INCREASING RETURNS AND THE SMITH DILEMMA

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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.

1. Introduction

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. (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 and Yang, 2004, 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 labor.

However, since the Pareto optimality of a competitive equilibrium depends on the absence of increasing returns and since the division of labor gives rise to increasing returns through

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*This paper is an expansion of some points made in a keynote speech by the first author at the Singapore Economic Review Conference, August 2005 while he was a visiting Goh Keng Swee Professor at the Department of Economics, National University of Singapore.

†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.
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 Winch, 1997.) This paper argues that, interpreted in a practical sense, Smith was in fact correct on both points. Section 2 presents a verbal argument on the resolution of the Smith dilemma. Section 3 uses the Dixit–Stiglitz model to support the argument in Section 2.

2. 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 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 and 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 labor. 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 and 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”; Heal, 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 crises 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 labor 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 and 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.

3. The Efficiency of the Market: A Simulation Using the Dixit–Stiglitz Model

Dixit and 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

\[
U = x_0^{1-\gamma} \left( \sum_i v(x_i) \right)^\gamma,
\]
with \( v \) increasing and concave, \( 0 < \gamma < 1 \). Following Dixit and Stiglitz (1977), we define

\[
\frac{1 + \beta(x)}{\beta(x)} = -\frac{v'(x)}{x v''(x)},
\]

\[
\rho(x) = \frac{x v'(x)}{v(x)},
\]

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

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

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

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

\[
\frac{c x_e}{a + c x_e} = \frac{1}{1 + \beta(x_e)},
\]

and

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

\[
n_e = \frac{I \omega(x_e)}{a + c x_e},
\]

\[
u_e = x_0^{1-\gamma} [n_e v(x_e)]',
\]

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

\[
\frac{c x_c}{a + c x_c} = \frac{1}{1 + \beta(x_c)} - \frac{\omega(x_c) x_c \rho'(x_c)}{\gamma \rho(x_c)},
\]

and

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

\[
n_c = \frac{I \omega(x_c)}{a + c x_c},
\]

\[
u_c = I \gamma^\gamma (1 - \gamma)^{1-\gamma} \left[ \frac{\rho(x_c) v(x_c)}{\gamma \rho(x_c) + (1 - \gamma)} \right]'
\]

where the subscript \( c \) stands for the constrained optimum.
For the unconstrained optimum, \( x_u \) is defined by
\[
\frac{c x_u}{a + c x_u} = \rho(x_u),
\]
and
\[
p_u = c, \quad n_u = \frac{I \gamma}{a + c x_u}, \quad u_u = [n v(x_u)]^{\gamma} [1 - n_u(a + c x_u)/I]^{1-\gamma} I^{1-\gamma},
\]
where the subscript \( u \) stands for the unconstrained optimum.

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

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 \( u_u - u_c \), the results are shown in Table 2.

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 \( u_u - u_c \), 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 \( \frac{u_u - u_c}{u_c - u_e} \) 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.)
Increasing Returns and the Smith Dilemma

### Table 2. Comparative Statics for Fixed Cost $a$

<table>
<thead>
<tr>
<th>$a$</th>
<th>100</th>
<th>200</th>
<th>300</th>
<th>400</th>
<th>1000</th>
<th>2500</th>
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<tr>
<td>$x_e$</td>
<td>1.31221</td>
<td>1.32579</td>
<td>1.3304</td>
<td>1.33272</td>
<td>1.33692</td>
<td>1.33861</td>
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<tr>
<td>$x_c$</td>
<td>1.82918</td>
<td>1.84977</td>
<td>1.85676</td>
<td>1.86027</td>
<td>1.86664</td>
<td>1.8692</td>
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<tr>
<td>$x_u$</td>
<td>4.56356</td>
<td>4.76179</td>
<td>4.84119</td>
<td>4.87948</td>
<td>4.95074</td>
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<td>$n_c$</td>
<td>23.6421</td>
<td>11.8681</td>
<td>7.92272</td>
<td>5.94608</td>
<td>2.38136</td>
<td>0.953015</td>
</tr>
<tr>
<td>$n_u$</td>
<td>47.8178</td>
<td>24.418</td>
<td>16.402</td>
<td>12.3494</td>
<td>4.97537</td>
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<td>$n_e - n_c$</td>
<td>441.799</td>
<td>313.722</td>
<td>256.63</td>
<td>222.322</td>
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<td>261.19</td>
<td>226.371</td>
<td>143.369</td>
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<td>$n_c - n_u$</td>
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<td>406.809</td>
<td>333.462</td>
<td>289.364</td>
<td>183.225</td>
<td>116.341</td>
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<td>4.049</td>
<td>2.576</td>
<td>1.6023</td>
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<tr>
<td>$n_e - n_u$</td>
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<td>0.065</td>
<td>0.063</td>
<td>0.064</td>
<td>0.065</td>
<td>0.062</td>
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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 $\frac{u_c - u_e}{u_c - u_u}$, 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 $\alpha$ affects the various endogenous variables $n$, $x$, $u$ for the three equilibria, $u_c - u_e$ and $\frac{u_c - u_e}{u_c - u_u}$, the results are showed in Table 5.

Finally, we examine the comparative statics for the utility parameter $\gamma$. For a given set of other parameters, $\alpha = 0.5$, $c = 1$, $a = 100$, $I = 10000$, we see how a change in utility...
### Table 4. Comparative Statics for Marginal Cost \( c \)

<table>
<thead>
<tr>
<th>( c )</th>
<th>0.1</th>
<th>0.2</th>
<th>0.3</th>
<th>0.5</th>
<th>1</th>
<th>1.5</th>
<th>2</th>
</tr>
</thead>
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<td>( x_e )</td>
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<td>1.33132</td>
<td>1.32579</td>
<td>1.31221</td>
<td>1.299</td>
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<td>( x_c )</td>
<td>1.8664</td>
<td>1.86239</td>
<td>1.85816</td>
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<td>( x_u )</td>
<td>4.95074</td>
<td>4.90289</td>
<td>4.8564</td>
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<td>23.7764</td>
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<td>49.282</td>
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<td>( u_e )</td>
<td>445.901</td>
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<td>449.619</td>
<td>449.627</td>
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<td>567.823</td>
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\[ u_e - u_c \]

\[ \frac{u_e - u_c}{u_u - u_c} \]

### Table 5. Comparative Statics for Sub-utility Parameter \( \alpha \)

<table>
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<tr>
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<td>( x_u )</td>
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<td>731.725</td>
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</tr>
<tr>
<td>( u_u )</td>
<td>2541.52</td>
<td>896.492</td>
<td>375.804</td>
<td>187.215</td>
</tr>
</tbody>
</table>

\[ u_c - u_e \]

\[ \frac{u_c - u_e}{u_u - u_c} \]

### Table 6. Comparative Statics for Utility Parameter \( \gamma \)

<table>
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<td>1.31221</td>
<td>1.31221</td>
<td>1.31221</td>
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<td>2268.19</td>
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<td>( u_u )</td>
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</table>

\[ u_c - u_e \]

\[ \frac{u_c - u_e}{u_u - u_c} \]
parameter $\gamma$ affects the various endogenous variables $n, x, u$ for the three equilibria, $u_c - u_e$ and $\frac{u_u}{u_c}$, the results are showed in Table 6.

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.

4. 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 labor but also in coordinating the pattern of division of labor itself is further shown in a framework designed to analyze the division of labor (Yang and 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 labor 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 and Stiglitz, 1977; Arrow, 2000) also remain to be further explored.
References


