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Input–output linkages and optimal product diversity

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HIGHLIGHTS

- We study the role of technological side for welfare effects.
- IO linkages could reduce excess entry in equilibrium with pro-competitive effects.
- The CES case is not the border line between excess and insufficient entry.
- The equilibrium with pro-competitive effects may deliver excess or insufficient entry.

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ABSTRACT

We derive a simple necessary and sufficient condition on preferences for the market outcome to be socially optimal under monopolistic competition with input–output (IO) linkages. Preferences that satisfy this condition are typically non-CES and display pro-competitive effects, although they converge to the CES when IO linkages become negligibly weak. We show that the equilibrium with pro-competitive effects may deliver both excess and insufficient entry of firms in equilibrium.

1. Introduction

This paper addresses the question of how agglomeration economies affect optimum product diversity. The discussion on optimum product diversity was launched by Spence (1976), who pointed out that love for variety and tougher competition push the economy, respectively, towards excess and insufficient entry compared to the optimum. Hence, the comparison is generally ambiguous. The key message is that a decreasing elasticity of utility usually generates excess entry (Dixit and Stiglitz, 1977; Dhingra and Morrow, 2012) while the links between a decreasing elasticity of utility and pro-competitive effects have been studied by Bykadorov et al. (2015). They show that utilities with decreasing elasticity typically generate pro-competitive effects under monopolistic competition with additive preferences. Hence pro-competitive effects generally lead to excess entry. We contribute to the literature by showing that taking IO linkages into account dramatically changes these results.

We show that the properties of the technological side of the economy are key for welfare effects. Contrary to the majority of the existing normative analysis, the CES case is no longer the border line between excess and insufficient entry in the presence of IO linkages. The reason is that IO linkages affect the market outcome in different ways. First, the existence of the intermediate sector increases variety.[1] Second, a higher substitution in production decreases love for variety which is a 'weighted average' of consumers' love for variety and love for variety in production. Hence, the higher the technological substitutability, the more likely a low love for variety in production is to dominate the love for variety in consumption, thus reducing variety. In other words, the two effects work in opposite directions. This leaves room for shifting the

[1] Agglomeration economies intensify market interactions between firms via IO linkages which increase demand for varieties. Thus, an increase in product demand invites new entrants and drives firms to exploit the increasing returns to scale more heavily which may foster competition in the presence of pro-competitive effects. This effect is of paramount importance in the literature on international trade (Ethier, 1982) and economic growth (Romer, 1990; Grossman and Helpman, 1990).

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equilibrium towards insufficient entry. Hence, under high technological substitution IO linkages reduce excess entry in equilibrium with pro-competitive effects. As a result, the subclass of utilities for which the optimum and the equilibrium coincide display pro-competitive markup behavior, i.e. markups decrease with the mass of firms. Moreover, the equilibrium with pro-competitive effects may feature insufficient entry when that effect is strong enough. However, for given preferences with pro-competitive effects and a relatively low technological substitution, first effect dominates the second, so that IO linkages increase variety.

Thus, we revisit the role of agglomeration economies for optimum product diversity. In this respect, our results are related to those by Ethier (1982) and Benassy (1996), who study the role of external increasing returns to scale and consumption externalities, respectively. However, we diverge from these studies by employing a well-known micro-founded mechanism of IO linkages instead of 'black-box' assumptions on consumption externalities, thus complementing their results. We show that for any non-zero size of the intermediate good sector, there exists a utility function with pro-competitive markup behavior such that the market outcome coincides with the social optimum. Therefore, since pro-competitive effects generally lead to excess entry, IO linkages may push the market outcome towards optimal levels of product diversity under the presence of pro-competitive effects.

2. The model

Consider an economy with a mass L of consumers each of whom supplies one unit of labor. There is one sector producing a horizontally differentiated good which involves a mass of varieties N. Each firm $k \in [0, N]$ produces a single variety, and each variety is produced by a single firm. In other words, our framework suggests monopolistic competition without scope economies.

2.1. Preferences and technology

We assume that consumers share identical and symmetric additive preferences (Krugman, 1979; Vives, 1999; Zhelobodko et al., 2012) given by

$$U = \int_0^N u(x_k)dk, \tag{1}$$

where $u(x_k)$ is the utility of per capita consumption x_k of variety k. We assume that $u(\cdot)$ is thrice differentiable, increasing and concave, and $u(0) = 0$. Each consumer seeks to maximize her utility (1) subject to the budget constraint

$$\int_0^N p_k x_k dk = w, \tag{2}$$

where w is the wage. The first order conditions yield a demand function D_k^F for final consumption

$$D_k^F = L(u')^{-1}(\lambda p_i), \tag{3}$$

where λ is the Lagrange multiplier.

On the supply side, we assume a technology à la Krugman and Venables (1995) – the whole range of differentiated varieties is used both in final consumption and in production of the differentiated good. Hence, the total cost function is Cobb–Douglas over labor and intermediates:

$$C(q_k) = (F + cq_k)w^{\alpha}P^{1-\alpha}, \tag{4}$$

where q_k is the output of firm k, α is a share of labor in production, P is the CES price index,

$$P = \left(\int_0^N p_k^{1-\sigma}\mathrm{d}k\right)^{\frac{1}{1-\sigma}},$$

and $\sigma > 1$ is the elasticity of technological substitution across intermediate varieties. We assume that final and intermediate goods are traded on the same market, therefore, in equilibrium, the price for each variety is the same for both types of buyers.

The total demand D_k for each variety k is given by

$$D_k(p_k) = D_k^F + D_k^I, \tag{5}$$

where D_k^I is the demand for variety k as the intermediate good. Each firm spends $(1-\alpha)C(q_k)$ on intermediates due to the Cobb–Douglas technology (4), therefore, D_k^I takes the form

$$D_k^I = N \cdot \frac{p_k^{-\sigma}}{P^{1-\sigma}} \cdot (1-\alpha) \cdot C(q_k). \tag{6}$$

2.2. Equilibrium

Since both production costs and demand schedules are identical across firms, we suppress the index k and study the symmetric equilibrium. The price elasticity $\varepsilon_p(D)$ of demand for each variety takes the standard form of a weighted average

$$\varepsilon_p(D) = \frac{\frac{D^F}{r_u(x)} + \sigma D^I}{D^F + D^I}, \tag{7}$$

where $r_u(x)$ is the elasticity of inverse demand for the final consumption given by

$$r_u(x) = -\frac{xu''(x)}{u'(x)}.$$

Using the zero-profit condition $pq = C(q)$ and the firm's budget constraint $(1-\alpha)C(q) = p \cdot D^I$, we obtain that the shares of the output q used for final and intermediate consumption are constant and equal, respectively, to α and $1-\alpha$. Using (7) the markup $m = 1/\varepsilon_p(D)$ takes the form

$$m(x) = \frac{1}{\frac{\alpha}{r_u(x)} + \sigma(1-\alpha)}. \tag{8}$$

Eq. (8) shows that, similar to the case without IO linkages (Zhelobodko et al., 2012), (i) we can represent the equilibrium markup (8) as a function of individual consumption x only, and (ii) preferences exhibit pro-competitive behavior of markups, i.e. $m'(x) > 0$, if the elasticity $r_u(x)$ of inverse demand is an increasing function.

The symmetric equilibrium price index is given by:

$$P = N^{\frac{1}{1-\sigma}}p, \tag{9}$$

whence the equilibrium price is

$$p = w \cdot \left(\frac{c}{(1-m)N^{\frac{1-\alpha}{\sigma-1}}}\right)^{\frac{1}{\alpha}}. \tag{10}$$

Plugging (10) into the zero profit condition $pq = C(q)$ and using $Lx = \alpha q$, we obtain

$$\frac{xm}{1-m} = \alpha \cdot \frac{F}{cL}. \tag{11}$$

Finally, plugging (8) in (11) we get the formula

$$\frac{cLx}{cLx + F} = \frac{(\sigma(1-\alpha) - 1)\, r_u(x) + \alpha}{\left(\sigma(1-\alpha) - 1 + \frac{1}{\alpha}\right) r_u(x) + \alpha}, \tag{12}$$

which pins down the equilibrium individual consumption x_{eq}.