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)

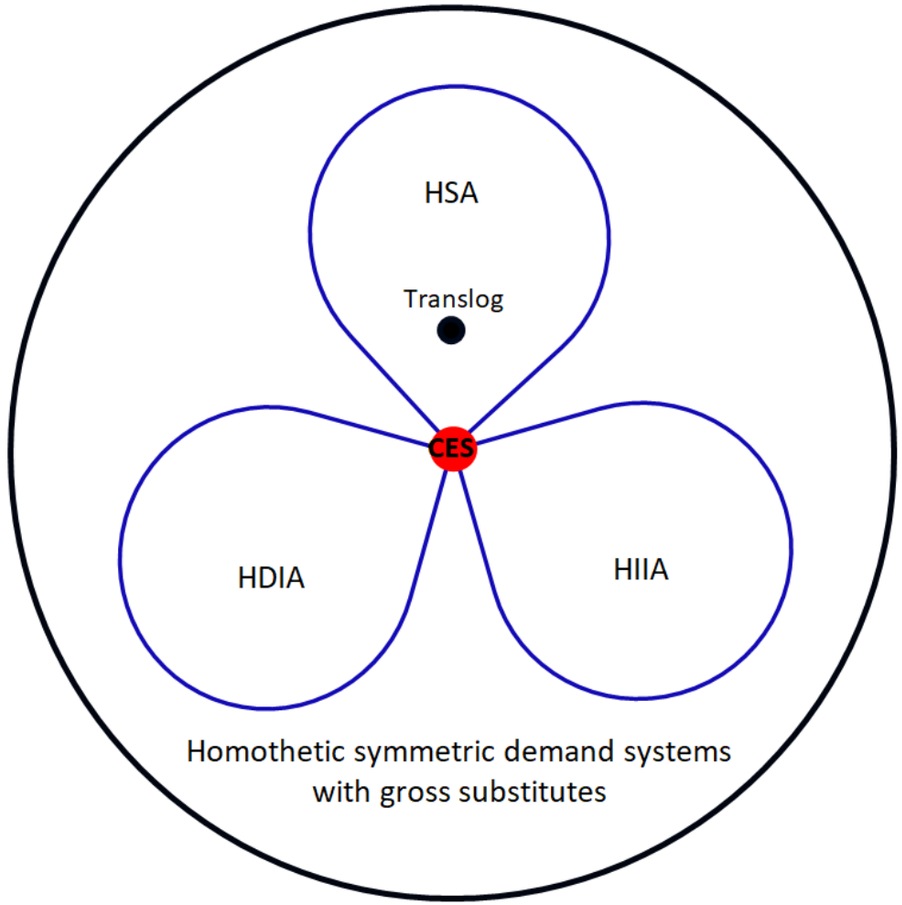
- **H.S.A.** (Homotheticity with a Single Aggregator)
- **HDIA (**Homotheticity with Direct Implicit Additivity)
- **HIIA (**Homotheticity with Indirect Implicit Additivity)

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

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

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

- the monotonicity and quasi-concavity of $P(\mathbf{p})$ or $X(\mathbf{x})$
- the gross substitutability, as well as the existence and 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 develop 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 price (or quantity) 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 for 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 *always* excessive (insufficient) if *globally* procompetitive (anticompetitive), i.e., the equilibrium markup rate is monotonically decreasing (increasing) in market size.
  - 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.

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 functions, $s_\omega(\cdot)$, are 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.*
- **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
  - LQ: Ottaviano-Tabuchi-Thisse(2002), Melitz-Ottaviano(2008), Nocco et.al. (2014).
    Under LQ, markup rate goes up (down) due to market expansion via 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**.

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