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 $2 \times 2 = 4$ 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, $\psi$

*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:**
  
  $$X = X(x) \equiv \min_p \left\{ px = \int_\Omega p_\omega x_\omega d\omega \mid P(p) \geq 1 \right\}$$

  **Unit Cost Function:**
  
  $$P = P(p) \equiv \min_x \left\{ px = \int_\Omega p_\omega x_\omega d\omega \mid X(x) \geq 1 \right\}$$

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

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

Inverse Demand Curve for $\omega$

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

Market Size of the Sector

*taken as exogenous*

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

Revenue Share of $\omega$

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

Revenue Share of $\omega$

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

Price Elasticity of $\omega$:

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

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

Under general CRS, little restrictions on $\zeta_\omega$ beyond the homogeneity of degree zero in $(p_\omega, p)$ or in $(x_\omega, x)$.
Under CES, $\zeta_\omega$ is constant, independent of $(p_\omega, p)$ and of $(x_\omega, x)$. 
(Symmetric) H.S.A., HDIA, and HIIA: Definitions & Key Properties

<table>
<thead>
<tr>
<th>H.S.A. in two equivalent representations</th>
<th>( P(p) ) or ( X(x) )</th>
<th>Revenue Share: ( s_\omega )</th>
<th>Price Elasticity: ( \zeta_\omega )</th>
<th>For CES</th>
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<tbody>
<tr>
<td>( \frac{P(p)}{cA(p)} = \exp \left[ - \int_\Omega \left[ \int_{\frac{x_\omega}{A(p)}}^2 \frac{s(\xi)}{\xi} d\xi \right] d\omega \right] )</td>
<td>( s \left( \frac{p_\omega}{A(p)} \right) )</td>
<td>( \zeta \left( \frac{p_\omega}{A(p)} \right) \equiv 1 - \frac{z s'(z)}{s(z)} \left</td>
<td>\frac{z - p_\omega}{A(p)} \right</td>
<td>&gt; 1 )</td>
</tr>
<tr>
<td>( X(x) = \exp \left[ \int_0^{x_\omega/\lambda^<em>(x)} s^</em>(\xi) \frac{d\xi}{\xi} \right] )</td>
<td>( s^* \left( \frac{x_\omega}{\lambda^*(x)} \right) )</td>
<td>( \zeta^* \left( \frac{x_\omega}{\lambda^<em>(x)} \right) \equiv \left[ 1 - \frac{y s^</em>(y)}{s^*(y)} \right]^{-1} &gt; 1 )</td>
<td>( C^*(x) = \text{const.} ) ( \Leftrightarrow \phi(\cdot) ) is a power function.</td>
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HDIA Kimball

| \( \int_\Omega \phi \left( \frac{x_\omega}{X(x)} \right) d\omega \equiv 1 \) | \( \frac{x_\omega}{C^*(x)} \phi' \left( \frac{x_\omega}{X(x)} \right) \) | \( \zeta^B \left( \frac{x_\omega}{X(x)} \right) \equiv - \frac{\phi'(y)}{y \phi''(y)} \left| \frac{y - x_\omega}{x_\omega} \right| > 1 \) | \( \frac{C(p)}{P(p)} = \text{const.} \) \( \Leftrightarrow \phi(\cdot) \) is a power function. |

HIIA

| \( \int_\Omega \theta \left( \frac{p_\omega}{P(p)} \right) d\omega \equiv 1 \) | \( \frac{p_\omega}{C(p)} \theta' \left( \frac{p_\omega}{P(p)} \right) \) | \( \zeta^I \left( \frac{p_\omega}{P(p)} \right) \equiv - \frac{z \theta''(z)}{\theta'(z)} \left| \frac{z - p_\omega}{P(p)} \right| > 1 \) | \( \frac{C(p)}{P(p)} = \text{const.} \) \( \Leftrightarrow \theta(\cdot) \) 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 \( P(p) \) or \( X(x) \)
- 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
  o Entry is globally excessive (insufficient) if globally pro-competitive (anti-competitive); see Figure.
  o 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
  o We do not assume that an economy has only one MC sector.
  o The MC sector we model may coexist with other sectors, which may not have to be MC.
  o We study distortion of intra-sectoral allocation conditional on the size of the sector.
  o 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
  
  o 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 \( A(p) \), not \( P(p) \)

  o 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
    - 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.
    - 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 (2021) “Selection and Sorting of Heterogeneous Firms through the Procompetitive Effect” 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 2\(^{nd}\) 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