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The Smith Dilemma: Towards A Resolution

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Abstract

The Smith dilemma refers to the inconsistency ('strictly an error') between the Smith theory on the efficiency of the market based on the absence of increasing returns and the Smith theorem on the facilitation of the economies of specialization (which gives rise to increasing returns) by the extent of the market. This paper argues that, despite the prevalence of increasing returns, Adam Smith was largely right on the efficiency of the invisible hand and hence that the Smith dilemma does not really exist. Ignoring separate issues such as environmental disruption, the market is very efficient in coordinating the allocation of resources even in the presence of increasing returns. The efficiency due to the automatic and incentive-compatible adjustments, free trade and enterprise (entry/exit) largely prevails. The Dixit-Stiglitz model shows that the free-entry market equilibrium coincides with the (non-negative profit) constrained optimum when the elasticity of substitution between products is constant. For non-constant elasticities, the divergences between the market equilibrium and the constrained optimum in output levels, in the numbers of firms and in utility levels are shown to be small.

Keywords: Increasing returns, the Smith dilemma, invisible hand, economic efficiency, market.

Many important insights in economics can be traced to Adam Smith (1776), if not earlier. For example, the crowning jewel on the Pareto optimality of a competitive equilibrium is a formal proof of the Smith theory on the efficiency of the indivisible hand of the market.[1] (For a much earlier but less detailed case on this, see Si-ma (104 B.C.)). For another example, the recent emphasis on the economies of specialization (see Cheng & Yang, forthcoming, for a survey) is a formal analysis (though also with many new results) of the Smith theorem on the facilitation of the economies of specialization by the extent of the market through the division of labour.

However, since the Pareto optimality of a competitive equilibrium depends on the absence of increasing returns and since the division of labour gives rise to increasing returns through the economies of specialization, we have the Smith dilemma: '*The inconsistency of the efficiency of the invisible hand (the Smith theory) based on the absence of increasing returns with the facilitation of the economies of specialization (which gives rise to increasing returns) by the extent of the market (the Smith theorem).*' (See Stigler 1951.) In fact, Heal (1999, p.xiii) regards this as an inconsistency ('strictly an error') of Smith. (Compare the 'conflict' discussed by Donald 1997.) This paper argues that, interpreted in a practical sense, Smith was in fact correct on both points. Section 1 presents a verbal argument on the resolution of the Smith dilemma. Section 2 uses the Dixit-Stiglitz model to support the argument in Section 1.

1. Towards A Resolution of the Smith Dilemma

First-year economics allows us to see the incompatibility of increasing returns with perfect competition. A perfectly competitive firm faces a horizontal demand curve for its product and also cannot influence input prices. In the presence of increasing returns, its average cost is falling and its marginal cost curve lies below its AC curve. If this situation persists and the price is high enough such that some production is better than no production, the firm will keep increasing its profit by increasing output. Eventually, it must become too large to remain perfectly competitive. As early as

[1] While there are different senses in Smith's usage of the indivisible hand (e.g. see Rothschild 1994, Ahmad 1990), the commonly used interpretation is clear.

Marshall (1920), attempts have been made to save perfect competition from the devastation of increasing returns by confining increasing returns to those resulting from external effects between the production processes of different firms rather than from the internal economies within the firm. Each firm sees its average cost as not falling with its output, though the average costs of all firms fall as the whole industry expands. We may then have a competitive equilibrium though, without tackling the external economies, Pareto optimality is in general absent. (See Chipman 1970, Romer 1986, Suzuki 1996 for formal analysis). More importantly, while such external economies capture an important aspect of the real economy, the equally important factors of internal economies and product differentiation have been abstracted away.

Buchanan & Yoon (1999) attempt to resolve the Smith dilemma. Their basic point is this. If the increasing returns are due to the facilitation of more economies of specialization by a larger market, it is generalized increasing returns at the level of the whole economy or the whole network of division of labour. This type of increasing returns may be consistent with perfect competition. Will it be Pareto-optimal in the absence of other problems? Buchanan believes that the market equilibrium is sub-optimal with respect to the amount of work. This issue is discussed in Ng & Ng (2003). Here, ignoring work-leisure choice as well as external economies, consider the implications of increasing returns from internal economies.

Strictly speaking, the existence of a (perfectly) competitive equilibrium in practice is clearly impossible. The prevalence of increasing returns rules out the universality of perfect competition and the virtual universality of product differentiation makes perfect competition a rare exception. Marginal-cost pricing equilibrium is also impractical as, in the presence of increasing returns, it involves losses. Thus, in a sense, Heal is correct in saying that the Smith theory on the efficiency of the invisible hand is inconsistent ('strictly an error'; 1999, p.xiii) with the Smith theorem on the economies of specialization. However, it may be reasonably argued that Smith was both correct on the efficiency of the invisible hand and on the economies of specialization, at least to a very large extent.

Ignoring external effects, ignorance/irrationality, and occasional major failures like financial crisis and depressions (and possibly as caused by informational asymmetry on which see Stiglitz 2002), which are issues largely separate from the consistency between the efficiency of the invisible hand and increasing returns, the real market economy is very efficient (though not 100% efficient) in coordinating the separate activities of individual decision makers in the economy despite the widespread prevalence of increasing returns and the rarity of perfect competition. The economies of specialization (especially with the additional power of learning by doing and exogenous technical progress) made possible by the division of labour also do lead to increasing returns at the economy level and propel economic growth and the evolution of economic organization. Provided that Smith did not intend to mean that the invisible hand is 100% efficient (in the same sense of the perfect Pareto efficiency of an Arrow-Debreu model of perfect competition which has never existed 100% in the real world), he was correct both in the Smith theory and the Smith theorem! The real market economy is characterized both by high (even if imperfect) efficiency and increasing returns; there is really no Smith dilemma. In this perspective, it is misleading to say that 'the fact that a competitive equilibrium has a desirable property is of no significance if such an equilibrium does not exist' (Vohra 1994, p.102). Even if a competitive equilibrium does not exist, many features that define a competitive equilibrium largely exist in the real market economy and these features make the real economy largely efficient. (Our remark here and below refers to most advanced countries with free enterprise, property rights and the rule of law.)

The features that make both the real economy and the imaginary perfectly competitive economy efficient include: the use of the price system, automatic market coordination, incentive-compatible decisions through the utility and profit maximization of individual consumers and producers, free trade and free enterprise (entry/exit). Compared to the real economy, the imaginary economy has the additional feature of perfect competition, making it perfectly efficient (ignoring problems like external effects). Largely speaking, the real economy possesses all these features except perfect competition. However, due to free entry/exit, competition remains high, making it largely efficient. (More on this below and the next section.)

The above common-sense point is very difficult to establish rigorously since it applies only 'largely speaking', not perfectly. Not only small inefficiencies may exist as remarked above, we cannot even rule out occasional large inefficiencies, especially when the dynamic perspective is explicitly taken into account. In the presence of increasing returns, 'A technology that improves slowly at first but has enormous long-term potential could easily be shut out, locking an economy into a path that is both inferior and difficult to escape' (Arthur 1994, p.10). The real case of the elimination of the technically superior Beta by VHS in video cassettes may also be recalled.

It may be thought that, even ignoring such occasional large inefficiencies (which may become more frequent in the future with the increase in importance in the role of knowledge and increasing returns in the economy), the remaining inefficiencies may still be large. For a firm with a high degree of monopolistic power (or in the presence of perfect contestability, for a firm with a high degree of increasing returns), if it were willing to increase output, efficiency would be significantly improved. So, how could the initial situation with $MR=MC<MV=AC$ be said to be highly efficient? This alleged high inefficiency is based on comparing the actual situation with some infeasible situation. If we are confined to feasible situations, the degree of inefficiency will be much less. It is true that, the market solution need not even be (non-negative profit) constrained optimal. But the divergence, if any, of the market solution from the constrained optimum is much less than that from the unconstrained optimum.

For the case of a constant elasticity of substitution, Dixit & Stiglitz (1977) show that the market equilibrium in fact coincides with the constrained optimum, irrespective of the degree of the constant elasticity of substitution. This result may be roughly explained intuitively. The higher the elasticity of substitution (the more the product of one producer is substitutable to that of another), the more price elastic is the demand for the product of any one producer. Profit maximization thus results in less markup of price above marginal cost. Thus, the larger is the output per producer and the lower is the number of producers. However, the higher the elasticity of substitution also means that it is less important to have a large number of producers/products. This makes the requirement of constrained optimality coincides with that of MR=MC of profit maximization. For the case of a variable elasticity of substitution, precise optimality cannot be ensured. Dixit and Stiglitz show that no general conclusion could be obtained. (The lack of definite general conclusions is also obtained by other analysts; see, e.g. Spence 1976, Lancaster 1979, Hart 1985, Ireland 1985.) Nevertheless, it is our contention that, since we have precise optimality for the case of constant elasticity, the divergence in terms of welfare losses for the general case is unlikely to be very large for most cases, as they are unlikely to diverge from the case of a constant elasticity (at whatever value) by a big margin,. This point is shown more rigorously in the next section not only for absolute and relative welfare losses but also for output levels and the number of firms.

2. The Efficiency of the Market: A Simulation Using the Dixit-Stiglitz Model

Dixit & Stiglitz (1977) show that the market equilibrium in fact coincides with the constrained optimum in the case of a constant elasticity of substitution (irrespective of the degree of this constant elasticity), but they did not coincide in the case of a variable elasticity of substitution. In this section, we show that the divergences in the output level, the number of firms, and in utility between the market equilibrium and the constrained optimum are very small both absolutely and relative to the divergences with the unconstrained optimum in the case of a variable elasticity of substitution.

The utility function is

$$u = x_0^{1-\gamma}\{\sum_i v(x_i)\}^\gamma$$

with v increasing and concave, $0<\gamma<1$. Following Dixit and Stiglitz (1977), we define

$$\frac{1+\beta(x)}{\beta(x)} = -\frac{v'(x)}{xv''(x)}$$

$$\rho(x) = \frac{xv'(x)}{v(x)}$$

$$\omega(x) = \frac{\gamma\rho(x)}{[\gamma\rho(x)+(1-\gamma)]}$$

We can write the DD curve and the demand for the numeraire as

$$x = \frac{I}{np}\omega(x), \quad x_0 = I[1-\omega(x)]$$

Three equilibria are considered: the Chamberlinian equilibrium (i.e. market equilibrium with free entry/exit), the constrained optimum, and the unconstrained optimum. Denote p as the price of product, x as the output level, n as the number of firms, I as income. These equilibria results are following.

For the Chamberlinian equilibrium,

x_e is defined by

$$\frac{cx_e}{a+cx_e} = \frac{1}{1+\beta(x_e)},$$

and

$$p_e = c[1+\beta(x_e)],$$

$$n_e = \frac{I\omega(x_e)}{a+cx_e},$$

$$u_e = x_o^{1-\gamma}[n_e v(x_e)]^{\gamma}.$$

where a is the fixed cost, c is marginal cost, subscript e stands for the Chamberlinian equilibrium.

For the constrained optimum,

x_c is defined by

$$\frac{cx_c}{a+cx_c} = \frac{1}{1+\beta(x_c)} - \frac{\omega(x_c)x_c\rho'(x_c)}{\gamma\rho(x_c)},$$

and

$$p_c = c[1+\beta(x_c)],$$

$$n_c = \frac{I\omega(x_c)}{a+cx_c},$$

$$u_c = I\gamma^{\gamma}(1-\gamma)^{1-\gamma}\frac{[\frac{\rho(x_c)v(x_c)}{a+cx_c}]^{\gamma}}{\gamma\rho(x_c)+(1-\gamma)}.$$

Where the subscript c stands for the constrained optimum.

For the unconstrained optimum,

x_u is defined by

$$\frac{cx_u}{a+cx_u} = \rho(x_u),$$

and

$$p_u = c,$$

$$n_u = \frac{I\gamma}{a+cx_u},$$

$$u_u = [nv(x_u)]^\gamma [1 - n_u(a+cx_u)/I]^{1-\gamma} I^{1-\gamma}.$$

Where the subscript u stands for the unconstrained optimum

If we specify $v(x) = e^{-0.1x} x^\alpha$, $\alpha = 0.5$, $c = 1, a = 100, \gamma = 0.5, I = 10000$, we have following simulation results, they are summarized in Table 1.

Table 1: Simulation results for three equilibria

	Output level	Number of firms	Utility
The Chamberlinian equilibrium	$x_e = 1.31221$	$n_e = 26.5932$	$u_e = 441.799$
The constrained optimum	$x_c = 1.82918$	$n_c = 23.6421$	$u_c = 449.656$
The unconstrained optimum	$x_u = 4.56356$	$n_u = 47.8178$	$u_u = 568.865$

From Table 1, we can see that the divergences in output level, in the number of firms, and in welfare (utility) between the market equilibrium with free entry/exit (the Chamberlinian equilibrium) and the constrained optimum are very small and also small relative to the divergences with the unconstrained optimum. To examine the sensitivity of the results, we undertake the following comparative statics analysis for various parameters. First, for a given set of parameters, $\alpha = 0.5$, $c = 1$, $\gamma = 0.5$, $I = 10000$, we examine how an increase in fixed cost a affects the various endogenous variables n, x, u for the three equilibria, $u_c - u_e$ and $\frac{u_c - u_e}{u_u - u_c}$, the results are shown in Table 2.

Table 2: Comparative statics for fixed cost *a*

a	100	200	300	400	1000	2500
x_e	1.31221	1.32579	1.3304	1.33272	1.33692	1.33861
x_c	1.82918	1.84977	1.85676	1.86027	1.86664	1.8692
x_u	4.56356	4.76719	4.84119	4.87948	4.95074	4.98012
n_e	26.5932	13.3463	8.90882	6.68586	2.67743	1.07147
n_c	23.6421	11.8681	7.92272	5.94608	2.38136	0.953015
n_u	47.8178	24.418	16.402	12.3494	4.97537	1.99602
u_e	441.799	313.722	256.63	222.322	140.793	89.092
u_c	449.656	319.401	261.19	226.371	143.369	90.6943
u_u	568.865	406.809	333.462	289.364	183.225	116.341
$u_c - u_e$	7.857	5.679	4.56	4.049	2.576	1.6023
$\frac{u_c - u_e}{u_u - u_c}$	0.066	0.065	0.063	0.064	0.065	0.062

Where $a = 2500$ is the critical value to make $u_c \approx u_e, n \approx 1$. We can see that the welfare levels between the market equilibrium and the constrained optimum converge as the fixed cost a increases; there is a critical value for a to make welfare between the market equilibrium and the constrained optimum equal.

Next, we examine the comparative statics for the income parameter *I*. For a given set of parameters, $\alpha = 0.5$, $c = 1, a = 100, \gamma = 0.5$, we see how an increase in income *I* affects the various endogenous variables *n*, *x*, *u* for the three equilibria, $u_c - u_e$ and $\frac{u_c - u_e}{u_u - u_c}$, the results are showed in Table 3.

From Table 3, we can see that the difference in welfare between the market equilibrium and the constrained optimum is very small but this difference increases as income increases, but the ratio $\frac{u_c - u_e}{u_u - u_c}$ remains constant. This constancy result is interesting and comes from the fact that income *I* is only a scale factor which does not affect the elasticity of demand. (In the model here, income *I* may be taken as the product of per-capita income times the number of individuals.)

Thirdly, we examine the comparative statics for the marginal cost parameter c. For a given set of parameters, $\alpha = 0.5$, $a = 100$, $\gamma = 0.5$, $I = 10000$, we see how an increase in marginal cost c affects the various endogenous variables n, x, u for the three equilibria, $u_c - u_e$ and $\frac{u_c - u_e}{u_u - u_c}$, the results are showed in Table 4.

It can be seen that, while the relevant divergences change as c changes, the divergences between the market equilibrium and the constrained optimum remain low in output levels, the numbers of firms, and in utility levels, both absolutely and relative to the divergences with the unconstrained optimum.

Fourthly, for a given set of parameters, $c = 1$, $a = 100$, $\gamma = 0.5$, $I = 10000$, we see how a change in sub-utility parameter α affects the various endogenous variables n, x, u for the three equilibria, $u_c - u_e$ and $\frac{u_c - u_e}{u_u - u_c}$, the results are showed in Table 5.

Table 3: Comparative statics for income I

I	1000	5000	9000	10000	11000	15000
x_e	1.31221	1.31221	1.31221	1.31221	1.31221	1.31221
x_c	1.82918	1.82918	1.82918	1.82918	1.82918	1.82918
x_u	4.56356	4.56356	4.56356	4.56356	4.56356	4.56356
n_e	2.65932	13.2966	23.9339	26.5932	29.2526	39.8898
n_c	2.36421	11.8211	21.2779	23.6421	26.0063	35.4632
n_u	4.78178	23.9089	43.036	47.8178	52.5996	71.7267
u_e	44.1799	220.9	397.62	441.799	486.01	662.7
u_c	44.9656	224.828	404.691	449.656	494.622	674.485
u_u	56.8866	284.433	511.979	568.865	625.752	853.298
$u_c - u_e$	0.7857	3.928	7.071	7.857	8.621	11.784
$\frac{u_c - u_e}{u_u - u_c}$	0.066	0.066	0.066	0.066	0.066	0.066

Table 4: Comparative statics for marginal cost c

c	0.1	0.2	0.3	0.5	1	1.5	2
x_e	1.33692	1.33412	1.33132	1.32579	1.31221	1.299	1.28614
x_c	1.8664	1.86239	1.85816	1.84977	1.82918	1.80912	1.78956
x_u	4.95074	4.90289	4.8564	4.76719	4.56356	4.3831	4.22144
n_e	26.8556	26.7537	26.7333	26.6927	26.5932	26.4963	26.4019
n_c	23.8136	23.794	23.7764	23.7362	23.6421	23.5509	23.4625
n_u	49.7537	49.5145	49.282	48.8359	47.8178	46.9155	46.1072
u_e	445.901	444.838	444.451	443.685	441.799	439.958	438.159
u_c	449.619	449.627	449.634	449.645	449.656	449.646	449.614
u_u	567.823	568.063	568.266	568.574	568.865	568.631	568.015
$u_c - u_e$	3.718	4.789	5.183	5.96	7.857	9.688	8.215
$\frac{u_c - u_e}{u_u - u_c}$	0.031	0.040	0.043	0.050	0.066	0.081	0.068

Table 5: Comparative statics for sub-utility parameter α

α	0.2	0.4	0.6	0.8
x_e	0.288131	0.920343	1.74101	2.68545
x_c	0.364064	1.25895	2.45623	3.8357
x_u	1.82114	3.64804	5.48043	7.31809
n_e	14.5745	23.3307	29.3577	33.7951
n_c	14.0083	21.2461	25.538	28.3139
n_u	49.1057	48.2402	47.4022	46.5905
u_e	307.034	396.708	491.192	609.772
u_c	307.968	401.2461	502.885	631.901
u_u	478.861	530.132	616.627	742.134
$u_c - u_e$	0.934	4.5381	11.693	22.129
$\frac{u_c - u_e}{u_u - u_c}$	0.0055	0.035	0.1028	0.2

Finally, we examine the comparative statics for the utility parameter γ. For a given set of other parameters, $\alpha = 0.5$, $c = 1$, $a = 100$, $I = 10000$, we see how a change in utility parameter γ affects the various endogenous variables n, x, u for the three equilibria, $u_c - u_e$ and $\frac{u_c - u_e}{u_u - u_c}$, the results are showed in Table 6.

Table 6: Comparative statics for utility parameter γ

γ	0.2	0.4	0.6	0.8
x_e	1.31221	1.31221	1.31221	1.31221
x_c	1.68756	1.7708	1.90628	2.17959
x_u	4.56356	4.56356	4.56356	4.56356
n_e	8.33191	19.4781	35.1542	58.8259
n_c	7.52067	17.3274	31.1038	51.8804
n_u	19.1271	38.2542	57.3814	76.5085
u_e	2258.98	723.342	283.339	137.577
u_c	2268.19	731.725	290.969	146.563
u_u	2541.52	896.492	375.804	187.215
$u_c - u_e$	9.21	8.383	7.03	8.986
$\frac{u_c - u_e}{u_u - u_c}$	0.0337	0.0509	0.082	0.22

These results show that, under a wide range of parametric values, the divergences in the output level, the number of firms, and in utility between the market equilibrium and the constrained optimum are very small both absolutely and relative to the divergences with the unconstrained optimum. They also show how the various endogenous variables changes with respect to the changes in the various parametric variables.

3. Concluding Remarks

This paper argues that, despite the prevalence of increasing returns, Adam Smith was largely right on the efficiency of the invisible hand and hence that the Smith dilemma does not really exist. Ignoring separate issues such as environmental disruption, the market is very efficient in coordinating the allocation of resources even in the presence of increasing returns. The efficiency due to the automatic and incentive-compatible adjustments, free trade and enterprise (entry/exit) largely prevails.

To a large extent, Heal is likely to concur, as he writes: "*It is puzzling that although economies of scale are undoubtedly important in reality, our belief in the invisible hand, in the efficiency of competition, seems verified by observation and experience, although not supported by current theory. This suggests that our understanding of economies with increasing returns is far from complete: there may be a role for competition and markets in allocating resources in the presence of increasing returns that we have not yet understood*" (Heal 1999, p.xvi). We certainly agree that more research on increasing returns is needed but the 'puzzle' may also be partly explained by the high degree of efficiency of the market economy as argued above. It may be added that this high degree of efficiency is to a large extent due to the presence of largely free entry/exit of producers. (Nevertheless, free entry/exit contributes to efficiency only in the absence of artificial price maintenance. A combination of price maintenance and free entry could lead to a very inefficient situation.) The importance of this can already be seen in the traditional analysis. The role of the market in coordinating not only the resource allocation problems of an economy of a given network of division of labour but also in coordinating the pattern of division of labour itself is further shown in a framework designed to analyse the division of labor (Yang & Ng 1993), though this coordination is not only done by the price system as such but also by the important function of entrepreneurs. Thus, the generalized increasing returns at the economy level due to the economies of specialization at the individual level can be largely realized through the division of labour facilitated by market coordination. However, the increasing returns at the firm level and the associated efficiency problems have yet to be analyzed in the new framework. Other related issues such as path dependency (and thus the importance of history) due to increasing returns (as ably analyzed by Arthur 1994; see also Dixit & Stiglitz (1977) 2000) also remain to be further explored.

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