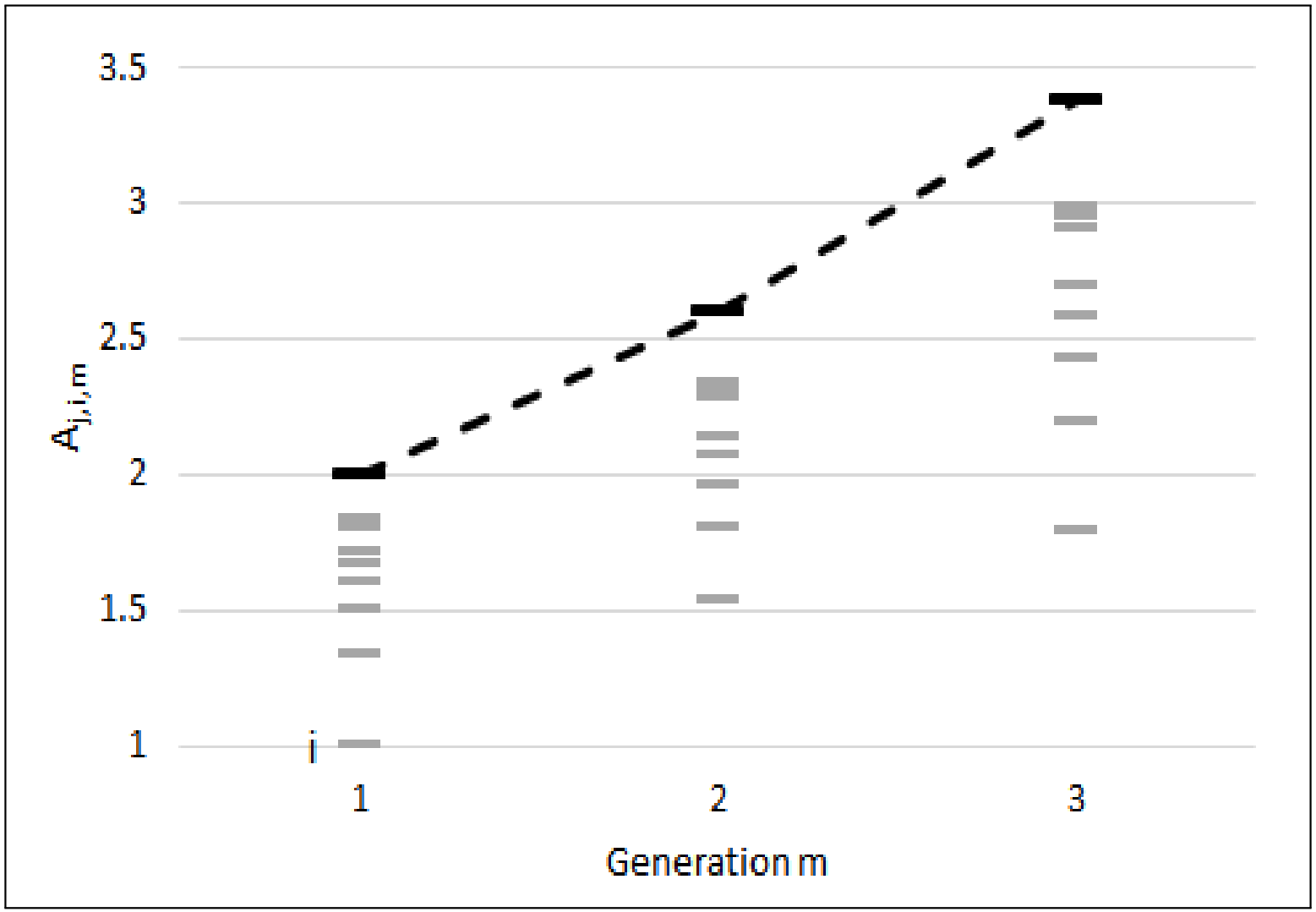
- Having Bluetooth in your car $\neq$ Tesla, or innovation heterogeneity sparks different firm behavior;
- Less TFP now for more TFP latter could impact aggregate measurement;
- Finance has a role in "footing the bill" and reallocation;
- Normative: how to spur abrupt innovation?

Framework

Starting point: Klette and Kortum (2004) + Aghion and Howitt (1992) + Grossman and Helpman (1991) (+ Akcigit and Kerr (2016)):

- Sectors: Consumers - Intermediate firms - Final good (used in R&D, price normalized to 1);
- Consumers have Cobb-Douglas preferences $\Rightarrow$ They spend the same share in each sector;
- Firms have a portfolio of n_p products;
- Labor (inelastic): can work in production or R&D (scientists), wage w;
- Innovation: internal (incremental or abrupt), external, and entrants (the last two only abrupt).

Framework



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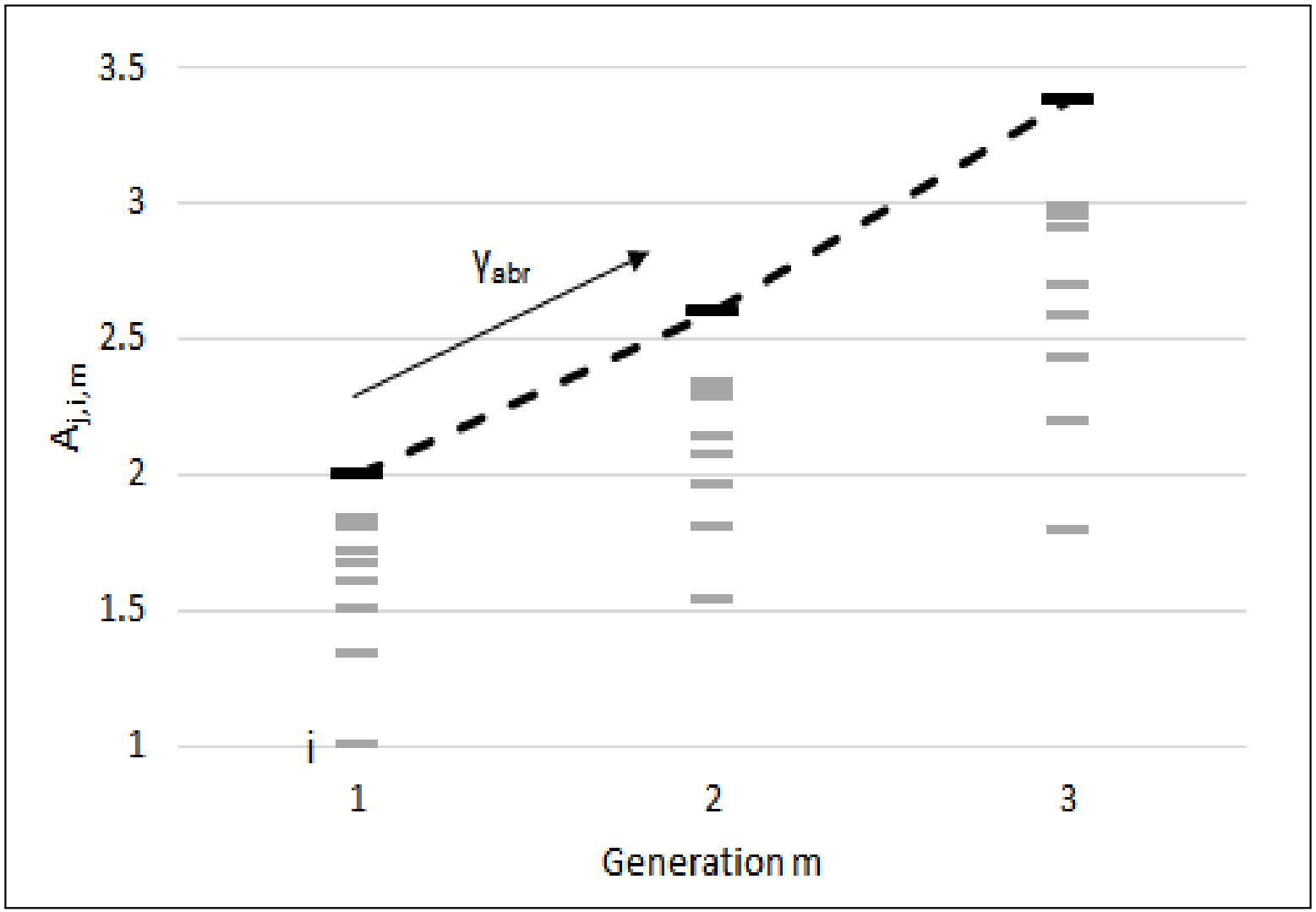

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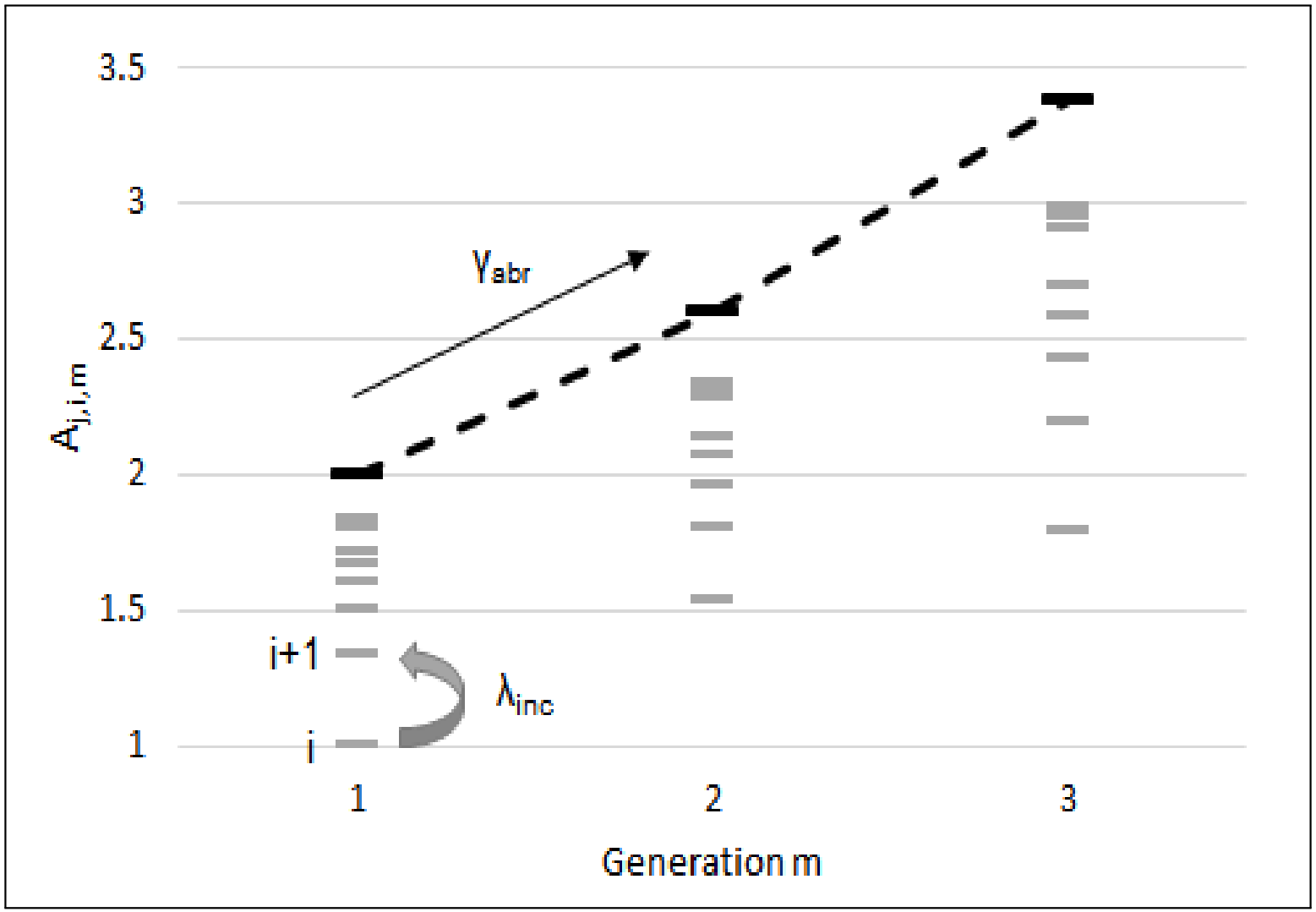

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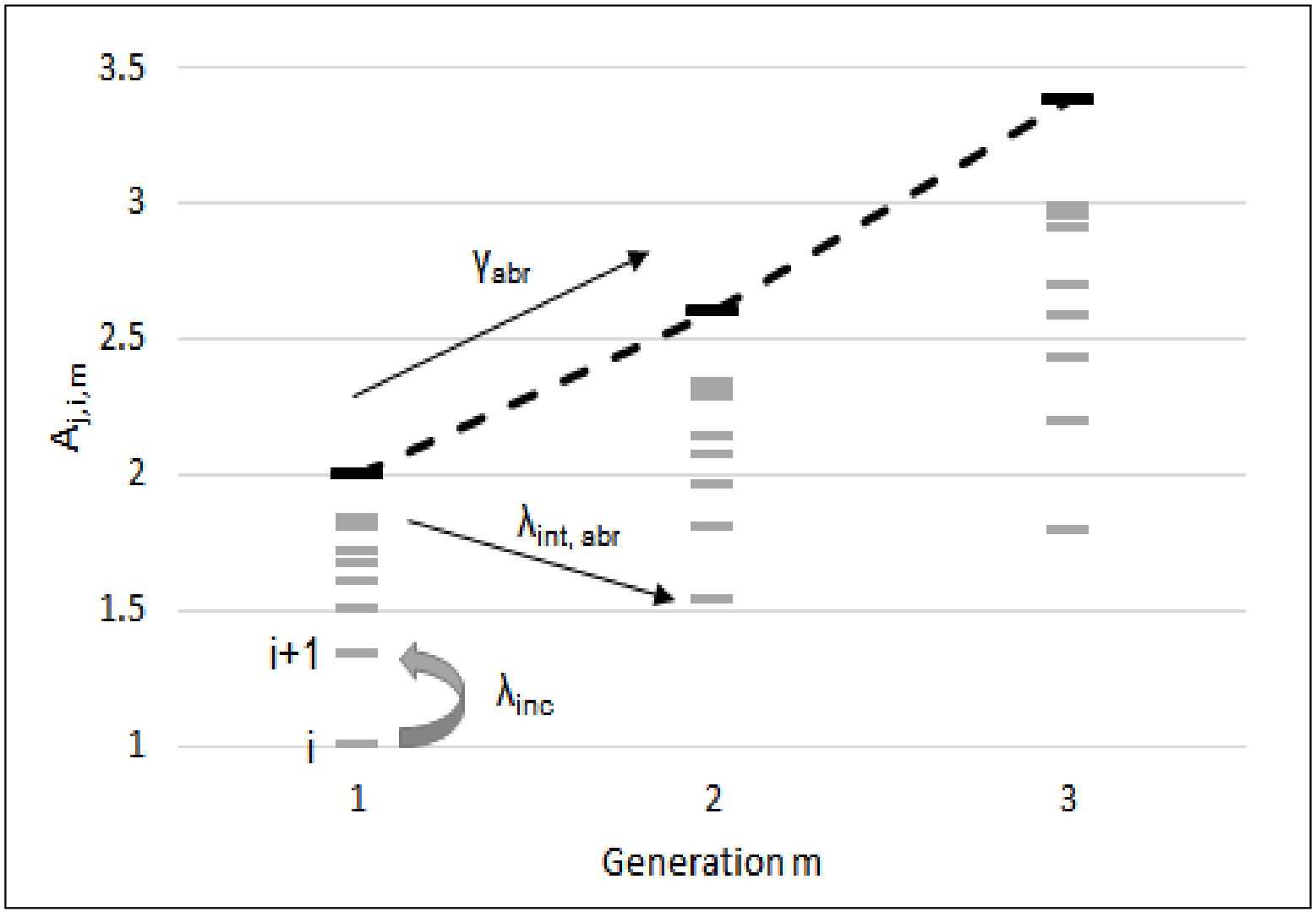
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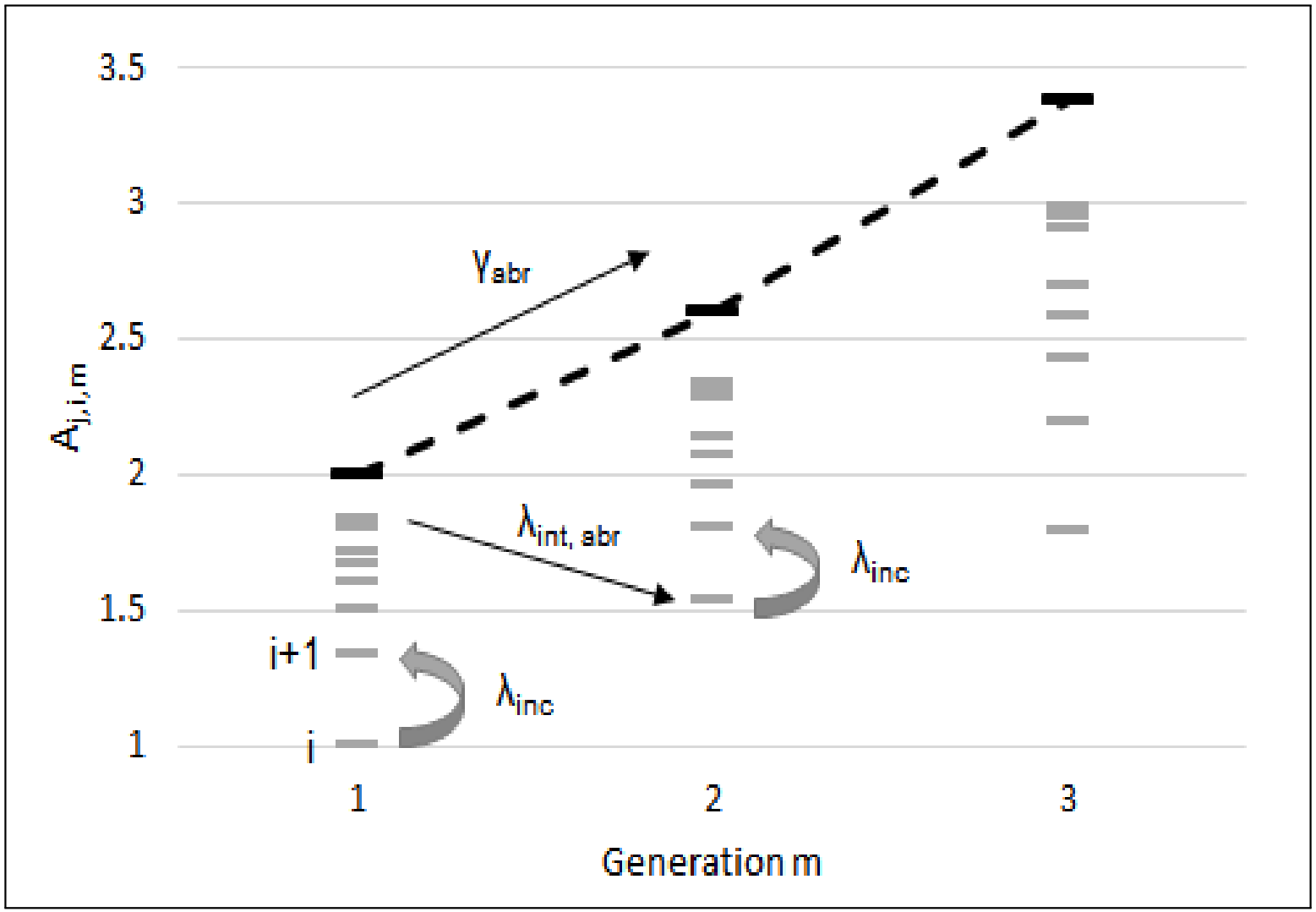
Generation m

Framework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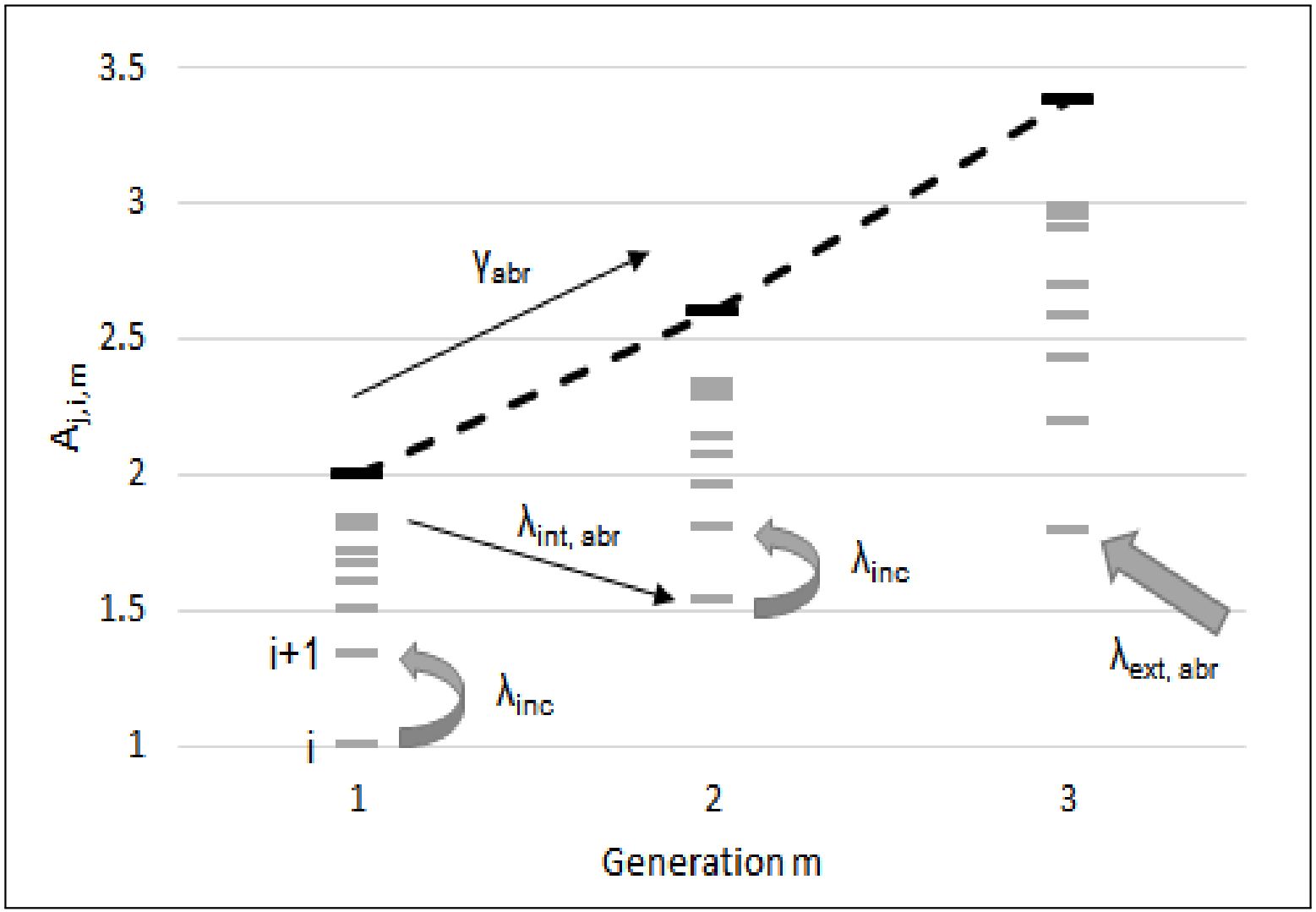
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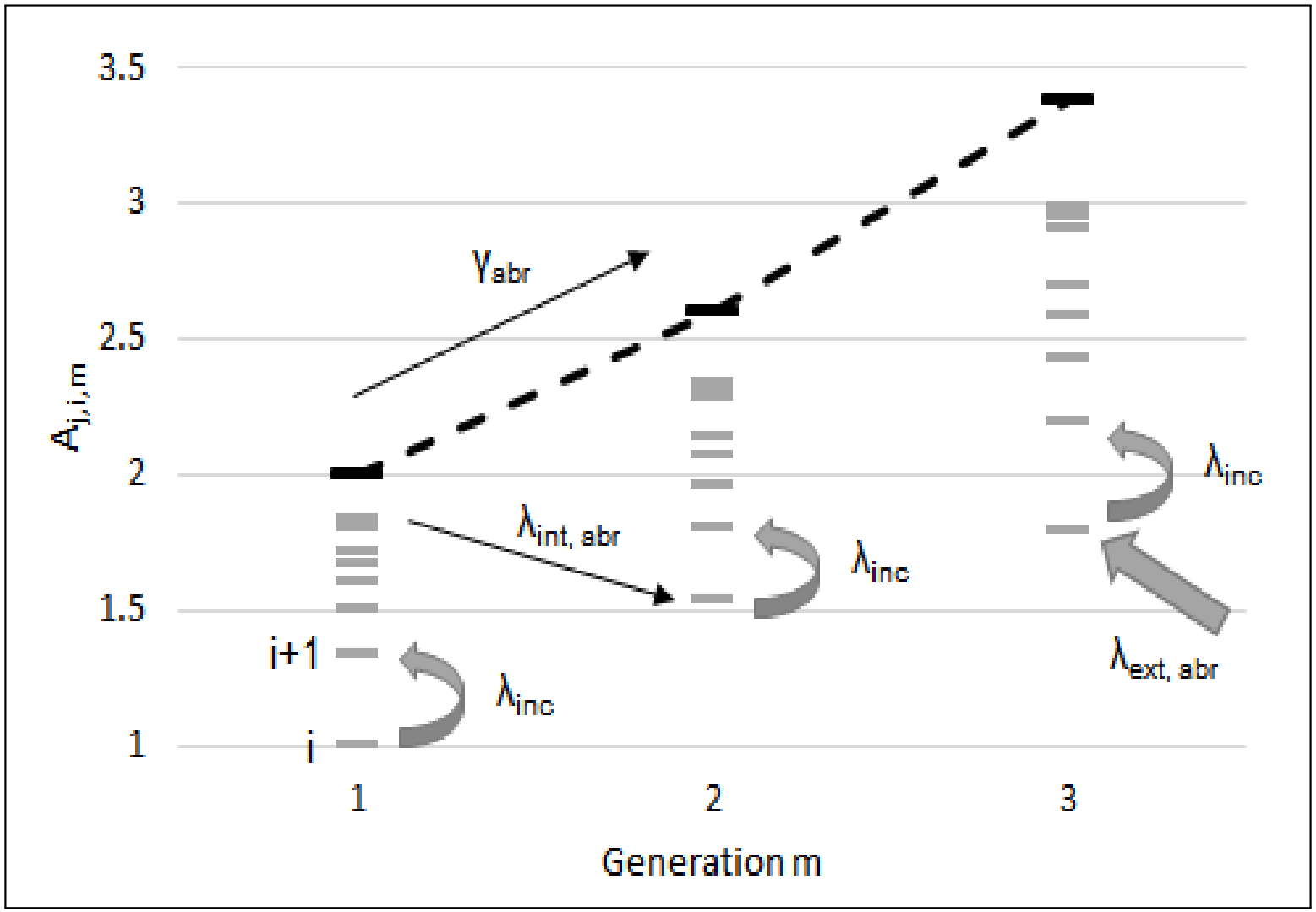
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Framework

- Law of motion: $A_{t+\Delta t} = \begin{cases} A_m \left[1 - \frac{(A_m - 1)}{A_m} \frac{1}{i}\right] \ , \ \lambda_{inc} \Delta t \\ A_t \gamma_{inc,abr} \ , \ \lambda_{int,abr} \Delta t \\ A_t \ , \ \left[1 - \lambda_{inc} \Delta t; 1 - \lambda_{int,abr} \Delta t\right] \end{cases}$
- Incremental R&D cost: $\psi_{inc}(\lambda_{inc}, A_t) = \xi_j A_t \lambda_{inc}^{\eta}$
- Catching-up: laggards pay $\psi_{inc}(\lambda_{inc}, A_t)$ and get an arrival $\lambda_{inc} + h$;
- Abrupt R&D cost (for $n_p > 0$): $\psi_{abr}(\lambda_{ext,abr}, \bar{A}_t) = \xi_j \bar{A}_t \lambda_{ext,abr}^{\eta}$, $\bar{A}_t$ sector average;
- Cournot competition: profits π_t scale with $\frac{A_{j,i,m}}{\sum_j A_{j,i,m}}$ within an industry.

Framework

Outside entrepreneur:

- Value function:
  $$rV_0 - \dot{V}_0 = \max_{\lambda_{ext,abr}} \left[\lambda_{ext,abr}\left[E_j\left[V(A_{t,m+1})\right] - V_0\right] - v\bar{A}_t\lambda_{ext,abr}\right]$$
- Cost: $C_E(\lambda_{ext,abr}, \bar{A}_t) = v\bar{A}_t\lambda_{ext,abr}$, v a constant;
- Free entry condition: $E_j\left[V(A_{t,m+1})\right] = v\bar{A}_t$
- $\Rightarrow$ Each firm faces an aggregate endogenous creative destruction (CE) of rate τ_{CE} and internal competition rate τ_I.

Framework

Incumbents:

- Value function: $rV(A_t) - \dot{V}(A_t) =$

$$\max_{\substack{\lambda_{inc},\, \lambda_{int,abr} \\ \lambda_{ext,abr}}} \left[\sum_{k}^{n_{j,p}} \left[\begin{array}{c} \pi_t n_{j,p} - \{\xi_j \lambda_{inc}^{\eta} A_{t,m}; \xi_j \bar{A}_t \lambda_{int,abr}^{\eta}\} \\ + \{\lambda_{inc}\left[V(A_{t,m}^{k-} \cup A_{t+\Delta t,m}^{k}) - V(A_{t,m})\right]; \\ \lambda_{int,abr}\left[E_j\left[V(A_{t,m}^{k-} \cup A_{t+\Delta t,m+1}^{k}\right] - V(A_{t,m})\right]\} \\ - \tau_I\left[V(A_{t,m} \setminus \bar{A}_{t+\Delta t,m}^{k}) - V(A_{t,m})\right] \\ - \tau_{CE}\left[V(A_{t,m} \setminus \bar{A}_{t+\Delta t,m+1}^{k}) - V(A_{t,m})\right] \end{array} \right] \right.$$
$$\left. + \lambda_{ext,abr}\left[E_j\left[V(A_{t,m}^{k} \cup A_{t+\Delta t,m+1}^{k'}\right] - V(A_{t,m})\right] - \xi_j \bar{A}_t \lambda_{int,abr}^{\eta} - \Phi \bar{A}_t \right]$$

- 1st: instant returns - costs;
- 2nd, 3rd: return from int. R&D;
- 4th: internal competition;
- 5th: external CE;
- 6th: return from abr. R&D;
- 7th: Abr. R&D and fixed costs;

Empirical Work

How to discipline $\{\gamma_{inc,abr}, \gamma_{ext,abr}, \lambda_{inc}, \lambda_{int,abr}, \lambda_{ext,abr}, \xi_j, \eta, h, v, \Phi\}$ (for now, focusing on Partial Equilibrium)?

- Compustat's firm-level data (e.g. financials, firm turnover, R&D expenditure);
- BLS industry series (to estimate labor costs);
- USPTO patent data (e.g. # patents, # patent citations, if it's self-citation or external...).

Conclusion

- Model (simple, KK case): can be solved analytically for predictions;
- Data: discipline the parameters (2x SMM) and test predictions;
- Answer some intriguing questions!
- Possibilities:
  - Solve the General Equilibrium (with elastic labor);
  - Add finance (e.g. HH finance new entrepreneurs);
  - Patent blocking competition.

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