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WORKING PAPER

Product Diversity, Strategic Interactions and Optimal Taxation

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Product Diversity, Strategic Interactions and Optimal Taxation*

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Abstract

The entry of a new product increases consumer surplus through additional product diversity but decreases firm profits. In markets where firm entry intensifies competition and reduces markups through strategic interactions, we expect entry to be excessively high. In a simple general equilibrium model, this is true for industries with very similar goods. If goods are instead highly differentiated, entry is below optimum. In both cases, the optimal policy is a labour subsidy and a tax on entry. If labour subsidies are unavailable, subsidising entry is optimal for industries with low degrees of product differentiation.

Keywords: product diversity, entry, strategic interactions, optimal taxation
JEL classification: E22, E61, E62

1 Introduction

How should taxes be set to obtain an optimal number of firms and products? This question is important because more product diversity is welfare-enhancing, as empirical evidence in Broda and Weinstein (2007) shows. However, insofar as firm entry requires labour services, too many startups imply an inefficient drain on resources.[1] The optimal taxation literature has until recently neglected the extensive production margin. This paper sheds light on the role of strategic interactions for the number of firms and the resulting policy implications under different sets of tax instruments.

There are two externalities associated with the entry of a new firm and differentiated product into an industry, with opposite implications for welfare. On one hand, it raises consumption utility more than proportionately ('consumer surplus effect'). On the other hand, it has a negative effect on profits ('profit destruction effect') as firms see demand for their products fall. In Dixit and Stiglitz (1977), firms do not influence each others' production decisions. Markups

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[1] Hsieh and Moretti (2003) present evidence of excess entry in the real estate industry.

are constant. If firm entry is costly,[2] markups on goods prices are efficient and indeed necessary for firms to cover entry costs and to produce. As a consequence, a distortion of the leisure-consumption tradeoff arises from the absence of a tax on leisure. Bilbiie et al (2008) argue that it is optimal to align markups on consumption and leisure by subsidising labour income appropriately. Then the consumer surplus and profit destruction effects offset each other and product diversity is optimal. However, in the case of strategic interactions between competitors where entry compresses markups,[3] this is no longer true. This paper shows that entry can be above or below its optimal level, depending on the substitutability of goods within an industry. I analyse how different tax instruments (entry taxes, labour taxes and lump sum taxes) should be used to bring about an efficient level of product diversity, consumption and labour.

I consider a static general equilibrium model with endogenous firm and product entry. The industrial structure follows Devereux and Lee (2001). Households consume a composite of many differentiated industry goods. Within each industry, firms produce differentiated goods using labour and compete in a Cournot fashion. Each firm is large enough for its production choice to affect industry output. There is a labour requirement for firm entry into an industry. Households finance entry costs by buying shares. The results are the following. If the within-industry substitution elasticity between goods is low (high), entry is below (above) optimum. It is optimal to subsidise labour, tax entry and balance the government budget with lump sum taxes. If labour taxes are unavailable, it is optimal to subsidise entry if goods are sufficiently differentiated.

Mankiw and Whinston (1986) analyse entry and efficiency in a partial equilibrium setting. Bilbiie et al (2008) derive optimal fiscal policies in a real business cycle (RBC) model with endogenous entry, but do not consider strategic interactions. Colciago and Etro (2010) derive an RBC model with Cournot competition but do not discuss optimal policy. Chugh and Ghironi (2009) analyse a public finance problem in a dynamic endogenous-entry model; however, strategic interactions are absent.

2 Model

Consumption C is a bundle of many differentiated industry goods $C(i)$.

$$C = \left(\int_0^1 C(i)^{\frac{\omega-1}{\omega}} \, di \right)^{\frac{\omega}{\omega-1}}, \omega > 1$$

[2] For empirical estimates of entry costs, see Barseghyan and DiCecio (2010) and the references therein.

[3] Campbell and Hopenhayn (2005) uncover empirical evidence for this *additional* profit destruction effect operating in several industries.

Industry goods, in turn, are a bundle of differentiated intermediate goods $X(i,f)$.

$$C(i) = \left(\sum_{f=1}^{N} X(i,f)^{\frac{\theta-1}{\theta}} \right)^{\frac{\theta}{\theta-1}}, \theta > 1$$

There is a fixed range of industries of measure 1. Within each industry, indexed by $i \in [0,1]$, there are N firms, each producing a differentiated intermediate good. Firms and intermediate goods carry the index (i,f), where $f = 1, \ldots, N$. Let ω denote the elasticity of substitution between industry goods and θ the elasticity of substitution between goods within an industry. The demand for intermediate goods is

$$X(i,f) = \left(\frac{P(i,f)}{P(i)} \right)^{-\theta} \left(\frac{P(i)}{P} \right)^{-\omega} C \tag{1}$$

where P, $P(i)$ and $P(i,f)$ are the prices of final consumption, industry goods and intermediate goods, respectively. Intermediate firms use labour L_c at price W to produce differentiated goods. They set output to maximise profits subject to a linear production function with productivity Z and demand given by (1). Each firm takes into account how its production choice affects industry output, while taking as given the production levels of other firms in the industry and the output levels of other industries. The optimal price is a markup

$$1 + \mu = \frac{\theta}{\theta - 1 - \frac{\theta-\omega}{\omega N}}$$

over marginal cost. The term $-\frac{\theta-\omega}{\omega N}$ captures the effect of the number of producers on markups, which is negative for $\theta > \omega$. Broda and Weinstein (2006) estimate substitution elasticities between goods for different levels of aggregation. As they disaggregate product categories, goods varieties appear to be closer substitutes. This suggests that $\theta > \omega$ is a reasonable assumption.[4] Starting up a firm requires labour services L_f. Let F denote the exogenous entry cost in terms of effective labour units ZL_f. In real terms, the entry cost is $(1+\tau_F)\frac{W^R F}{Z}$, where W^R is the real wage and τ_F is a tax on entry. Here, an entry tax is equivalent to a tax on dividends/profits, or a tax on shares. Households finance the entry costs incurred by new firms in exchange for claims on firms' profits. Households choose consumption C, hours worked L and shares $S(i,f)$ to maximise utility $U(C) - V(L)$, where $U(\cdot)$ is strictly increasing, twice differentiable and concave, $V(\cdot)$ is strictly increasing, twice differentiable and convex, subject to the budget constraint

$$\int_0^1 \sum_{f=1}^{N} S(i,f)\, Q(i,f)\, di = \int_0^1 \sum_{f=1}^{N} S(i,f)\, D^R(i,f)\, di + (1-\tau_L)\, W^R L + T - C \tag{2}$$

[4] If $\theta = \omega$, we have a constant markup $\frac{\theta}{\theta-1}$ as in Dixit-Stiglitz' model (1977) of Chamberlinian monopolistic competition.

The price of a share is denoted $Q(i,f)$ and its payoff is a share of the entrant's real profits $D^R(i,f)$. Agents receive labour income taxed at rate τ_L and lump sum transfers T from the government. Under free entry, households finance new firms up to the point where the share price just covers the entry cost, $Q(i,f) = (1+\tau_F)\frac{W^R F}{Z}$. Then in equilibrium,

$$(1+\tau_F)\frac{W^R F}{Z} = D^R(i,f) \tag{3}$$

$$(1-\tau_L)W^R = \frac{V_L}{U_C} \tag{4}$$

where U_C and V_L are the first derivatives of consumption utility and labour disutility, respectively. Equation (3) states that the cost of setting up a firm must equal profits; (4) equates the after-tax real wage to the marginal rate of substitution between leisure and consumption. The government finances lump sum transfers with taxes on labour income and on entry, $\tau_L W^R L + N\tau_F \frac{W^R F}{Z} = T$. Labour is used to produce firms and to produce consumption goods, $L = N(L_f + L_c)$. The market clearing condition for shares is $S(i,f) = 1$.

Eliminating several variables through substitution, we can define an equilibrium as a set of prices W^R, allocations C, N, L and policies T, τ_L, τ_F, such that:

1. the household budget constraint (2) is satisfied,
2. the resource constraint $ZL = N^{-\frac{1}{\theta-1}}C + NF$ is satisfied,
3. three equilibrium conditions are satisfied: the consumption-leisure tradeoff (4), as well as

$$\begin{aligned}(1+\tau_F)\frac{W^R F}{Z} &= \left(1+\frac{\theta-\omega}{\omega N}\right)\frac{C}{\theta N}\\ N^{\frac{1}{\theta-1}} &= (1+\mu)\frac{W^R}{Z}\end{aligned}$$

3 Consumer Surplus and Profit Destruction Effects

In a symmetric equilibrium, consumption utility satisfies

$$C = N^{\frac{1}{\theta-1}}\left[NX(i,f)\right]$$

where $\frac{1}{\theta-1} > 0$ represents the degree of 'love of variety'. As $\theta \to \infty$, love of variety diminishes. The term $N^{\frac{1}{\theta-1}}$ represents the 'consumer surplus effect' of entry. We can express real profits as

$$D^R(i,f) = \frac{1}{\theta}\left(\frac{P(i,f)}{P}\right)\left(\frac{C}{N}\right)\left(\left[1+\frac{\theta-\omega}{\omega N}\right]N^{-\frac{1}{\theta-1}}\right)$$

The last term in round brackets captures the 'profit destruction effect' of entry. The first part, $N^{-\frac{1}{\theta-1}}$ arises because demand can in part be satisfied through increased product diversity, shifting firm-specific demand curves inwards. The second part, $\frac{\theta-\omega}{\omega N}N^{-\frac{1}{\theta-1}}$ captures the reduction in the markup. Thus, as long as $\theta \neq \omega$, the consumer surplus and profit destruction effects do not cancel out as they do under monopolistic competition.

4 Optimal Tax Policy

The First Best allocation satisfies an intrasectoral and an intersectoral efficiency condition:

$$\frac{V_L}{U_C} = N^{\frac{1}{\theta-1}} Z \tag{5}$$

$$F = \frac{1}{\theta-1} N^{-\frac{\theta}{\theta-1}} C \tag{6}$$

Equation (5) states that the marginal rate of substitution between labour and consumption equals the marginal rate of transformation of labour into final output. Equation (6) states that the cost (in effective labour units) of producing one additional firm equals the reduction in the cost of producing goods - due to the additional product diversity - to attain the same level of utility.

The first two columns of Table 1 exhibit the decentralised equilibrium and the First Best under log consumption utility and linear labour disutility.

[Table 1]

Labour is too low for all values of θ. Thus, production falls short of its optimal level in one of the two sectors, or in both. It follows that consumption is below optimum for all θ.

Suppose that the across-industry substitution elasticity ω is normalised to 1 as in Devereux and Lee (2001). Productivity is normalised to 1 and $\frac{F}{Z} = 0.0038$ to match the value of legal entry fees for the US as a fraction of output per worker, see Barseghyan and DiCecio (2010). Figure 1 shows the number of firms in the First Best and in the decentralised equilibrium, as a function of the within-industry substitution elasticity θ.

[Figure 1]

Broda and Weinstein (2006) estimate elasticities between 1.2 (footwear) and 17 (crude oil). A low θ implies that goods within an industry are highly differentiated. Love of variety and thus the consumer surplus effect are strong; it is therefore efficient to have many firms. As goods become more substitutable, the consumer surplus effect falls and with it the optimal number of firms. Therefore, the First Best number of firms is decreasing in θ. In the decentralised equilibrium, the number of firms is also decreasing in θ, because a rise in substitutability erodes markups and profits. The profit destruction effect through lower markups, as captured by $\frac{\theta-\omega}{\omega N}$, becomes stronger as θ increases. For low (high) values of θ, the consumer surplus effect is strong (weak) relative to the profit destruction effect, such that entry is too low (high). A rise in the entry cost F shifts both curves downwards. The number of firms falls; the extensive production margin shrinks relative to the intensive margin.

[Figure 2]

As Figure 2 shows, total overhead labour (as a share of output) ranges from 0.13 (for high θ) to 0.5. Domowitz et al (1988) report[5] a lower range, $0.05 - 0.17$, but note that this underestimates the true fixed labour costs in the presence of labour hoarding. Moreover, our model abstracts from capital inputs. The net markup ranges from 0.12 to 1, which is consistent with empirical estimates. Out of fifty sectors in the US, Christopoulou and Vermeulen (2008) estimate markups below 0.12 for seven sectors and markups above 1 for only three sectors.

At the optimum, the policy maker taxes entry and subsidises labour setting a markup on leisure equal to the goods price markup. Two instruments are needed because there are two distortions: the markup misalignment between consumption and leisure, which is rectified through a labour income subsidy, and the production distortion due to the strategic interactions between firms, which is addressed through an entry tax.

[Figure 3]

As goods become more substitutable, labour must be subsidised less and entry must be taxed more; the required lump sum tax declines.

If only one distortionary instrument is available, policy cannot decentralise the First Best.[6] First, suppose that entry taxes are unavailable. The optimal labour tax is computed as

$$\tau_L^{opt} = \arg\max_{\tau_L} \{U(C) - V(L)\} \text{ s.t. constraints (1) to (4) in Table 1 ; } \tau_F = 0$$

If labour taxes are unavailable, the optimal entry tax is computed analogously. For very low substitution elasticities ($\theta < 4$), a large positive labour tax is optimal, see Figure 4. Subsidising labour is recommended for industries with greater substitutability across goods. The optimal entry tax is positive for high values of the substitution elasticity θ and negative for intermediate values. For $\theta < 4$, τ_F^{opt} is prohibitively high. The difference in welfare between the two equilibria is negligible (not shown).

[Figure 4]

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Table 1: Comparing Allocations

	First Best	Decentr. Equ.	Optimal Policy Mix	Restricted Set of Instruments
N	$\frac{1}{\theta-1}\frac{Z}{F}$	$\frac{1}{\theta}\left(1+\frac{\theta-\omega}{\omega N}\right)\frac{Z}{F}$	$\frac{1}{\theta-1}\frac{Z}{F}$	(1) $\frac{1}{\theta}\left(\frac{1-\tau_L}{1+\tau_F}\right)\left(1+\frac{\theta-\omega}{\omega N}\right)\frac{Z}{F}$
C	$N^{\frac{1}{\theta-1}}Z$	$\frac{1}{1+\mu}N^{\frac{1}{\theta-1}}Z$	$N^{\frac{1}{\theta-1}}Z$	(2) $\frac{1-\tau_L}{1+\mu}N^{\frac{1}{\theta-1}}Z$
L	$\frac{\theta}{\theta-1}$	1	$\frac{\theta}{\theta-1}$	(3) $\frac{1-\tau_L}{1+\mu}+\frac{NZ}{F}$
$1+\mu$	-	$\frac{\omega N\theta}{\omega N(\theta-1)-(\theta-\omega)}$	$\frac{\frac{\omega\theta}{\theta-1}\frac{Z}{F}}{\frac{\omega}{\theta-1}\frac{Z}{F}(\theta-1)-(\theta-\omega)}>1$	(4) $\frac{\omega N\theta}{\omega N(\theta-1)-(\theta-\omega)}$
τ_L	-	0	μ	$\tau_L=\tau_L^{opt};\tau_F=0$
τ_F	-	0	$\frac{\omega\frac{Z}{F}+(\theta-\omega)(\theta-1)}{\omega\frac{Z}{F}-(\theta-\omega)}>0$	$\tau_F=\tau_F^{opt};\tau_L=0$

Figure 1: Number of Firms

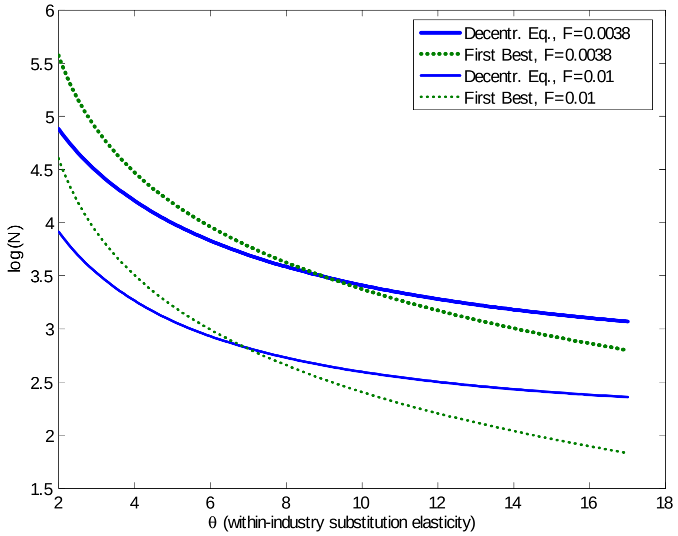

Figure 2: Markup and Overhead Labour Share

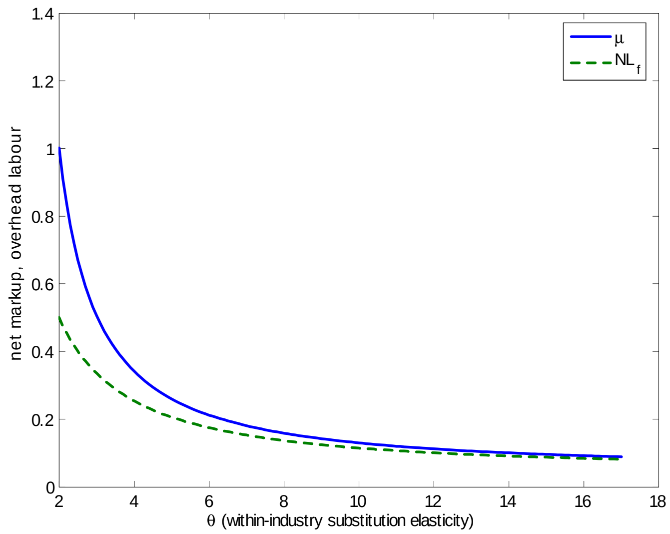

Figure 3: Optimal Tax Policy Mix

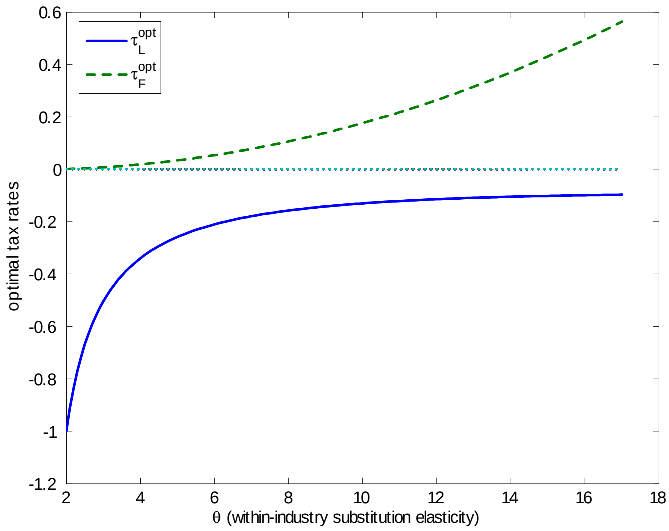

Figure 4: Restricted Set of Instruments