When Does Procompetitive Entry Imply Excessive Entry?

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Introduction

- **Dixit-Stiglitz Monopolistic Competition under CES,** widely used as a building block in applied GE

- **Two remarkable (but knife-edge) features:**
  - **Markup Rate Invariance**, particularly with respect to market size of the sector
  - **Optimality of Free-Entry Equilibrium**, efficient resource allocation within an MC sector. (Intersectoral allocation is generally inefficient even if all sectors are CES.)

- Departure from CES could make equilibrium entry to the sector *either*
  - **Pro-** *or* **Anti-competitive**: Market expansion → more product varieties → **markup rate down or up**
  - **Excessive** *or* **Insufficient:** too many varieties produced too little *or* too few varieties produced too much

- What do we know about
  - The condition for pro- vs. anti-competitive entry?
  - The condition for excessive vs. insufficient entry?
  - The relation between the two conditions?

- Generally, all 2x2 = 4 combinations are possible.
  - Comparative static questions like "pro- vs. anti-competitive" hinge on the *local* property of the demand system
  - Welfare questions like "excessive vs. insufficient" hinge on the *global* property

But, there are some close connections between the two conditions.

- **Two Sources of Externalities in Entry** (Introduction of a new product variety)

  - **Negative externalities (business stealing)**, entry reduces the profit of other firms → excessive entry
  - **Positive externalities (imperfect appropriability),** entrants do not fully capture social surplus created → insufficient entry

CES: *one* of the demand systems under which the two sources of externalities exactly cancel out at any market size.

- Starting from the knife-edge CES benchmark, introducing

  - **Procompetitive effect** *amplifies* negative externalities (business stealing), tips the balance for **excessive entry**
  - **Anticompetitive effect** *mitigates* negative externalities (business stealing), tips the balance for **insufficient entry**

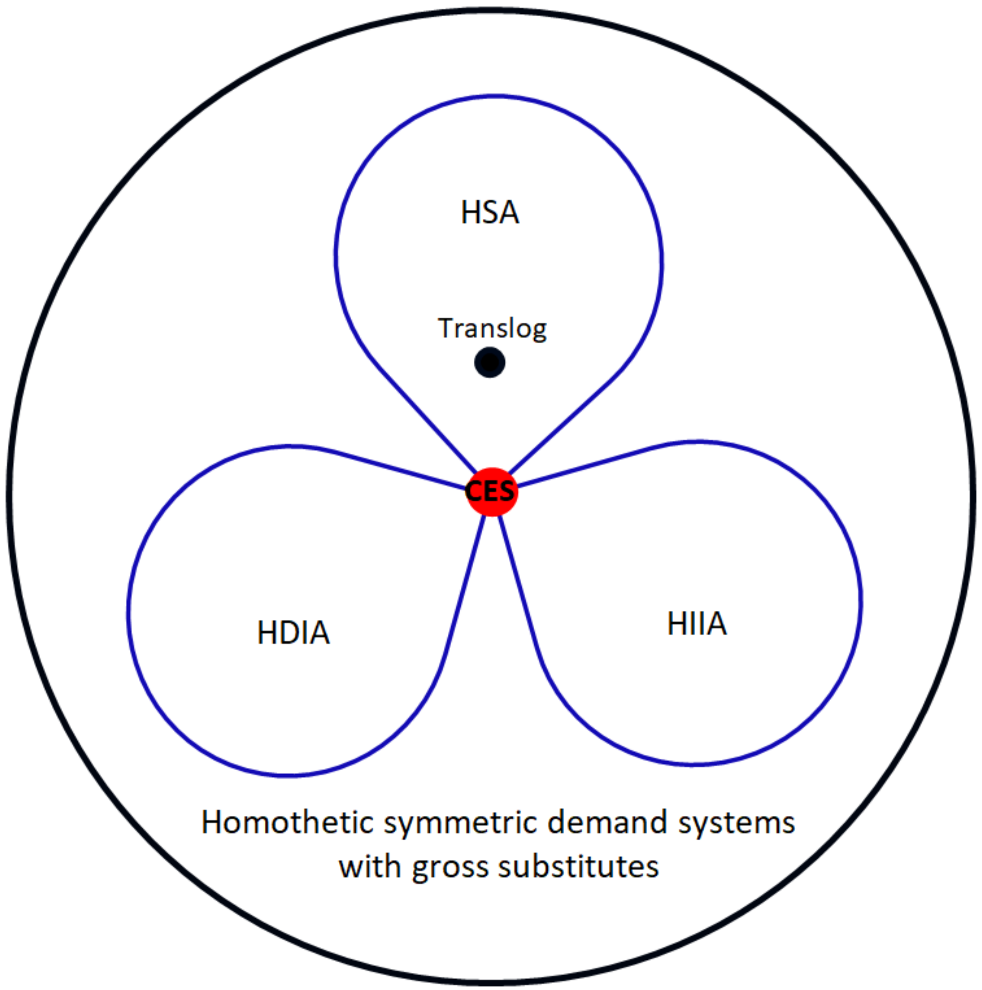
Only *suggestive,* because positive externalities (imperfect appropriability) may also be affected.

- That is why we ask: ***When (i.e., under what additional restrictions)***
  - Is procompetitive entry excessive?
  - Is anticompetitive entry insufficient?

Three Classes of Homothetic Demand Systems: Matsuyama-Ushchev (2017)

- **H.S.A.** (Homotheticity with a Single Aggregator)
- **HDIA (**Homotheticity with Direct Implicit Additivity)
- **HIIA (**Homotheticity with Indirect Implicit Additivity)

which are pairwise disjoint with the sole exception of CES.



Here, we apply these 3 classes to **the Dixit Stiglitz environment** by imposing
- **Symmetry**
- **Gross Substitutability**

across a **continuum** of product varieties.

The Dixit-Stiglitz Environment: A General Case

A Sector consists of

- **Monopolistic competitive firms:** produce a continuum of differentiated *intermediate inputs varieties*, $\omega \in \Omega$
  - Fixed cost of entry, F
  - Constant marginal cost, ψ

We can also allow multi-product MC firms, as long as they do not produce a positive measure of products.

- **Competitive firms:** produce a single good by assembling intermediate inputs, using **CRS technology**

CRS Production Function:

$$X = X(\mathbf{x}) \equiv \min_{\mathbf{p}} \left\{ \mathbf{px} = \int_{\Omega} p_\omega x_\omega d\omega \,\middle|\, P(\mathbf{p}) \geq 1 \right\}$$

Unit Cost Function:

$$P = P(\mathbf{p}) \equiv \min_{\mathbf{x}} \left\{ \mathbf{px} = \int_{\Omega} p_\omega x_\omega d\omega \,\middle|\, X(\mathbf{x}) \geq 1 \right\}$$

Duality Principle: Either $X = X(\mathbf{x})$ or $P = P(\mathbf{p})$ can be used as a primitive of the CRS technology, as long as linear homogeneity, monotonicity and quasi-concavity are satisfied.

Demand Curve for ω

$$x_\omega = X(\mathbf{x})\frac{\partial P(\mathbf{p})}{\partial p_\omega}$$

Inverse Demand Curve for ω

$$p_\omega = P(\mathbf{p})\frac{\partial X(\mathbf{x})}{\partial x_\omega}$$

Market Size of the Sector
taken as exogenous

$$\mathbf{px} = \int_\Omega p_\omega x_\omega d\omega = P(\mathbf{p})X(\mathbf{x})$$

Revenue Share of ω

$$s_\omega = \frac{p_\omega x_\omega}{\mathbf{px}} = \frac{p_\omega x_\omega}{P(\mathbf{p})X(\mathbf{x})}$$

$$s_\omega(p_\omega, \mathbf{p}) = \frac{\partial \ln P(\mathbf{p})}{\partial \ln p_\omega}; \quad s_\omega(x_\omega, \mathbf{x}) = \frac{\partial \ln X(\mathbf{x})}{\partial \ln x_\omega}$$

Price Elasticity of ω:

$$\zeta_\omega = -\frac{\partial \ln x_\omega}{\partial \ln p_\omega}$$

$$\zeta_\omega(p_\omega, \mathbf{p}) = 1 - \frac{\partial \ln\left(\frac{\partial \ln P(\mathbf{p})}{\partial \ln p_\omega}\right)}{\partial \ln p_\omega}; \quad \zeta_\omega(x_\omega, \mathbf{x}) = \left[1 - \frac{\partial \ln\left(\frac{\partial \ln X(\mathbf{x})}{\partial \ln x_\omega}\right)}{\partial \ln x_\omega}\right]^{-1}$$

Under general CRS, little restrictions on ζ_ω beyond the homogeneity of degree zero in $(p_\omega, \mathbf{p})$ or in $(x_\omega, \mathbf{x})$.
Under CES, ζ_ω is constant, independent of $(p_\omega, \mathbf{p})$ and of $(x_\omega, \mathbf{x})$.

(Symmetric) H.S.A., HDIA, and HIIA: Definitions & Key Properties

	$P(\mathbf{p})$ or $X(\mathbf{x})$	Revenue Share: s_ω	Price Elasticity: ζ_ω	For CES
H.S.A. in two equivalent representations	$\frac{P(\mathbf{p})}{cA(\mathbf{p})} = \exp\left[-\int_\Omega \left[\int_{p_\omega/A(\mathbf{p})}^{\bar{z}} \frac{s(\xi)}{\xi} d\xi\right] d\omega\right]$	$s\left(\frac{p_\omega}{A(\mathbf{p})}\right)$ with $\int_\Omega s\left(\frac{p_\omega}{A(\mathbf{p})}\right) d\omega \equiv 1$	$\zeta\left(\frac{p_\omega}{A(\mathbf{p})}\right) \equiv 1 - \left.\frac{zs'(z)}{s(z)}\right\rvert_{z=\frac{p_\omega}{A(\mathbf{p})}} > 1$	$\frac{P(\mathbf{p})}{A(\mathbf{p})} = \frac{A^*(\mathbf{x})}{X(\mathbf{x})} = const.$ $\Leftrightarrow$ $s(\cdot)$ or $s^*(\cdot)$ is a power function.
	$\frac{X(\mathbf{x})}{cA^*(\mathbf{x})} = \exp\left[\int_\Omega \left[\int_0^{x_\omega/A^*(\mathbf{x})} \frac{s^*(\xi)}{\xi} d\xi\right] d\omega\right]$	$s^*\left(\frac{x_\omega}{A^*(\mathbf{x})}\right)$ with $\int_\Omega s^*\left(\frac{x_\omega}{A^*(\mathbf{x})}\right) d\omega = 1$	$\zeta^*\left(\frac{x_\omega}{A^*(\mathbf{x})}\right) \equiv \left[1 - \left.\frac{ys^{*\prime}(y)}{s^*(y)}\right\rvert_{y=\frac{x_\omega}{A^*(\mathbf{x})}}\right]^{-1} > 1$	
HDIA Kimball	$\int_\Omega \phi\left(\frac{x_\omega}{X(\mathbf{x})}\right) d\omega \equiv 1$	$\frac{x_\omega}{C^*(\mathbf{x})}\phi'\left(\frac{x_\omega}{X(\mathbf{x})}\right)$ with $C^*(\mathbf{x}) \equiv \int_\Omega x_\omega \phi'\left(\frac{x_\omega}{X(\mathbf{x})}\right) d\omega$	$\zeta^D\left(\frac{x_\omega}{X(\mathbf{x})}\right) \equiv -\left.\frac{\phi'(y)}{y\phi''(y)}\right\rvert_{y=\frac{x_\omega}{X(\mathbf{x})}} > 1$	$\frac{C^*(\mathbf{x})}{X(\mathbf{x})} = const.$ $\Leftrightarrow$ $\phi(\cdot)$ is a power function.
HIIA	$\int_\Omega \theta\left(\frac{p_\omega}{P(\mathbf{p})}\right) d\omega \equiv 1$	$\frac{p_\omega}{C(\mathbf{p})}\theta'\left(\frac{p_\omega}{P(\mathbf{p})}\right)$ with $C(\mathbf{p}) \equiv \int_\Omega p_\omega \theta'\left(\frac{p_\omega}{P(\mathbf{p})}\right) d\omega$	$\zeta^I\left(\frac{p_\omega}{P(\mathbf{p})}\right) \equiv -\left.\frac{z\theta''(z)}{\theta'(z)}\right\rvert_{z=\frac{p_\omega}{P(\mathbf{p})}} > 1$	$\frac{C(\mathbf{p})}{P(\mathbf{p})} = const.$ $\Leftrightarrow$ $\theta(\cdot)$ is a power function.

with some additional restrictions on $s(\cdot)$ or $s^*(\cdot), \phi(\cdot), \theta(\cdot)$ for

- the integrability (i.e., monotonicity and quasi-concavity) of $P(\mathbf{p})$ or $X(\mathbf{x})$
- the gross substitutability to ensure the existence of the free-entry equilibrium.
- The uniqueness of the free-entry equilibrium

Appealing Features of These Three Classes

Homothetic:

- Without homotheticity, we would need to worry about the composition of market size.
- To *isolate* the efficiency effect of the markup rate response to market size, we need to avoid introducing the scale effect of market size due to nonhomotheticity
- can be given a cardinal interpretation, and hence useful for a *building block* in a *multi-sector* setting

Nonparametric: To avoid functional form restrictions.

But we have many parametric examples to illustrate our results in the paper.

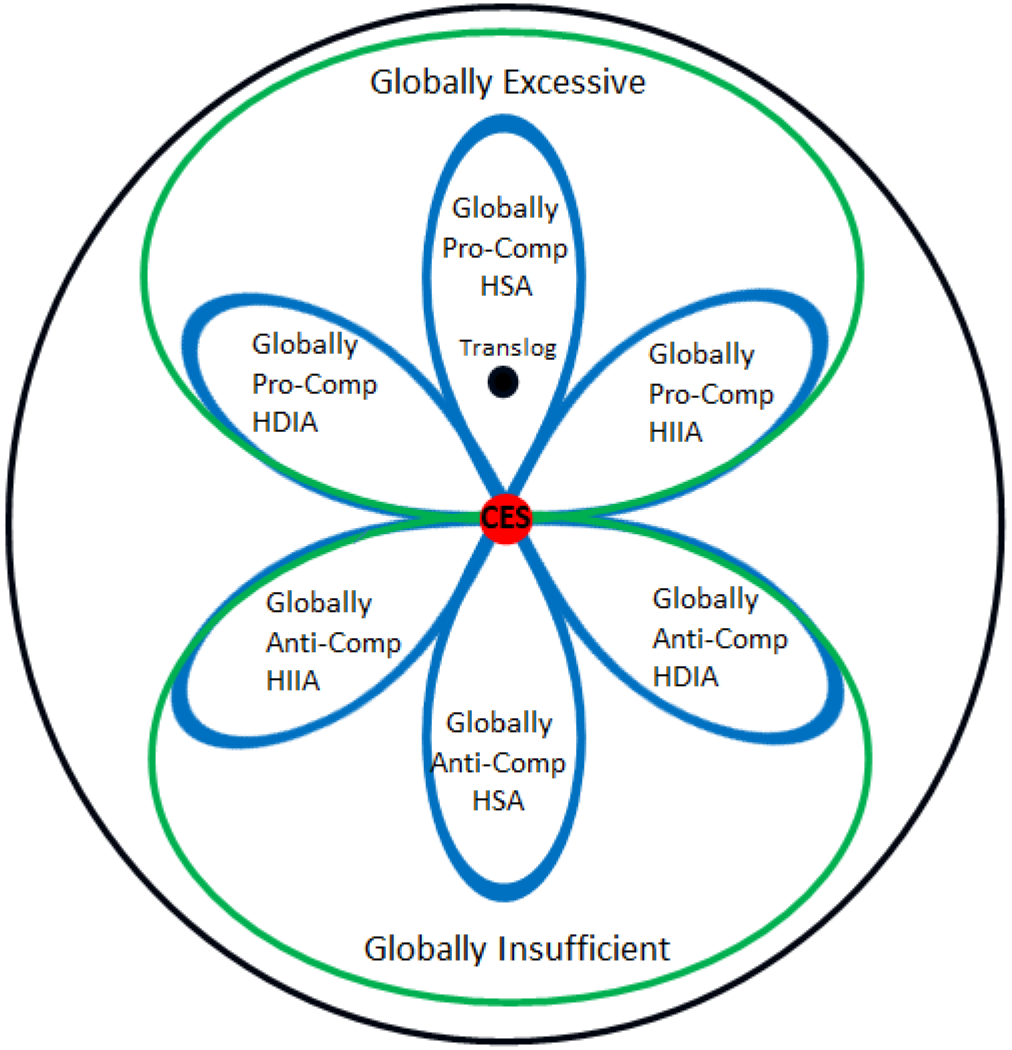
Sufficient-statistic property; tractable**,** because entry and pricing behavior of other firms affect

- Revenue share only through a single aggregator under H.S.A; and two aggregators under HDIA & HIIA
- Price elasticity only through a single aggregator under all three classes
    - A single aggregator captures the effect of competition on the markup rate.
    - Comparative statics results dictated by the derivative of the price elasticity function

which help to find

- The conditions that guarantee the ***existence*** and ***uniqueness*** of free-entry equilibrium for any given market size
- The condition for **procompetitive vs. anticompetitive**
- The condition for **excessive vs. insufficient**
- the relation between the last two conditions

Main Results: In each of these three classes,



- CES *uniquely* ensures the optimality of free entry equilibrium.
- Procompetitive Entry ⇔ Strategic complementarity ⇔ Marshall's 2nd Law (Incomplete Pass-Through)
  These equivalences do not hold in general, including many commonly used non-CES demand systems!!
- Two *sufficient* conditions
  - Entry is *globally* excessive (insufficient) if *globally* pro-competitive (anti-competitive); see Figure.
  - Entry is procompetitive & excessive for *a sufficiently large market size in the presence of the choke price.*

Cautionary Notes on interpreting these results

- We model a MC sector as a *building block in a multi-sector model*
  - We do *not* assume that an economy has only one MC sector.
  - The MC sector we model may coexist with other sectors, which may not have to be MC.
  - We study distortion of ***intra-sectoral*** allocation ***conditional*** on the size of the sector.
  - In a multisector setting, ***inter-sectoral*** allocation is generally distorted even if all sectors are MC under CES.
- Excessive entry result may not justify an entry restriction, ***in the presence of other sources of distortions.***

One Frequently Asked Question

What are the relative advantages of the three classes for applications?

We believe that H.S.A. has advantages over HDIA and HIIA, because

- **the revenue share function**, $s(\cdot)$, **is the primitive of H.S.A.** and hence it can be readily identified by typical firm level data, which has revenues but not output. Kasahara-Sugita (2020)

- **With free-entry,** easier to ensure the existence and uniqueness of equilibrium, to characterize the equilibrium and to conduct comparative statics under H.S.A., because

  - For H.S.A., the interaction across products operates through only one aggregator in each sector.
    - An easy characterization of the free-entry equilibrium, as it minimizes $A(\mathbf{p})$, not $P(\mathbf{p})$

  - For HDIA and HIIA, the interaction across products operates through two aggregators in each sector, creating more room for the *multiplicity* and *non-existence* of equilibrium.

Related Literature

Excessive entry in *homogeneous* good oligopoly: Mankiw-Whinston (1986), Suzumura-Kiyono (1987)

Macro Misallocation, starting with Hsieh-Klenow (2009)

MC under non-CES: Thisse-Ushchev (2018) for a survey

- Parenti-Thisse-Ushchev (2017) studied the uniqueness, symmetry, and the "pro- vs. anti-competitive" under **general symmetric demand** *but only under the conditions given in reduced form, not in the primitives.*
- **MC under *nonhomothetic* non-CES**, *Blue compare the equilibrium and optimum.*
  - DEA: $U = \int_{\Omega} u(x_{\omega})d\omega$. Dixit-Stiglitz (1977), Zhelobodko et.al.(2012), Mrazova-Neary(2017), Dhingra-Morrow (2019), Behrens et.al.(2020). Under DEA, markup rate unaffected by market expansion through higher spending
  - Linear Quadratic: Ottaviano-Tabuchi-Thisse(2002), Melitz-Ottaviano(2008), Nocco et.al. (2014). Under LQ, markup rate goes up (down) due to market expansion through higher spending (more consumers).
- **MC under *homothetic* non-CES** *None compare the equilibrium and the optimum.*
  - Feenstra (2003)'s **translog**, a special case of H.S.A.
    - Functional form implies procompetitive entry and choke price.
    - Our analysis suggests excessive entry.
  - Kimball (1995) uses HDIA with **an exogenous set of firms** (no entry), Baqaee-Farhi (2020) introduces entry.
    - Under the popular functional form used in calibration study, non-existence of equilibrium under free entry
    - We identify the conditions for the existence & uniqueness of free-entry equil. for each of the 3 classes.
  - Bucci-Ushchev (2021) uses general **homothetic,** *again under the conditions given in reduced form.*

This is a part of our big project!!

Matsuyama-Ushchev (2017) *"Beyond CES: Three Alternative Classes of Flexible Homothetic Demand Systems"*
Propose **the same 3 classes** *more broadly*, which allow us to introduce **Asymmetric Demand Across Sectors** with
- a mixture of gross complements and gross substitutes
- a mixture of essential and inessential sectors, etc.

Matsuyama-Ushchev (2020) *"Constant Pass-Through"*
Propose and characterize **parametric families** within each of **the same 3 classes**
- with **firm heterogeneity** in *many* dimensions (market size, quality, substitutability, productivity, pass-through rate)
- MC firms operating at lower markup (not necessarily smaller firms) suffer more from tougher competition

Matsuyama-Ushchev (2020) *"Destabilizing Effects of Market Size in the Dynamics of Innovation"*
Replace CES with **H.S.A.** in a **dynamic** MC model of innovation cycles and show, under the procompetitive effect
- Under the procompetitive effect, large market size makes *the dynamics of innovation more volatile*

Matsuyama-Ushchev (coming soon!) *"Procompetitive Effect and Selection and Sorting of Heterogenous Firms"*
Replace CES with **H.S.A.** to introduce the procompetitive effect in a MC model with **Melitz-heterogeneity**
- Large market size leads to more selection of more productive firms in a closed economy
- More productive firms self-select to larger regions in a spatial model.

In the last two, we use H.S.A. not HDIA or HIIA, for the ease for ensuring the existence & the uniqueness of equilibrium.

Summing Up:

Dixit-Stiglitz under 3 classes of nonparametric homothetic demand systems

- **H.S.A.** (Homotheticity with a Single Aggregator)
- **HDIA** (Homotheticity with Direct Implicit Additivity)
- **HIIA** (Homotheticity with Indirect Implicit Additivity)

- mutually exclusive except CES.
- **Sufficient-statistic property:** entry and behavior of other firms affect
    - revenue and profit of each firm only through one aggregator (for H.S.A.) or two aggregators (for HDIA and HIIA)
    - its price elasticity only through a single aggregator (for all three classes)
- flexibility and tractability allow us to identify the conditions for
    - the existence of the unique symmetric free entry equilibrium
    - the non-existence for an asymmetric free-entry equilibrium
    - procompetitive vs. anticompetitive
    - excessive vs. insufficient entry

as well as the relation between the last two conditions

- Main findings: In these three classes
    - Optimal if and only if CES, generally not true!!
    - Procompetitive entry ⇔ Strategic complementarity ⇔ Marshall's 2nd Law (Incomplete pass-through). generally not true!!
    - Entry is *always* excessive (insufficient) if it is *globally* procompetitive (anticompetitive)
    - Entry is procompetitive and excessive for a large market size in the presence of the choke price