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 $\rightarrow$ more product varieties $\rightarrow$ 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 $\rightarrow$ excessive entry
  - **Positive externalities (imperfect appropriability)**, entrants do not fully capture social surplus created $\rightarrow$ 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, $\omega \in \Omega$
  o Fixed cost of entry, $F$
  o 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:**
  \[
  X = X(x) \equiv \min \{ px = \int_\Omega p_\omega x_\omega d\omega \mid P(p) \geq 1 \}
  \]

  **Unit Cost Function:**
  \[
  P = P(p) \equiv \min \{ px = \int_\Omega p_\omega x_\omega d\omega \mid X(x) \geq 1 \}
  \]

**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 $\omega$

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

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>
</tr>
</thead>
<tbody>
<tr>
<td>$\frac{P(p)}{cA(p)} = \exp \left[ - \int_\Omega \int \frac{s(\xi)}{\xi} d\xi \right] d\omega$</td>
<td>$\frac{X(x)}{cA^<em>(x)} = \exp \left[ \int_\Omega \int \frac{s^</em>(\xi)}{\xi} d\xi \right] d\omega$</td>
<td>$s_\omega \left( \frac{p_\omega}{A(p)} \right)$</td>
<td>$\zeta_\omega \left( \frac{p_\omega}{A(p)} \right) \equiv 1 - \frac{zs'(z)}{s(z)} \left</td>
<td>\frac{z}{z_0} \right</td>
</tr>
<tr>
<td>$\int_\Omega \phi \left( \frac{x_\omega}{X(x)} \right) d\omega \equiv 1$</td>
<td>$\frac{x_\omega}{C^*(x)} \phi' \left( \frac{x_\omega}{X(x)} \right)$</td>
<td>$\zeta^B \left( \frac{x_\omega}{X(x)} \right) \equiv - \frac{\phi'(y)}{s'\phi''(y)} \left</td>
<td>\frac{y}{y_0} \right</td>
<td>^\omega &gt; 1$</td>
</tr>
<tr>
<td>$\int_\Omega \theta \left( \frac{p_\omega}{P(p)} \right) d\omega \equiv 1$</td>
<td>$\frac{p_\omega}{C(p)} \theta' \left( \frac{p_\omega}{P(p)} \right)$</td>
<td>$\zeta^I \left( \frac{p_\omega}{P(p)} \right) \equiv - \frac{z\theta''(z)}{\theta'(z)} \left</td>
<td>\frac{z}{z_0} \right</td>
<td>&gt; 1$</td>
</tr>
</tbody>
</table>

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 $\iff$ Strategic complementarity $\iff$ Marshall’s 2\textsuperscript{nd} 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
  
  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


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 \textbf{general symmetric demand \textit{but only under the conditions given in reduced form, not in the primitives}}.

- MC under \textbf{nonhomothetic non-CES}, \textit{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 \textbf{homothetic non-CES} \textit{None compare the equilibrium and the optimum}.
  - Feenstra (2003)’s \textit{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 \textbf{homothetic}, \textit{again under the conditions given in reduced form}. 


This is a part of our big project!!

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