ON THE WELFARE EFFECTS AND POLITICAL ECONOMY OF COMPETITION-ENHANCING POLICIES*

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We analyse the welfare effects of policies that intensify product market competition, and the channels through which they operate. Using a circular model of horizontal product differentiation with asymmetric costs, we study the effects of increased price competition on market selection among incumbent firms, cost reduction effort, and entry of new firms. The model also generates an endogenous demand for competition-enhancing or retarding policies arising from cost heterogeneity, and we demonstrate the possibility of a ‘low-competition’ political economy trap. Simulations of the model illustrate that the selection effects we analyse, which traditional cost-benefit analysis is unlikely to capture, can be large.

Major institutional reforms, such as the establishment of the single market in Europe, the creation of NAFTA, and the introduction of the single European currency, have often been advocated by policy makers as increasing efficiency and welfare by intensifying product market competition. Recent studies provide empirical support for competition-enhancing institutions or reforms. For example, in a recent study using industry-level panel data for nineteen OECD countries, Nicoletti and Scarpetta (2003) show that increased product and labour market competition has positive and large effects on multi-factor productivity. Nickell (1996), Blundell *et al.* (1999) and Aghion *et al.* (2002) provide firm-level evidence of the positive link between product market competition and productivity performance.

A quite separate empirical literature has established a clear link between productivity growth and certain types of *physical* infrastructure – notably transport and telecommunications, both of which reduce transaction costs (Fernald, 1999; Roeller and Waverman 2001). In a recent study of firms in Russia, Brown and Earle (2001) show that the level of productive efficiency is positively related to the quality of transport and telephone infrastructure and to measures of product market competition.¹

These empirical studies document the importance of competition-enhancing policies, institutions and infrastructure, but what is missing is a theoretical model of the underlying mechanisms at work and their implications for welfare (or ‘cost-benefit’) analysis. This paper tries to provide such a framework. In so doing, we

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¹ There is also a large literature emphasising the importance of appropriate *institutional* infrastructure and policies for market development and economic growth. Leading examples include legal reforms to improve contract enforcement (McMillan, 1997; McMillan and Woodruff, 1999) and corporate governance (Pistor *et al.*, 2000), policies to reduce regulatory barriers to the entry of new firms (Djankov *et al.*, 2002), and other aspects of good government (Weingast, 1995; Knack and Keefer, 1995; Acemoglu *et al.*, 2001). A key aspect of all these reforms is precisely that they underpin effective competition in product, financial and labour markets.

also show how an endogenous demand for such policies and institutions can arise. In contrast, the existing literature typically treats them as exogenous.

Common features of competition-enhancing policies and institutions, and of certain types of physical infrastructure, are, first, to facilitate the weeding out of less efficient firms, second to cost reduction investments by incumbent firms, and third to encourage the entry of new, more efficient firms.² This paper develops a simple theoretical framework for analysing and quantifying the welfare effects from intensifying product market competition that work through those three channels: market selection, cost reduction and entry. We use a simple extension of the circular model of competition (Salop 1979) in which there are *asymmetric* production costs for both incumbent firms and potential entrants. In this model, product market competition is measured by the unit transport cost, and we examine the welfare gains from reducing this cost. Of course, 'transport cost' is simply a metaphor for policies, institutions and infrastructure that intensify product market competition.

Apart from the direct savings of reduced transport cost, the model captures three types of indirect welfare gains:

- (i) *market selection among incumbents*: increasing competition generates a larger equilibrium market share for low-cost firms, and this reduces average production costs;
- (ii) *cost reduction (or restructuring)*: greater competition changes the incentives for firms to reduce their production cost but this effect works differently for high and low-cost firms; and
- (iii) *entry*: intensifying post-entry competition reduces the incentives for new high-cost firms to enter the market but, in sharp contrast to the symmetric cost case (Dasgupta and Stiglitz, 1980), it can actually encourage entry by low-cost potential entrants.

The last two effects are 'dynamic' by-products of the market selection effect in a two-stage framework, where price competition is preceded by firms' decisions to reduce costs and/or enter the market. We show that the strength of these indirect effects depends on the parameters of the economy, such as the initial degree of cost asymmetry, the number of firms, the initial level of product market competition and other factors.

We show that policies and infrastructure that intensify product market competition create both *gainers* and *losers*: namely, low-cost incumbent firms benefit from increased product market competition if there is sufficient cost asymmetry, but high-cost firms unambiguously lose. Thus the model generates an endogenous demand for competition-enhancing (or retarding) policies. Using a simple political economy model adapted from Acemoglu *et al.* (2002), in which special interest groups can 'capture' politicians, we show that under certain conditions

² The key characteristic of competition-enhancing policies and/or specific types of infrastructure that we model is that they facilitate the translation of existing cost differences into differences in equilibrium market shares and reductions in price-cost margins (the Lerner index). Only a few types of infrastructure affect the intensity of competition in this sense – most notably, transport and communications.

an economy that can fall into a low-competition trap in which politicians are successfully bribed by high-cost firms to maintain low competition. Such traps are more likely to occur in economies where the initial degree of competition is low, initial cost asymmetries are small, and politicians are less driven by social welfare concerns (i.e., political institutions do not effectively discipline their behaviour). These are the conditions under which the ability of high cost firms to bribe politicians to prevent increases in competition (or to reduce it) are greatest.

Finally, we present simulations of the model to illustrate that the indirect welfare effects of enhancing competition – i.e., the induced selection effect, cost reduction and entry – can be large. This point is important because traditional cost-benefit analysis is unlikely to capture these indirect effects in practice.

For our purposes the circular model has two important advantages: a simple, supply-side interpretation of intensified competition, and transparent algebra. However, the basic ideas are robust to alternative specifications, including the Dixit-Stiglitz and Cournot models with asymmetric costs, as we show in Appendices 2 and 3.^{3,4}

In addition to the literature on competition-enhancing policies and institutions, our paper is related to a growing number of empirical papers that document pervasive micro-level heterogeneity in productivity growth, entry and exit, both in industrialised and developing economies, (Baily *et al.*, 1992; Dunne *et al.*, 1988; Roberts and Tybout, 1996; Disney *et al.*, 2003). These studies show empirically how to decompose aggregate productivity growth into three main components: market selection (reallocation of market shares between firms of different productivity levels), cost reduction (within-plant improvement) and net entry. The relative importance of these different channels varies substantially across the countries that have been studied. Our model offers a potential explanation for such variation, since we show that the importance of the different channels depends on the characteristics ('initial conditions') of the economy. At the same time, this emphasises that the effectiveness of different policies to promote productivity growth will also depend on these initial conditions, as the simulations in Section 5 illustrate.

Our paper also contributes to the existing theoretical literature on competition and incentives (Hart, 1983; Scharfstein, 1988; Schmidt, 1997) and on competition and growth (Aghion *et al.*, 1997) by introducing market selection and analysing its welfare implications. In this we build on the earlier work by Vickers (1995), who first identified that new entry can generate a positive externality on existing firms when there is cost asymmetry.

The paper is organised as follows. Section 1 presents the basic model with asymmetric, exogenous cost levels and no entry. Section 2 examines how the

³ In independent work, Blanchard and Giavazzi (2001) also adopt a Dixit-Stiglitz specification and model market deregulation as an increase in the elasticity of substitution in the utility function. However, they focus on macroeconomic implications of product and labour market deregulation.

⁴ As we show in Appendix 2, the Dixit-Stiglitz specification: (i) allows for an *expansion effect* of intensified competition (more aggregate consumption due to lower prices), and (ii) introduces allocative inefficiency from imperfect competition. These aspects are absent from the circular model because aggregate demand is fixed, but we show that they do not affect the qualitative conclusions from the simpler circular model presented in the text.

model can generate an endogenous demand for competition-enhancing policies and the possibility of a low-competition trap arising simply from cost heterogeneity. Section 3 studies how increasing competition affects the incentives for high- and low-cost firms to reduce costs, and thus the degree of cost asymmetry itself. Section 4 analyses entry. Section 5 uses simulations to compare the welfare effects of enhancing product market competition and policies to subsidise cost reduction and entry, and shows that the selection and other indirect effects of increasing competition can be large. Brief concluding remarks follow.

1. Basic Model

We use a horizontal product differentiation model (Salop, 1979), where n firms are evenly located on a unit circle (location decisions are taken as exogenous). The demand side of the economy is standard: consumers are uniformly distributed on the circle, pay price p_j to purchase one unit of good from firm j , and incur a transport cost of t per unit of distance. Competition-enhancing policies are modelled here as a reduction in the unit transport cost, since this has the effect of reducing the equilibrium price-cost margin. We assume that consumers' willingness to pay for the differentiated product is sufficiently high that total demand remains equal to one for the range of prices considered.

Unlike the standard model, we introduce cost asymmetry: a fraction q of firms have high unit costs (c_H) and $1 - q$ have low unit costs (c_L), and $\Delta c = c_H - c_L > 0$ denotes the degree of cost asymmetry. Firms do not know the cost characteristics of neighbouring firms, and thus base their pricing decisions on the 'average' price of their neighbours, which reflects the mix between high and low-cost firms in the economy.⁵ The parameters q, c_H and c_L are common knowledge. In this Section we study price competition among the n firms. As price decisions are made

⁵ This assumption can be rationalised in the following way. Consider the case of markets in which, at each period, there is a positive turnover of firms and/or a technological shock to which firms only adapt with probability $(1 - q)$. If firms do not immediately observe whether their competitors have adapted successfully to the shock, every period a given firm faces uncertainty about the unit costs of its immediate competitors.

This assumption is made for the sake of tractability but it does not affect our analysis in any major way. In particular, we have looked at an alternative specification where firms are paired on a series of Hotelling lines and each firm knows its Hotelling neighbour's cost levels *ex post* but firms do not know *ex ante* how they will be paired. For n large, by the law of large numbers a fraction q^2 of pairs will involve high cost firms only, a fraction $(1 - q)^2$ of pairs will involve low cost firms only, and the remaining fraction $2q(1 - q)$ will consist of non-assortative pairs involving one low cost and one high cost firm. For each type of pairing, one can compute the equilibrium profit of each firm involved in the pair. While only the traditional consumer-surplus and business stealing effects will be at work in the pairs (H, H) or (L, L) , the selection effect pointed out in this paper will be at work in the pairs (L, H) and the magnitude of this effect will obviously increase with the cost differential Δc .

To evaluate the welfare effects of a reduction in t , we can simply aggregate over all pairs, which is equivalent to doing the welfare analysis *ex ante*, when firms are under the *veil of ignorance* regarding their own cost and/or the types of firms with which they will be paired. Introducing *ex ante* uncertainty in this way, instead of *ex post* uncertainty at the pricing stage, does not alter the main conclusions of welfare analysis – in particular, we obtain qualitatively similar welfare effects of a reduction in t and comparative statics with respect to Δc . But it is harder to analyse entry in a Hotelling model.

simultaneously by firms, we can analyse the equilibrium without considering signalling of cost characteristics through prices.

Let p_i , p_{i-1} , and p_{i+1} denote the prices charged by firm i and its two immediate neighbours. The marginal consumer between i and $i + 1$ lies at a distance x_R from firm i , where

$$x_R = \frac{p_{i+1} - p_i}{2t} + \frac{1}{2n}.$$

The marginal consumer between i and $i - 1$ is defined similarly. When picking its price p_i , firm i does not observe prices p_{i-1} and p_{i+1} charged by its neighbours. Rather, anticipating that all low (high) cost firms will charge the same price p_L (p_H) in equilibrium, firm i chooses price p_i to

$$\max_p (p_i - c_i) D_i(p_i \mid p_H, p_L)$$

where

$$D_i(p_i, p_H, p_L) = E_{p_{i-1}} x_L + E_{p_{i+1}} x_R = \frac{1}{n} + \frac{qp_H + (1-q)p_L - p_i}{t}$$

is the expected demand for good i conditional on all other high (low) cost firms charging price p_H (p_L). In this, we assume that n is large enough so that q is unaffected by any single firm.

From the first-order conditions and focusing on the symmetric Nash equilibrium ($p_i = p_H$ for $c_i = c_H$ and $p_i = p_L$ for $c_i = c_L$), we get the equilibrium prices and market shares:

$$p_H = \frac{t}{n} + c_H + \frac{(1-q)\Delta c}{2} \quad (1)$$

$$p_L = \frac{t}{n} + c_L - \frac{q\Delta c}{2} \quad (2)$$

$$D_H = \frac{1}{n} - \frac{(1-q)\Delta c}{2t} \quad (3)$$

$$D_L = \frac{1}{n} + \frac{q\Delta c}{2t} \quad (4)$$

where the parameters $\{c_L, c_H, q, t, n\}$ must satisfy $p_j \geq 0$ and $1 \geq D_j \geq 0$ for $j = L, H$. Note that $D_L > D_H$ and that a reduction in t raises D_L .

Equilibrium profits are given by

$$\Pi_H = t \left[\frac{1}{n} - \frac{(1-q)\Delta c}{2t} \right]^2 = tD_H^2 \quad (5)$$

$$\Pi_L = t \left(\frac{1}{n} + \frac{q\Delta c}{2t} \right)^2 = tD_L^2. \quad (6)$$

A reduction in transport cost t has two effects on equilibrium profits. The first is a *competition effect*: a lower transport cost (greater product market competition) reduces the profit margins for both low and high-cost firms, for given

(equilibrium) market shares. The second is a *selection effect*: intensified product market competition increases the market share of low cost firms and reduces it for high-cost firms. Thus an intensification of product market competition unambiguously reduces profits for high-cost firms, but the overall effect on low-cost firms depends on the relative strength of the competition and selection effects.

For future reference, we note the effect of competition on total profits in equilibrium. Total profits are given by $\Pi \equiv n[q\Pi_H + (1 - q)\Pi_L] = t/n + nq(1 - q)(\Delta c)^2/4t$. Thus

$$\frac{\partial \Pi}{\partial t} = \frac{1}{n} - \frac{nq(1 - q)(\Delta c)^2}{4t^2}$$

$$\frac{\partial^2 \Pi}{\partial t^2} = \frac{nq(1 - q)(\Delta c)^2}{2t^3} > 0.$$

Thus $\partial \Pi / \partial t$ is negative for small t and positive for large t .

We next study the welfare effects of reducing transport cost. Since total demand is fixed in this model, maximising total surplus is equivalent to minimising the sum of production costs incurred by firms and transport costs incurred by consumers. When n is large, we can write this sum (see Appendix 1) as:

$$K = \underbrace{n[(1 - q)D_L c_L + qD_H c_H]}_{\text{total production cost}} + \underbrace{\left[\frac{t}{4n} + \frac{nq(1 - q)t}{2} \left(\frac{\Delta c}{2t} \right)^2 \right]}_{\text{total transport cost}}. \quad (7)$$

Reducing transport cost t has three basic effects on welfare:

- (i) A *direct cost reduction* effect: a lower t reduces the expected transport costs, $t/4n$, incurred by consumers located between identical firms. This direct effect is smaller in markets with many firms, since the average distance travelled is smaller.
- (ii) A *selection* effect: a lower t increases the market share differential $D_L - D_H$ between low and high-cost firms, which in turn reduces aggregate production costs in equilibrium.
- (iii) A *reallocation* effect: a lower t increases the market share differential $D_L - D_H$, which in turn raises the average distance travelled by a consumer located between high- and low-cost firms, $nq(1 - q)/2(\Delta c/2t)^2$.⁶

Proposition 1 describes how these various effects add up in this circular model with linear transportation costs:

PROPOSITION 1 *Intensifying competition (reducing transport cost) raises aggregate welfare, and the welfare gain is increasing in the degree of cost asymmetry.*

⁶ The selection and reallocation effects work in opposite directions on welfare. With linear transport costs, the selection effect dominates.

Proof. From (7)

$$\frac{dK}{dt} = \underbrace{\frac{1}{4n}}_{\text{direct cost reduction effect}} + \underbrace{2nq(1-q)\left(\frac{\Delta c}{2t}\right)^2}_{\text{selection effect}} - \underbrace{\frac{nq(1-q)}{2}\left(\frac{\Delta c}{2t}\right)^2}_{\text{reallocation effect}} > 0$$

which established the first claim. The second claim follows from the fact that the sum of the selection and reallocation effects is positive and increasing in Δc . $\square$

A reduction in t increases the asymmetry of market shares through the selection effect. This implies that an intensification of competition *increases* equilibrium concentration in the economy when there is cost asymmetry. At the same time, a reduction in t lowers the profit margin both for low and high-cost firms. However, since low-cost firms have a higher profit margin than high-cost firms and since their market share increases with competition, the aggregate profit margin in the economy can rise when competition intensifies, if there is enough cost asymmetry. This is summarised in the following proposition.

PROPOSITION 2 *Let $H_0 = n(1-q)D_L^2 + nqD_H^2$ denote the Herfindahl index of concentration in the circle model. When there is cost asymmetry, an increase in competition (i) raises the equilibrium level of H_0 , (ii) reduces the profit margin of both low and high cost firms, but (iii) increases aggregate profit if $H_0 > 2/n$.*

Proof. See Appendix 1.

Proposition 1 and 2 together imply that concentration and welfare are *positively* correlated when there is sufficient cost asymmetry (implying high H_0) in the economy. This important idea dates back to early critiques of antitrust policy that stressed the importance of cost asymmetries in perfect competition (Demsetz, 1972). The same idea has reappeared in more recent analysis of the welfare effects of horizontal mergers (Farrell and Shapiro, 1990).

2. Political Economy Traps

In this Section we show that the model generates an endogenous demand for competition enhancing or retarding policies and the possibility of a low-level competition trap. We use a simple political economy model in which special interest groups can ‘capture’ politicians. The model, developed by Acemoglu *et al.* (2002), is a simplified version of the lobbying model of Grossman and Helpman (2001).

Suppose that the politician determines the extent to which the institutional environment is competition-enhancing – e.g. the nature of competition or regulatory policy. In the circular model this is summarised by the unit transport cost parameter, t . Assume $t \in (t_{\min}, t_{\max})$. The politician’s pay-off is proportional to social welfare $W(t)$ if he behaves honestly by not taking bribes, say $hW(t)$ where

$h > 0$. Otherwise, the pay-off is the bribe paid to adopt some other value of t . The parameter h is an index of the degree to which social welfare concerns drive the politician's decision. This will depend on the effectiveness of the underlying checks and balances in the political system.

In the circular model, maximising $W(t)$ is equivalent to minimising production plus transport cost, $K(t)$. The important properties of K are that it is increasing and concave in t . From the analysis in Section 1, we know that $t^* = t_{\min}$ maximises welfare. If the politician chooses to be honest (equivalently, $h \rightarrow \infty$), he sets $t^* = t_{\min}$. Otherwise, the politician decides on the policy by comparing the potential bribes with his private marginal cost of deviating away from the welfare maximising policy (i.e. of increasing t). Let $b(t)$ denote the politician's marginal cost of increasing t : $b(t) = h dK(t)/dt$.

As (5) and (6) show, an increase in competition reduces profit of high cost firms, but it can increase the profit of low-cost firms if there is sufficient cost asymmetry (i.e., when the selection effect dominates the competition effect). Thus cost heterogeneity can lead to a situation where the interests of low and high cost firms conflict. In a pure rent-seeking economy, incumbent firms 'vote' in proportion to these private gains or losses. In this analysis we abstract from any problems associated with the public goods aspect of such lobbying activities (i.e., firms have an incentive to free ride on other firms' bribes). We carry out the analysis for a small change in competition but the analysis would be similar for larger, discrete changes in policies.

Case 1: $\partial \Pi_L / \partial t < 0$. In this case there is a divergence of interests between high and low cost firms. High and low-cost firms will lobby the government *non-cooperatively*, with the high (low) cost firms pushing the government towards increasing (reducing) t . In order for high-cost firms successfully to bribe the politician to increase t , the politician must be better off taking the bribe from high-cost firms and incurring the cost $b(t)$ than he would be if he takes the bribe from low-cost firms to lower t . More formally, we must have:

$$nq\partial \Pi_H / \partial t - b(t) > n(1 - q) | \partial \Pi_L / \partial t |. \quad (8)$$

Using the expressions for Π_L and Π_H from (5) and (6), we can write this inequality as:

$$\Phi(t) = \frac{1}{n} - nq(1 - q) \frac{\Delta c^2}{4t^2} - h \frac{dK(t)}{dt} \Big|_{t=t_0} > 0 \quad (9)$$

where t_0 is the initial policy level. Using Proposition 1, it is easy to show that $\Phi(t)$ is monotone increasing in t . Define $t^* = G(q, \Delta c, n)$ such that $\Phi(t^*) = 0$. Then if $t_0 > t^*$ high-cost firms successfully bribe the politician to increase t . Since $\Phi(t)$ is monotonic, the economy moves toward $t_{\max}$. If $t_0 \leq t^*$ the politician reduces t and the economy moves toward $t_{\min}$.

The intuition is straightforward: if competition is initially low, then high-cost firms' marginal willingness to pay not to increase competition is high (they have a lot to lose from such an increase). It is worthwhile for them to bribe politicians to

prevent a rise in competition. However, when competition is initially high, equilibrium profits are already low and firms will have a lower marginal willingness to pay for preventing further increases in competition. In the former case, the economy will end up in a low-competition trap.

Two comparative statics of $\Phi(\cdot)$ are of particular interest. First, $\Phi(\cdot)$ decreases when h increases. This means that the critical t^* increases, making it more likely that the initial policy level t_0 will be less than t^* . Hence a higher h makes it less likely that the economy ends up in a low-competition trap. When politicians are more constrained to act to increase social welfare, traps are less likely. Second, $\Phi(\cdot)$ decreases when Δc rises (noting that $dK(t)/dt$ increases with Δc). Hence greater asymmetry makes it less likely that the economy ends up in a low-competition trap.

To summarise, the economies that are most vulnerable to a low competition trap are those where the initial level of competition is low, the initial degree of cost asymmetry is low, and politicians are less driven by social welfare concerns (i.e., political institutions do not effectively discipline their behaviour).

Case 2: $\partial\Pi_L/\partial t > 0$. In this case there is no divergence of interests. Both high and low-cost firms will lobby the government *cooperatively* for it to increase t , and they will succeed whenever their combined bribes are greater than the politician's disutility from moving in the opposite direction from the welfare maximising policy. More formally, if:

$$nq\partial\Pi_H/\partial t + n(1 - q)\partial\Pi_L/\partial t > b(t). \quad (10)$$

But then we immediately see that this condition, which itself boils down to

$$\frac{\partial\Pi}{\partial t} > b(t),$$

where $\Pi = nq\Pi_H + n(1 - q)\Pi_L$ denotes total profits in equilibrium, is identical to (9). Thus the conclusions are the same as in the previous case.

We summarise these results in the following proposition:

PROPOSITION 3 *If the initial level of competition is below the threshold level t^* defined by $\Phi(t^*) = 0$, and if $\partial\Pi_L/\partial t < 0$ (the selection effect dominates the competition effect), then high cost firms can successfully bribe the politician to raise t , and the economy converges to $t_{\max}$. If $t_0 < t^*$, the economy converges to $t = t_{\min}$ and there are no bribes paid. If $\partial\Pi_L/\partial t > 0$, the same results hold except that both high and low-cost firms bribe the politician. A low-competition trap, in which the economy moves toward $t_{\max}$, is most likely to occur when the initial level of competition t_0 is low, cost asymmetry Δc is small, and the politicians attach less weight to social welfare (low h).*

Thus, in the absence of a mechanism for side-payments, the economy may converge to a low competition trap. In earlier models of (physical) infrastructure, a 'low infrastructure' trap can arise from non-convexities in the production technology (Murphy *et al.*, 1989). In our model, the 'low competition' trap arises from

the heterogeneity of firms. Of course, this political economy model is highly simplified. A more complete framework should also incorporate the design of institutions that determine how ‘voting’ takes place – e.g., whether there are mechanisms for workers, consumers and potential entrants to ‘vote.’

3. Competition and Cost Reduction

3.1. Nash Effort Levels

In this Section we allow incumbent firms to make investments to reduce their production costs.⁷ Suppose that firm i can reduce its unit cost from c_i^0 to $c_i = c_i^0 - e$ by incurring a quadratic effort cost be^2 . Thereafter, firms compete on the circle as in the basic model. We solve for a symmetric perfect equilibrium where all firms with initial cost parameter $c_i^0 \in \{c_H^0, c_L^0\}$ first choose the same cost reducing effort $e_i \in \{e_H, e_L\}$ and then set the same price $p_i \in \{p_H, p_L\}$.

Proceeding by backward induction, we first solve for equilibrium prices, given e_H and e_L . Given these prices, a type- i firm chooses effort e_i to solve:

$$\max_e (\max_{p_i} [p_i - c_i(e)] \{ [qp_H + (1-q)p_L] / t + 1/n \} - be^2). \quad (11)$$

The Nash equilibrium effort levels for high- and low-cost firms are (see Appendix 1):

$$e_H = \frac{1}{2bn} - \frac{(1-q)\Delta c^0}{4bt-1} \quad (12)$$

$$e_L = \frac{1}{2bn} + \frac{q\Delta c^0}{4bt-1}. \quad (13)$$

where $4bt > 1$ by second order conditions. From these expressions we get:

PROPOSITION 4 *Low-cost firms have stronger incentives to reduce costs: $e_L > e_H$. Moreover, an increase in competition (reducing t) promotes cost reduction by low-cost firms and discourages it for high-cost firms, thereby magnifying the initial cost asymmetry: $\partial e_L / \partial t < 0$, $\partial e_H / \partial t > 0$.*

Incentives to reduce costs differ for low and high cost firms. Since the payoff to cost-reducing effort is proportional to market share, the initial cost difference is magnified by such ‘restructuring’ activity. Knowing that they will capture a lower share of the market, high-cost firms have less incentive to invest in cost reduction. The incentives of low-cost firms to reduce costs are increasing in: (a) the proportion of high-cost firms q (the higher q , the bigger the additional increase in low cost firms’ market share from reducing costs), and (b) the initial degree of cost asymmetry Δc^0 (the higher Δc^0 , the more will high-cost firms be deterred from investing in cost reduction and thus the higher the marginal return to such effort

⁷ Such ‘restructuring’ covers any expenditure of money or effort to increase productivity, including innovation and organisational or management change.

by low-cost firms). The incentives are inversely related to the number of firms, since more firms implies greater competition and thus a lower rent from further reducing costs.⁸

It is well known that firms have a strategic incentive to overinvest in cost reduction for rent transfer reasons (they may also underinvest because they cannot appropriate the full social surplus). This incentive is stronger when the market is more competitive, so that if the initial level of cost reduction is socially excessive, making the economy more competitive can exacerbate this and reduce social welfare as a result (for more discussion, see the simulations in Section 6). In Appendix 1 we show that $\partial e_i / \partial t < 0$, if p^* is held constant and $p^* > c_i^0$. However, a decline in t also reduces p^* in equilibrium, which in turn reduces the marginal gain from cost reduction. It turns out that when costs are linearly decreasing in effort, as we have assumed in this Section, the two effects exactly offset each other in the symmetric case, so that the equilibrium effort is independent of t . However, this is no longer true if costs are initially asymmetric, as Proposition 4 shows.

Remark 1. In this model, cost-reducing activity reinforces the selection effect because it magnifies cost asymmetry. In this sense, competition-enhancing policies and cost-reducing activity are *complements*. Formally, denoting average production cost by $K_P = qD_H c_H + (1 - q)D_L c_L$, we have:

$$\frac{dK_P}{dt} = \underbrace{q(1 - q) \left(\frac{\Delta c}{t} \right)^2}_{\text{selection effect}} - \underbrace{q(1 - q) \Delta c^0 (D_L - D_H) \frac{d}{dt} \left(\frac{1}{2bt - 1} \right)}_{\text{cost-reduction effect}} > q(1 - q) \left(\frac{\Delta c^0}{t} \right)^2. \quad (14)$$

Remark 2. Cost Reduction With Catch-Up Advantage. In practice it may be easier for high-cost firms to reduce costs, since they are likely to have more ‘slack’. If there is such a ‘catch-up’ advantage for high-cost firms, we now show that the perfect equilibrium can involve high-cost firms doing more cost reduction than low-cost firms, reversing the market share effect described in Proposition 3.

To illustrate this point, let effort costs for a high-cost firm vary inversely with the initial degree of cost asymmetry: $C(e_H) = \max\{be_H^2 - \beta \Delta c^0 e_H, 0\}$, $\beta > 0$, with marginal cost equal to $\max\{2be_H - \beta \Delta c^0, 0\}$. It is straightforward to derive the following equilibrium effort levels:

⁸ It may be surprising that intensified competition discourages cost-reducing effort by high cost firms, since the cost of *not* doing so is higher for such firms (a given cost difference implies a larger difference in market shares). However, the quadratic cost functions are sufficiently convex that a lower t will discourage a high cost firm from competing more effectively with low-cost firms by making such effort. Greater cost-reducing effort by high-cost firms could easily be generated in variants of this model by reducing the convexity of effort costs or introducing some other costs associated with low market shares, such as bankruptcy costs or a non-monetary private benefit (say, managerial reputation) that increases with a firm’s market share.

$$e_H^* = \frac{1}{2bn} - \frac{\{1 - q - \frac{\beta}{2b}(4bt - q)\}\Delta c^0}{4bt - 1} \quad (15)$$

$$e_L^* = \frac{1}{2bn} + \frac{q(1 - \frac{\beta}{2b})\Delta c^0}{4bt - 1} \quad (16)$$

provided that $e_j^* \in [0, c_j^0]$ for $j = L, H$. Since $4bt > 1 \geq q$, it follows that $e_H^* > e_H$ and $e_L^* < e_L$. That is, high (low) cost firms do more (less) cost reduction than in the case where there is no catch-up advantage. Also, the relative effort levels of high and low cost firms depend on the size of the catch-up parameter, β . Since $e_H^* - e_L^* = (2\beta - 1)\Delta c^0 / 4bt - 1$, if $\beta > 1/2t$ the high-cost firm does more cost reduction, reducing the initial cost asymmetry. It is easy to verify that an increase in competition raises $e_H^* - e_L^*$, provided effort costs are not too convex.

3.2. Second-Best Benchmark

We now turn to a welfare analysis of cost reduction. We introduce a *second-best benchmark* generated under the assumption that the government controls the level of cost reducing activity, but not prices. We think this is an appropriate benchmark in practice, because it is much easier for the government to affect the cost of restructuring by firms (e.g., by setting severance rules and other labour market regulations) than to control product market prices. In addition, it facilitates comparison between Nash and second-best effort levels, holding pricing behaviour constant. The question is, should the social planner set effort levels for low and high-cost firms so as to reduce or increase cost asymmetry?

The government minimises the sum of production, transport and restructuring costs, subject to Nash prices being set by firms in the second stage:

$$\begin{aligned} \min_{e_H, e_L} S = & n[(1 - q)c_L D_L + qc_H D_H] + \frac{t}{4n} + \frac{nq(1 - q)t}{2} \left(\frac{\Delta c}{2t}\right)^2 \\ & + nb[qe_H^2 + (1 - q)e_L^2] \end{aligned}$$

where $c_i = c_i^0 - e_i$. Substituting for the equilibrium markets demands (D_L, D_H), and taking first-order conditions,⁹ we get the second-best effort levels:

$$e_L^{**} = \frac{1}{2bn} + \frac{3q\Delta c^0}{8bt - 3} \quad (17)$$

$$e_H^{**} = \frac{1}{2bn} - \frac{3(1 - q)\Delta c^0}{8bt - 3}. \quad (18)$$

Comparing these solutions with the Nash outcomes derived earlier, we see that $e_L^{**} > e_L$ and $e_H^{**} < e_H$. Also note that e_L^* (e_H^*) is declining (rising) in t .

⁹ Second-order conditions require $8bt > 3\max(q, 1 - q)$ for all $q \in [0, 1]$, that is: $8bt > 3$.

The following proposition summarises these results.

PROPOSITION 5 *With linear transport costs, the second-best solution is characterised by:*

- (i) *low-cost firms engaging in more cost-reducing effort than high-cost firms, $e_L^{**} > e_H^{**}$,*
- (ii) *low (high) cost firms investing more (less) in cost reduction than in the Nash equilibrium, $e_L^{**} > e_L$ and $e_H^{**} < e_H$, and*
- (iii) *an increase in competition (lower t) raising cost-reducing effort by low-cost firms and decreasing it for high cost firms: $\partial e_H^{**}/\partial t > 0$, $\partial e_L^{**}/\partial t < 0$.*

The result that low-cost firms should engage in more cost reduction than high cost firms, may appear somewhat surprising. There are two countervailing effects at work. The first is a market share effect, which makes the social (as well as private) payoff to cost reduction by low-cost (high market share) firms larger than for high-cost firms. This induces a social planner to increase the level of cost reduction by low-cost firms, raising the asymmetry in market shares. However, the second effect is that social welfare (but not firms' profits) decreases with aggregate transport costs, and these are lowered by reducing cost asymmetry. This effect induces a social planner to favour cost reduction by high-cost firms but the strength of this effect will be mitigated by the convexity of effort costs.

In the model with linear transport and quadratic effort costs, the market share effect dominates, so $e_H^{**} < e_H$ and $e_L^{**} > e_L$. However, if transport costs were sufficiently convex, it can be efficient in this model to *reduce* cost asymmetry in order to save on the aggregate transportation (or 'reallocation') costs borne by consumers. Using a Dixit-Stiglitz specification in Appendix 2, we illustrate a case in which the social planner chooses to reduce cost asymmetry. This arises from the fact that reducing cost asymmetry in a Dixit-Stiglitz context results in *market expansion* and therefore in increased aggregate consumption.

The key conclusion from this analysis is that one cannot say, on *a priori* grounds, whether the market generates too much or too little investment in cost reduction by high and low-cost firms, or whether efficient cost-reduction should reduce or raise cost asymmetry.¹⁰ This negative conclusion implies that one needs to be careful before undertaking any policy to affect the degree of cost asymmetry (e.g., targetting production cost or restructuring subsidies toward particular types of firms). It is also worth reiterating that, if the market does generate socially excessive cost reduction because of strong rent transfer effects, an increase in competition can in principle exacerbate this problem. The same point applies to the effects of competition on entry, which we discuss in the next Section.

¹⁰ The same conclusion would also hold if we used the first-best benchmark in which the government can directly set prices. The reason is that the social planner faces a similar trade-off between the market share effect and the social cost of increasing equilibrium transport costs.

4. Competition and Entry

Does an increase in product market competition encourage or deter the entry of new firms? The classical circular model without cost asymmetry provides an unambiguous answer to this question: lower transport costs intensify *ex post* competition, thereby reducing post-entry rents and thus discouraging entry (Dasgupta and Stiglitz, 1980). The same result holds in Schumpeterian models of innovation with symmetric costs, where greater product market competition discourages R&D by reducing the rewards to successful innovation (Aghion and Howitt, 1992). In this Section we show that the effects of competition on entry are less clear-cut, and possibly reversed, when *cost asymmetry* and *selection* considerations are taken into account.

We model entry as an the outcome of an ‘innovation process’: by investing effort cost $E(P_i) = \gamma P_i^2$, a potential entrant succeeds in entering the market with probability P_i . This can be interpreted as the probability of an R&D success that allows the firm to enter the market.¹¹ For simplicity, we assume that the number of potential entrants is sufficiently large that strategic considerations can be ignored when analysing entry decisions. Before entry takes place, there are n incumbent firms in the product market, a fraction q of which are high cost. There are N potential entrants, a fraction θ of which are high cost. The parameters θ and q may differ. We assume that the entrant cannot target in advance who her future neighbours will be, and after entry all firms can adjust their locations on the circle so as to preserve maximum differentiation before competing in prices.¹²

Before analysing equilibrium entry, we need to explain why any high-cost firms would enter in this model. With sufficiently low product market competition, high-cost entrants can cover their entry costs, so they would be willing to enter if they could secure the necessary financing. But in order for banks to be willing to finance high-cost entrants, we need the assumption that banks have an exogenous opportunity cost of capital, in particular one that is not determined by existing low-cost potential entrants. One way to get this is to assume a finite number of low-cost potential entrants at any point in time.

Each potential entrant chooses its entry effort P_i so as to:

$$\max P_i \Pi_i - \gamma P_i^2$$

where Π_i denotes the *post-entry* profit flow of an entrant with unit cost c_i , $i \in \{H, L\}$. This profit flow depends both on the number and type of firms that enter. The post-entry proportion of high-cost firms is:

¹¹ Of course, the parameter γ is likely to differ across industries and countries, reflecting the cost of entry-related investments.

¹² Two points should be noted. First, we do not analyse strategic entry deterrence in this model with asymmetric costs. But deterrence becomes *less* likely when unit transport cost falls, since commitment becomes more of an issue (lower t increases the penalty of not relocating).

Second, we have also analysed a model in which the potential entrant chooses his entry location. In that case the entrant chooses a location between two high-cost incumbents in order to soften price competition. In that model we obtain the same qualitative results – i.e., the selection effect operates both on the composition of entrants and in the post-entry price competition.

$$q' = \frac{nq + \theta NP_H}{n + k} \quad (19)$$

where $k = [\theta P_H + (1 - \theta)P_L]N$ is the expected number of entrants. Post-entry profits for a low-cost entrant are equal to:

$$\Pi_L = t \left(\frac{1}{n'} + q' \frac{\Delta c}{2t} \right)^2 \quad (20)$$

and for a high-cost entrant:

$$\Pi_H = t \left[\frac{1}{n'} - (1 - q') \frac{\Delta c}{2t} \right]^2 \quad (21)$$

where $n' = n + k$ is the post-entry number of firms in the market. The profit-maximising entry probability for a firm of type $i = (L, H)$ is:

$$P_i = \Pi_i / \gamma. \quad (22)$$

We define an *entry equilibrium* as a pair of probabilities $\{P_H, P_L\}$ that satisfies (15) – (18). This system of equations determines P_L and P_H as functions of the primitives $\{n, q, \Delta c, t, \theta, N\}$.

Proposition 6 summarises the comparative statics of entry:

PROPOSITION 6 *In the entry equilibrium, a sufficient condition for $dP_L/dt < 0$ and $dP_H/dt > 0$ is $\partial \Pi_L / \partial t \leq 0$. This condition is equivalent to: (i) $H_0 > 1/nq$ where H_0 is the Herfindahl index (equivalently, $\Delta c/2t > 1/nq$).*

Proof. See Appendix 1.

Recall from Section 1 that $\Pi_L = tD_L^2$. The condition $\partial \Pi_L / \partial t \leq 0$ holds when the selection effect of a decline in t dominates the competition effect. Proposition 6 shows that a reduction in transport costs *encourages entry by low-cost firms*, provided there is sufficient cost asymmetry (equivalently, when concentration is sufficiently high). This finding goes counter to the traditional ‘Schumpeterian effect’ of product market competition that operates when costs are symmetric. However, for high cost firms, the selection and competition effects reinforce each other in discouraging entry.¹³

On the other hand, we can show that the competition effect dominates when the cost asymmetry is sufficiently small *or* unit transport cost is sufficiently high. That is:

¹³ One referee pointed out that an alternative specification is to assume that there is an infinity of possible entrants. If banks view the return to financing a low-cost entrant as the relevant opportunity cost, then only low-cost firms would enter. This is similar to our specification where $\theta \rightarrow 0$ and $n \rightarrow \infty$: the result is that the *ex ante* selection effect of a reduction in t on the composition of entry disappears but the *ex post* selection effect of entry on incumbent firms is strengthened (since any entry lowers average cost in that case).

PROPOSITION 7 As $\Delta c/t \rightarrow 0$, $\partial P_L/\partial t > 0$.

Proof. See Appendix 1.

Thus, when $\Delta c/t$ is small, a decline in t reduces monopoly rents for *all* firms on the circle, and thus discourages entry by both high and low-cost firms. This is the traditional result that *ex post* competition drives out *ex ante* entry.

5. Simulating Welfare Effects

In this Section we simulate the model to do two things. First, we illustrate how subsidising ‘transport cost’ raises welfare and compare these welfare gains to those obtained by alternative policies of subsidising cost reduction effort by firms and entry of new firms. Second, we identify the relative magnitude of the indirect welfare effects from increasing competition – induced market selection, cost reduction, and entry – since ‘traditional’ cost-benefit analysis is not likely to capture them in practice. The simulations involve computing the welfare effects of (1%) changes in the parameters (t, b, γ) , respectively. We can also compute the associated cost of each subsidy.¹⁴ This allows us to compute the marginal social rate of return to each subsidy. In doing this, we treat the transport cost subsidy literally as a subsidy for dt . More generally, of course, the cost of increasing competition would depend on the specific policies adopted to lower t .

The model consists of (1)–(4), (7), (9), (10) and (16)–(19).¹⁵ The welfare effects of each policy change depend on the parameters of the model, $\{\Delta c, t, q, \theta, b, \gamma, n, M\}$. We calibrate the parameters so that the equilibrium outcomes – the Herfindahl index of concentration, the average profit margin, entry rates, and the degree of cost reduction (labour productivity growth) – are consistent with the available microeconomic evidence. We briefly summarise the available evidence below:

Herfindahl index: The typical value of the H-index, averaged across industries, is about 10%. Examples of estimates for industrialising countries include 9.2% for Columbia and 7.9% for Mexico (Roberts and Tybout, 1996), and 5.3% for Russia (24.3% at the regional level; Brown and Earle, 2001). Average values at the 3-digit industry level are similar for the US (US Census of Manufacturers, 2001).

Price-Cost margin: The price-variable cost margin, averaged across industries, for Columbia, Chile, Mexico and Morocco ranges from about 20 to 35% (Roberts and Tybout, 1996). Estimates for OECD countries are broadly similar (Martins *et al.*, 1996).

¹⁴ These costs are $n[qe_H^2 + (1-q)e_L^2]db$ for the subsidy to cost reduction, $N[\theta P_H^2 + (1-\theta)P_L^2]d\gamma$ for the entry subsidy, and $\{(\frac{1}{4n} + \frac{nq(1-q)}{2})(\frac{\Delta c}{2t})^2\}dt$ for the subsidy to transport cost (increasing product market competition). The endogenous variables n, q, P_H, P_L and Δc refer to the equilibrium (post-subsidy) values in the model.

¹⁵ The simulations incorporate the relevant boundary conditions on equilibrium prices, market shares and cost-reducing effort levels.

Entry rates: Average annual entry rates in manufacturing (at plant level) are typically about 10%. Examples include 7.5% for the US (Dunne *et al.*, 1988), 7% for the UK (Geroski, 1991) and about 6% in Canada (Baldwin and Gorecki, 1991). Available estimates for developing countries include 12% in Columbia, 6% in Chile, and 13% in Morocco (Roberts and Tybout, 1996).

Cost reduction: The mean growth rate of labour productivity during the period 1996–2000 in seven of the more advanced transition economies varied from 5.7 to 10.6%, with an unweighted average of 7.7% (computed from Table A.3.8, EBRD, 2001). The mean productivity growth during 1992–7 in seven OECD countries varied from 3.0 in the US to 5.2 in Finland, with a simple average of 4.0% (Nicoletti and Scarpetta, 2003).

We use the following baseline parameter values: $\Delta c = 0.25$, $q = 0.75$, $\theta = 0.5$, $b = 0.5$, $\gamma = 0.35$, $n = 10$ and $N = 10$ (we normalise $c_L = 1$). The proportion of high cost potential entrants (θ) is set lower than for incumbents (q), as is especially likely in industrialising countries. We examine three competition regimes: high competition ($t = 2$), moderate competition ($t = 5$) and low competition ($t = 10$). For the high competition scenario, these parameters generate an H index of 11%, an average price-cost margin of 22%, an aggregate entry rate of 7.9% and average cost reduction of 10%. For the moderate-competition case, the parameters imply an H index of 10%, a price-cost margin of 50%, entry rate of 13.0% and average cost reduction of 10% (while the average is the same, the mix between high and low-cost firms is different from the high competition case). These implications broadly conform to the observed evidence cited above.

Panel (a) in Table 1 presents the marginal social rates of return from each type of subsidy, evaluated at different initial values of t and Δc . In each simulation, all selection, cost reduction and entry effects are taken into account. Turning first to the transport subsidy (column 1), there are large social welfare gains from reducing t . As an example, for $\Delta c = 0.10$ and $t = 2$, the marginal social return is 144% – i.e., spending an extra \$1 on transport cost subsidies increases the sum of consumer surplus and profit by \$2.44.¹⁶ As expected, we find that the welfare gains are much larger when the initial t is low and Δc is high, since that is when selection effects are stronger.

Second, we find large, positive returns to subsidising cost reduction effort (column 2). As we showed in Proposition 5, both the level and mix of cost reduction by high and low-cost firms differ from the (second best) welfare maximising levels. In addition to the wrong mix, it is theoretically possible for the laissez-faire restructuring effort by either type of firm, or in aggregate, to be ‘too high’ due to ‘rent transfer’ effects (rather than too low due to incomplete appropriation of the social surplus). The positive rates of return indicate that this does not occur, at least for the range of parameter values examined.

¹⁶ This is even more striking since, for the range of parameter values examined, the reduction in t actually lowers aggregate profit (this is so because $H < 1/2n$; see Proposition 2).

Table 1
Simulated Welfare Effects

<i>(a) Marginal Social Rates of Return to Subsidy Policies (in %)</i>			
	Transport subsidy ($dt < 0$)	Cost reduction subsidy ($db < 0$)	Entry subsidy ($d\gamma < 0$)
<i>Parameters</i>			
$\Delta c = 0.10$			
$t = 2$	144	87	-65
$t = 5$	165	78	-50
$t = 10$	191	66	-35
$\Delta c = 0.25$			
$t = 2$	173	83	-35
$t = 5$	168	74	-40
$t = 10$	191	64	-31
$\Delta c = 0.50$			
$t = 2$	218	80	-8
$t = 5$	177	68	-21
$t = 10$	192	60	-22

<i>(b) Sources of Welfare Gains from Increasing Competition (in %)</i>		
	Direct effect as % of welfare gain (no selection, cost reduction or entry)	Direct + selection effects as % of welfare gain (no cost reduction or entry)
<i>Parameters</i>		
$\Delta c = 0.10$		
$t = 2$	66	81
$t = 5$	60	62
$t = 10$	52	53
$\Delta c = 0.25$		
$t = 2$	43	107
$t = 5$	57	65
$t = 10$	52	54
$\Delta c = 0.50$		
$t = 2$	18	140
$t = 5$	48	77
$t = 10$	50	57

In sharp contrast, the rates of return to the entry subsidy are negative. There are two countervailing forces at work. The greater entry improves the *ex post* mix of firms via the selection effect (since low cost firms are more likely to enter than high cost ones). This effect is stronger when Δc is larger. However, as with cost reduction effort, the level of entry can be higher than the socially efficient level if the rent transfer effect is strong. For the parameter values examined, the rent transfer effect is strong enough to make the pre-entry level of entry socially excessive and the subsidy only exacerbates it.¹⁷ This negative return is smaller when Δc is higher since that is when the selection effect of entry is stronger. We found that the entry subsidy can generate welfare gains for parameter values outside the range reported

¹⁷ Recall that total demand is fixed in the circular model, so that there is no welfare gain from market expansion.

in the Table (e.g., when the initial cost differential is very large, $\Delta c = 1$). These simulations illustrate that in practice, as well as in theory, the cost-reduction and entry subsidies can either raise or lower welfare, since the level and mix of cost reduction and entry in the model can be either higher or lower than the socially efficient level.

In addition to the three subsidies analysed above, one might consider a direct subsidy to production cost. If the same per unit subsidy is applied to low and high cost firms, the degree of cost asymmetry is unchanged. Since the levels of demand, restructuring and entry all depend on the degree of cost asymmetry – see (4), (5), (12), (13), (20) and (21) – the production cost subsidy induces no selection or other indirect effects. In the absence of such externalities, the marginal, net social return to this subsidy is always zero. Of course, this would not be the case if a different production cost subsidy were imposed on low and high cost firm but, as we emphasised in Section 3.2, the theory offers no general guidance as whether or not a differential subsidy is actually socially efficient.

In Panel (b) we illustrate how well ‘traditional’ cost-benefit analysis (CBA) might be expected to capture the welfare effects of a policy to increase competition ($dt < 0$). The first column includes only the direct welfare effect of a reduction in t , without accounting for the selection, induced cost reduction, or entry effects. This would be the case if current market shares and cost levels were used to conduct the cost-benefit analysis. The first finding is that CBA substantially understates the welfare gains from competition-enhancing policies, even when the initial level of t is high (i.e., selection effects are weaker). For example, with a 25% cost differential and moderate competition ($t = 5$), the direct welfare effect of a reduction in t accounts for only 57% of the total effect.

The second column in Panel (b) includes the selection effect of a reduction in t , but excludes the induced changes in cost reduction and entry. As expected, the selection effect (given by the difference between columns 2 and 1) is larger when the initial Δc is higher or t is lower. The important finding is that ignoring the effects of competition on cost reduction effort and entry can also lead to a large error, especially when the initial level of competition is moderate or low. For example, when $\Delta c = 0.25$ and $t = 5$, the direct and selection effects only account for about 65% of the total welfare gain of reducing t – the rest being due to the induced changes in cost reduction and entry. The entries in column 2 that are larger than 100% reflect the fact that, because the initial level of entry (or cost reduction) can be socially excessive, the induced changes from a reduction in t can actually lower welfare.

6. Concluding Remarks

This paper develops a simple framework for analysing the welfare effects of policies and infrastructure that intensify product market competition. We showed that such policies increase productivity by:

- (i) reducing the market share of less efficient firms (the *market selection effect*);
- (ii) increasing the incentive of firms – particularly low-cost firms – to reduce costs (the *restructuring effect*);
- (iii) stimulating entry by new low-cost firms (the *entry effect*).

The magnitude of these effects depends on the characteristics ('initial conditions') of the economy. We use simulations to illustrate that these effects can be large, and that they are not likely to be captured by 'traditional' cost-benefit analysis.

There are several directions in which to extend the research in this paper. The first is to extend the welfare analysis to the context of a full-fledged endogenous growth model where new entry corresponds to productivity-increasing innovations. This would allow us to study the effects of growth on the private and social incentives for competition-increasing policies and provide a framework to study the interplay between vested interests and growth in a political economy context. The second, related extension is to develop a richer political economy framework which incorporates workers who vote, a labour market that potentially delinks their vested interests from those of individual firms, and a mechanism for potential entrants to influence policy choices. On the empirical side, there is a need for more micro-level work research to test the implications of competition-enhancing policies and infrastructure predicted by the model.

Appendix 1

Expected Transport Costs: To derive expected total transport cost in equilibrium, we consider two neighbouring firms at random and calculate the transport cost incurred by consumers on the market segment between them. With probability $P_{hh} = q(nq - 1)/(n - 1)$, both firms have high costs and share the market segment equally. Consumers incur total transport costs on the segment equal to

$$K_T^a = t \left[\int_0^{\frac{1}{2n}} x dx + \int_{\frac{1}{2n}}^{\frac{1}{n}} \left(\frac{1}{n} - x \right) dx \right] = \frac{t}{4n^2}. \quad (23)$$

With probability $P_{ll} = (1 - q)[n(1 - q) - 1]/(n - 1)$ both firms have low costs and share the market segment equally, with transport costs equal to: $K_T^b = t/4n^2$. With probability $P_{hl} = 2q(1 - q)n/(n - 1)$, one firm is high cost and the other is low cost, with consumers transport costs equal to

$$K_T^c = t \left[\int_0^{\bar{x}} x dx + \int_{\bar{x}}^{\frac{1}{n}} \left(\frac{1}{n} - x \right) dx \right],$$

where $\bar{x}$ satisfies the indifference condition: $p_H + t\bar{x} = p_L + t(1 - \bar{x})$. Using the equilibrium values of p_H and p_L , we get $\bar{x} = 1/2n - \Delta c/4t$. Thus

$$K_T^c = \frac{t}{4n^2} + t \left(\frac{\Delta c}{4t} \right)^2.$$

Using these expressions, we can write total expected transport costs $K_T = n(P_{hh}K_T^a + P_{ll}K_T^b + P_{hl}K_T^c)$ as:

$$K_T = \frac{t}{4n} + \frac{n^2 q(1-q)t}{2(n-1)} \left(\frac{\Delta c}{2t} \right)^2.$$

For large n , this simplifies to the second set of terms in (7). $\square$

Proof of Proposition 2

The Herfindahl index is $H_0 = n[qD_H^2 + (1-q)D_L^2]$ where D_j denotes the market share of firm j . From the equilibrium market shares $D_H = 1/n - (1-q)\Delta c/2t$ and $D_L = 1/n + q\Delta c/2t$, we get

$$H_0 = \frac{n^2 q(1-q) \left(\frac{\Delta c}{2t} \right)^2 + 1}{n}. \quad (24)$$

Thus $\partial H_0 / \partial t < 0$, which proves part (i) of the proposition. Let $m_j = (p_j - c_j) / c_j$ denote the profit margin for firm of type j . Using the expressions for the equilibrium prices p_H and p_L , (1) and (2) in the text, we get $\partial m_j / \partial t > 0$, which proves part (ii). Now use the fact that $\Pi_j = tD_j^2$ to write the aggregate profit margin as

$$M = n[q\Pi_H + (1-q)\Pi_L] = tH_0.$$

From the expression for H_0 , $\partial M / \partial t = 1/n - nq(1-q)(\Delta c/2t)^2$. Thus $\partial M / \partial t < 0$ if and only if: $(\Delta c/2t)^2 > 1/n^2 q(1-q)$. This condition is equivalent to $H_0 > 2/n$, which proves part (iii). $\square$

Proof of Proposition 4

We derive the perfect equilibrium where each firm with initial cost parameter $c_i^0 \in \{c_H^0, c_L^0\}$ sets effort level $e_i \in \{e_H, e_L\}$ in the first stage, and Nash equilibrium prices $p_i \in \{p_H, p_L\}$ are determined in the second stage. For given p_i s, the Nash efforts are determined by

$$e_i = \operatorname{argmax}_e \{ \max_{p_i} [p_i - c_i(e)] [(p^* - p_i)/t + 1/n] - be_i^2 \}$$

where $i \in \{H, L\}$, $c_i(e) = c_i^0 - e$, and $p^* = qp_H + (1-q)p_L$. Equilibrium prices are given by

$$p_i = \frac{1}{2} \left(\frac{t}{n} + p^* + c_i^0 - e_i \right) \quad (A1.1)$$

so first stage profits are

$$\Pi_i = \left(p^* + \frac{t}{n} - c_i^0 + e_i \right)^2 / 4t - be_i^2. \quad (A1.2)$$

Optimal effort for firm i is

$$e_i = \left(p^* + \frac{t}{n} - c_i^0 \right) / (4bt - 1). \quad (A1.3)$$

Substituting this in the expression for p^* , we get:

$$p^* = \frac{t}{n} + q(c_H^0 - e_H) + (1 - q)(c_L^0 - e_L). \quad (\text{A1.4})$$

Using (A1.1), (A1.3) and (A1.4), we get the equilibrium efforts levels

$$e_H = \frac{1}{2bn} - \frac{(1 - q)\Delta c^0}{4bt - 1} \quad (\text{A1.5})$$

$$e_L = \frac{1}{2bn} + \frac{q\Delta c^0}{4bt - 1}. \quad (\text{A1.6})$$

To introduce a ‘catch-up’ advantage for high-cost firms, we specify effort costs of be_L^2 for low-cost firms and $\max\{be_H^2 - \beta\Delta c^0 e_H, 0\}$ for high-cost firms, where $\beta \geq 0$. Following the same derivation as before yields equilibrium effort levels

$$e_H^* = \frac{1}{2bn} - \frac{\left[1 - q - \frac{\beta}{2b}(4bt - q)\right]\Delta c^0}{4bt - 1} \quad (\text{A1.7})$$

$$e_L^* = \frac{1}{2bn} + \frac{q(1 - \frac{\beta}{2b})\Delta c^0}{4bt - 1} \quad (\text{A1.8})$$

provided that $e_j^* \in [0, c_j^0]$ for $j = L, H$. $\square$

Proof of Propositions 6 and 7

The entry equilibrium satisfies the first-order conditions:

$$\gamma P_L = \Pi_L[t, n(P_H, P_L), q(P_H, P_L)] \quad (\text{A1.9})$$

$$\gamma P_H = \Pi_H[t, n(P_H, P_L), q(P_H, P_L)] \quad (\text{A1.10})$$

where P_L and P_H denote the probability of entry by low and high-cost firms, respectively, and

$$\Pi_L = t(1/n + q\Delta c/2t) \quad (\text{A1.11})$$

$$\Pi_H = t[1/n - (1 - q)\Delta c/2t] \quad (\text{A1.12})$$

$$n = n_0 + N[\theta P_H + (1 - \theta)P_L] \quad (\text{A1.13})$$

$$q = (q_0 n_0 + N\theta P_H) / \{n_0 + N[\theta P_H + (1 - \theta)P_L]\}. \quad (\text{A1.14})$$

Totally differentiating (A1.9) and (A1.10), we get:

$$\begin{bmatrix} A_{11} & A_{12} \\ A_{21} & A_{22} \end{bmatrix} \begin{bmatrix} dP_L \\ dP_H \end{bmatrix} = \begin{bmatrix} \Pi_{L,t} dt \\ \Pi_{H,t} dt \end{bmatrix}$$

where

$$\begin{aligned} A_{11} &= 2\gamma - \Pi_{L,n} n_L - \Pi_{L,q} q_L \\ A_{22} &= 2\gamma - \Pi_{H,n} n_H - \Pi_{H,q} q_H \\ A_{21} &= -(\Pi_{H,n} n_L + \Pi_{H,q} q_L) \\ A_{21} &= -(\Pi_{L,n} n_H + \Pi_{L,q} q_H). \end{aligned}$$

In these terms, the subscripts n and q refer to the derivatives of Π with respect to those variables, and the subscripts L and H in q and n refer to the derivatives of q and n with respect to P_L and P_H . Using (A1.11)–(A1.14) to evaluate these derivatives, we get:

$$A_{11} = \gamma + tN(1 - \theta)D_L^2/n > 0$$

$$A_{22} = \gamma + tN\theta D_L D_H/n > 0$$

$$A_{21} = tN(1 - \theta)D_L D_H/n > 0$$

$$A_{12} = tN\theta D_L D_H/n > 0.$$

It is easy to verify that $\det \mathbf{A} > 0$. We obtain:

$$\frac{dP_L}{dt} = \frac{A_{22}\Pi_{L,t} - A_{12}\Pi_{H,t}}{\det \mathbf{A}} \quad (\text{A1.15})$$

$$\frac{dP_H}{dt} = \frac{A_{11}\Pi_{H,t} - A_{21}\Pi_{L,t}}{\det \mathbf{A}} \quad (\text{A1.16})$$

We know that $\Pi_{H,t} > 0$. Therefore, if $\Pi_{L,t} < 0$, we have $dP_L/dt < 0$ and $dP_H/dt > 0$. This establishes the first part of Proposition 6. From (A1.11), $\Pi_{L,t} < 0$ if and only if $\Delta c/2t > 1/qn$. Using the expression for the Herfindahl index, $H_0 = 1/n + nq(1 - q)(\Delta c/2t)^2$, this condition is equivalent to $H_0 > 1/qn$. This proves the second part of the proposition.

To prove Proposition 7, observe that $\Delta c/t \rightarrow 0$ implies that $\Pi_{L,t} = \Pi_{H,t} = 1/n^2$, $A_{22} = 2\gamma + 2tN\theta/n^2$ and $A_{12} = 2tN\theta/n^2$. It follows directly that $dP_L/dt > 0$. $\square$

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References

- Acemoglu, D., Aghion, P. and Zilibotti, F. (2002). 'Distance to frontier, selection, and economic growth', NBER Working Paper 9066.
- Acemoglu, D., Johnson, S. and Robinson, J. (2001). 'The colonial origins of comparative development: an empirical investigation', *American Economic Review*, vol. 91, pp. 1369–401.
- Aghion, P., Bloom, D., Blundell, R., Griffith, R. and Howitt, P. (2002). 'Competition and innovation: an inverted U relationship'. NBER Working Paper 9269.
- Aghion, P. and Howitt, P. (1992). 'A model of growth through creative destruction', *Econometrica*, vol. 60(2), pp. 323–51.
- Aghion, P., Harris, C. and Vickers, J. (1997). 'Competition and growth with step-by-step innovations: an example', *European Economic Review, Papers and Proceedings*, vol. 41, pp. 771–82.
- Baily, M., Hulten, C. and Campbell, D. (1992). 'Productivity dynamics in manufacturing plants', *Brookings Papers on Economic Activity: Microeconomics*, pp. 187–267.
- Baldwin, J. and Gorecki, P. (1991). 'Firm entry and exit in the Canadian manufacturing sector', *Canadian Journal of Economics*, vol. 24, pp. 300–23.
- Blanchard, O. and Giavazzi, F. (2001). 'Macroeconomic effects of regulation and deregulation in goods and labor markets', NBER Working Paper 8120.
- Blundell, R., Griffith, R. and van Reenan, J. (1999). 'Market share, market value and innovation in a panel of British manufacturing firms', *Review of Economic Studies*, vol. 66(3), pp. 529–54.
- Brown, J.D. and Earle, J. (2001). 'Competition-enhancing policies and infrastructure: evidence from Russia', Stockholm Institute on Transition Economics, Staff Paper No. 01/04 (August). Stockholm School of Economics.
- Census of Manufacturers (2001). *Concentration Ratios in Manufacturing: 1997 Economic Census of Manufacturers*, Washington DC: U.S. Department of Commerce.
- Dasgupta, P. and Stiglitz, J. (1980). 'Industrial structure and the nature of innovative activity', *ECONOMIC JOURNAL*, vol. 90(358), pp. 266–93.
- Demsetz, H. (1972). 'Industry structure, market rivalry, and public policy', *Journal of Law and Economics*, vol. 16(1), pp. 1–10.
- Disney, R., Haskell, J. and Heden, Y. (2003). 'Restructuring and productivity growth in UK manufacturing', *ECONOMIC JOURNAL*, vol. 113(489), pp. 666–94.
- Dixit, A. and Stiglitz, J. (1977). 'Monopolistic competition and optimum product diversity', *American Economic Review*, vol. 67(3), pp. 297–308.
- Djankov, S., La Porta, R., Lopez-de-Silanes, F. and Shleifer, A. (2002). 'The regulation of entry', *Quarterly Journal of Economics*, vol. 117(1), pp. 1–37.
- Dunne, T., Roberts, M. and Samuelson, L. (1988). 'Patterns of firm entry and exit in US. manufacturing industries', *Rand Journal of Economics*, vol. 19(4), pp. 495–515.
- European Bank for Reconstruction and Development (2001). *Transition Report 2001*, London: EBRD.
- Farrell, J. and Shapiro, C. (1990). 'Horizontal mergers: an equilibrium analysis', *American Economic Review*, vol. 80(1), pp. 107–26.
- Fernald, J. (1999). 'Roads to prosperity? Assessing the link between public capital and productivity', *American Economic Review*, vol. 89 (3), pp. 619–37.
- Geroski, P. (1991). *Market Dynamics and Entry*, Oxford: Basil Blackwell.
- Grossman, G. and Helpman, E. (2001). *Special Interest Politics*, Cambridge MA: MIT Press.
- Hart, O. (1983). 'The market mechanism as an incentive scheme', *RAND Journal of Economics*, vol. 14, (Autumn), pp. 366–82.
- Knack, S. and Keefer, P. (1995). 'Institutions and economic performance: cross-country tests using alternative institutional measures', *Economics and Politics*, vol. 7, pp. 207–27.
- Martins, J., Scarpetta, S. and Pilat, D. (1996). 'Mark-up ratios in manufacturing industries – estimates for 14 OECD countries', OECD Economics Department, Working Paper 162.
- McMillan, J. (1997). 'Markets in transition', in (D. Kreps and K. Wallis), *Advances in Economics and Econometrics*, vol. 2, pp. 210–39, Cambridge: Cambridge University Press.
- McMillan, J. and Woodruff, C. (1999). 'Interfirm relationships and informal credit in Vietnam', *Quarterly Journal of Economics*, vol. 114, pp. 1285–320.
- Murphy, K., Shleifer, A. and Vishny, R. (1989). 'Industrialisation and the big push', *Journal of Political Economy*, vol. 97(5), pp. 1003–26.
- Nickell, S. (1996). 'Competition and corporate performance', *Journal of Political Economy*, vol. 104, pp. 724–46.
- Nicoletti, G. and Scarpetta, S. (2003). 'Regulation and growth: OECD evidence'. *Economic Policy*, vol. 18(1), pp. 9–72.
- Pistor, K., Raiser, M. and Gelfer, S. (2000). 'Law and finance in transition economies', *Economics of Transition*, vol. 8, pp. 325–68.

- Roberts, M. and Tybout, J. eds. (1996). *Industrial Evolution in Developing Countries*, New York: Oxford University Press.
- Roeller, L. H. and Waverman, L. (2001). 'Telecommunications infrastructure and economic development: a simultaneous approach', *American Economic Review*, vol. 91 (4), pp. 909–23.
- Salop, S. (1979). 'Monopolistic competition with outside goods', *Bell Journal of Economics and Management Science*, vol. 10, pp. 141–56.
- Scharfstein, D. (1988). 'Product market competition and managerial slack', *RAND Journal of Economics*, vol. 29(1), (Spring), pp. 147–55.
- Schmidt, K. (1997). 'Managerial incentives and product market competition', *Review of Economic Studies*, vol. 64, pp. 191–213.
- Vickers, J. (1995). 'Concepts of competition', *Oxford Economic Papers*, vol. 47(1), pp. 1–23.
- Weingast, B. (1995). 'The economic role of political institutions: market-preserving federalism and economic development'. *Journal of Law, Economics and Organization*, vol. 11, pp. 1–31.