External Increasing Returns and Production Subsidies in the Case of a Large Country

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Abstract

The strict superiority of production subsidies to increasing returns to scale (IRS) sectors of a small open economy are not justified when these scale effects are driven by world outputs. This paper extends and compares the case of a small country to that of a large country. In a free-trade equilibrium, the national IRS sectors under produce relative to their Pareto optimal levels, calling for a production subsidy to these sectors. Monopoly power of the large country calls for taxation of all exported goods. If some of the exports are subject to IRS, two opposing forces will be at work: the IRS effect will ask for an export subsidy, the terms-of-trade effect will call for export taxes. Hence for modern-day economies the case for state intervention, even in the presence of the externality inherent in external increasing returns, has been exaggerated: it is at best weak for a large country.

Key words: Production Subsidy, Trade Terms, Export Tax

1. Introduction

Chandra, Franck and Naqvi (2002) (hereafter CFN) demonstrate that the strict superiority of production subsidies to increasing returns to scale sectors is *not* justified when these scale effects are driven by world outputs. Their result applies only to a small open economy. This paper extends their model to the case of a large country. In the case of world increasing returns to scale, this paper also compares the results for a small open country *vis-à-vis* a large country. Our model identifies a large array of economic forces, some of which pull in different directions. Specifically, we note that in a free-trade equilibrium, the nationally driven increasing returns to scale sectors under produce relative to their Pareto optimal levels, and this, in turn, calls for a production subsidy to these sectors. On the other hand, monopoly power of the large country in world markets calls for taxation of all exported goods. This taxation improves the terms of trade obtained by restricting the supply of exports to world markets, causing these export prices to rise. Furthermore, if some of the exports exhibit increasing returns to scale, two opposing forces will be at work: the scale effect will ask for an export subsidy, the terms-of-trade effect will call for export taxes on these commodities. Hence for modern-day economies the case for state intervention, even in the presence of the externality inherent in external increasing returns, has been exaggerated: it is weak at best for a large country.

There is a well established result that for a competitive, small open economy in which some sectors have an *external* increasing returns technology, government intervention taking the form of permanent production subsidies to the increasing-returns sectors is strictly superior to free trade. As the story goes, since individual firms fail to take account of the industry-wide benefits of an expansion of their outputs, the economy *under* produces, relative to the Pareto optimum, goods that are subject to external increasing returns. Were all individual firms to expand their outputs, however, there would be an increase in the number of stages of production, occasioned, in turn, by the availability of more numerous categories of specialized workers. It is precisely because atomistic firms do not perceive that they have the ability to increase the division of labor simply by increasing their own outputs that government intervention encouraging the production of goods subject to increasing returns to scale is called for. The idea that increasing returns to scale in production emanate from a greater division of labor is not new to modern economic thought. In fact, Adam Smith considered it so fundamental to the creation of value that he devoted the first three chapters of *The Wealth of Nations* to it. In the opening sentence of Chapter 1, he wrote

> The greatest improvements in the productive powers of labor and the greater part of the skill, dexterity and judgement with which it is anywhere directed, or applied, seem to have been the effects of the division of labor.

The division of labor itself, according to Adam Smith, derives from the

> unique human propensity to truck, barter and exchange one thing for another[*]..... [And] as it is the power of exchanging that gives occasion to the division of labor, so the extent of this division must always be limited by the extent of that power or, in other words, by the *extent of the market*.[†]

In 1951, Stigler drew attention to Smith's theorem, that *the division of labor is limited by the extent of the market*, by appropriating it as the title of his paper in which he succinctly combined the classical theory of increasing returns to scale with the theory of vertical integration.

In late twentieth century, various stages of the production of certain goods have been dispersed around the world. If some stages of production indeed take place beyond national boundaries, then the division of labor is limited by the extent of the world market, and not by the extent of the national market. For example, a cotton shirt in an American department store may be the final product of the following stages: cotton is grown in Pakistan and made into yarn which is then shipped on a Hong Kong carrier to be woven and dyed in Thailand. The fabric is then shipped by a Norwegian freighter to South Korea where it is tailored, packaged and then shipped to the United States where it is further advertised by a Chicago-based firm, and marketed by various firms until it is available on the shelf in a department store in Pensacola, Florida.

With the expansion of international trade in intermediate goods and services, there has been a rise in both the number of stages of production, and in the geographical dispersion of the processes. The range of goods with such geographically dispersed stages of production extends from consumer goods like watches and food products, to heavy machinery, and has been steadily growing with the growth in the world demand for these commodities. Ethier (1979, p. 3) affirms the case for international increasing returns to scale thus,

> Though such a presumption [in favor of *national* output driving increasing returns] may have been quite natural in the nineteenth century, it is surely not so today. Advances in communications and transport have nearly fused the major industrial countries into a singular integrated economy within which former boundaries retain only residual significance as determinants of channels of technological communication.
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> ... Th[e] firms rely on international pools of bankers and managers (not infrequently members of international trade organizations) and operate in a milieu significantly influenced by international bureaucracies and international academic communities. To a large (and increasing) degree, trade consists of exchanges of intermediate industrial goods, significantly classifiable as intra industry-trade even on a fairly disaggregated basis. I doubt that an observer unfamiliar with the existing literature on increasing returns and international trade would ever spontaneously advance that literature's central and universal premise: that decreasing costs depend upon national output and not international output.

More formally, Chipman (1970) further advanced the theory of external IRS when he proved that external or parametric IRS, and perfect competition are consistent in a Walrasian general equilibrium as long as entry and exit of firms in every industry is free. And Panagariya (1980, 1981) extended the theory of external increasing returns and perfect competition to substantiate the case for state subsidies to increasing returns to scale sectors.

While we do not model the stages of production, nor do CFN (2002) and Ethier (1979), we argue that for modern economies, the appropriate externality is one of increasing returns driven not by *national* outputs, but by the *world* outputs, of the increasing returns sectors. In this case, the present paper shows that, for a large country, production subsidies to the increasing-returns sectors may be welfare *reducing*.

This paper expands the model presented in CFN (2002) and compares those results to our results for the large country. Specifically, we ask what is the most direct and optimal policy for a country if its economy is perfectly competitive, large and open, and the technology is mildly IRS in some, but not all, sectors?

[*] *The Wealth of Nations*, Chapter II, pp. 117.
[†] *The Wealth of Nations*, Chapter III, pp. 121 (emphasis added).

How does this result change if the IRS of all those sectors is driven not by the national but the international or world outputs of the respective commodities or activities?

In Section 2, we present a general model with international increasing returns. In Section 3, we analyze the implications of a government subsidy to goods subject to national and international increasing returns in a large open economy. We offer some concluding remarks in Section 4.

2. Two Country Model

While this model is taken directly from CFN (2002), we however make a completely different use of it. Consider a two country setting consisting of intermediate goods, joint production, an arbitrary number of goods and factors and some goods produced with an international increasing returns to scale technology. We further assume the increasing returns to scale are weak and there exist sufficient activities with constant returns to scale technology to preserve a convex production set. Home country variables and rest of the world (ROW) variables are represented by lower-case and upper-case letters respectively. Let $c + C = x + X$ represent the world market equilibrium condition where c and C denote the vectors of all goods consumed and x and X are the vectors of all goods produced. Goods in the x vector may be produced either by an IRS technology or a CRS technology and we explicitly assume a numeraire good is produced under constant returns.

Using the GDP function approach for an increasing returns to scale technology as developed by Helpman (1984), and recently used by CFN (2002), the international trade equilibrium is characterized by the world market equilibrium condition and the requirement that aggregate expenditure equals income in each country:

$$e(P,u) = g(p,a) - sx \tag{1}$$

$$E(P,U) = G(P,a) \tag{2}$$

and

$$e_P(P,u) + E_P(P,U) = g_p(p,a) + G_P(P,a) \tag{3}$$

where p and P are the vectors of domestic relative prices and prices prevailing in the ROW respectively. Also let $p = P + s$, where s is a vector of the home-country government's specific production subsidies to goods produced with increasing returns to scale technology, regardless of whether they are imports or exports. Consequently, the cost of subsidies provided to increasing returns to scale goods in (1) is sx. Also, in (1) - (3) above, $a = x + X$ is the vector of world outputs. It is important to note that $a = a(s, P)$, depends on the home subsidy as well as world prices P. In (1)-(3) above, the national expenditure functions for home and ROW representative agents are denoted $e(P, u)$ and $E(P, U)$, respectively. The GDP functions for home and ROW are denoted $g(p, a)$ and $G(P, a)$ and summarize the production side of the economy. Furthermore, we assume that the subsidy is financed by lump sum taxes.

From standard properties of the GDP function, the domestic output-supply vector is $g_p = x$, where $x > 0$. Hence, $x_i > 0$, for $i = 1,2,..,n$ denotes the domestic output of the ith good. Further, g_a is the additional value added because of the scale effect. Also, $g_{ai} = 0$ if good i is produced with a constant returns to scale technology while, $g_{ai} > 0$ if good i is produced with an international increasing returns to scale technology. Further, $G_P = X$ is the ROW output-supply vector, and $e_p = c(P, u)$ and $E_p = C(P, U)$ are the home and ROW compensated demand functions.

Upon total differentiation of (1) - (3), and as explained below, using the total differential of the vector of output supplies, $dx = \hat{x}_P dP + \hat{x}_s ds$, we have

$$dy = (g_a a_P - m - s\hat{x}_P)dP + (g_a a_s - s\hat{x}_s)ds \tag{4}$$

$$dY = (G_a a_P - M)dP + G_a a_s ds \tag{5}$$

$$c_I dy + C_I dY = (\psi + \Psi)dP + (\hat{x}_s + G_{Pa} a_s)ds \tag{6}$$

where $a_P = (I - g_{pa} - G_{Pa})^{-1}(g_{pp} + G_{PP})$ and $a_s = (I - g_{pa} - G_{Pa})^{-1} g_{pp}$, m and M are import demands, $dy = e_u du$ is the home real income and $dY = E_u dU$ is the ROW real income, both in terms of the numeraire good.

Further, $\psi = (\hat{x}_p - e_{pp})$, $\Psi = (X_P - E_{PP})$, $c_I = \frac{e_{pu}}{e_u}$ and $C_I = \frac{E_{PU}}{E_U}$, where c_I and C_I are the income effect vectors for home and ROW respectively. The output-supply responses to price changes at home and in ROW are $\hat{x}_p = g_{pp} + g_{pa}a_P$, $\hat{x}_s = g_{pp} + g_{pa}a_s$, and $X_P = G_{PP} + G_{Pa}a_P$. By assumption of weak scale effects, these matrices are positive definite.

3. IRS and the Large country

To obtain the expression for change in welfare if the home country is large, substitute (4) and (5) into (6), so that

$$dP = \left[c_I(g_a a_P - m - s\hat{x}_p) + C_I(G_a a_P - M) - (\psi + \Psi)\right]^{-1}\left[\hat{x}_S + G_{Pa}a_S - c_I(g_a a_S - s\hat{x}_S) - C_I G_a a_S\right]ds$$

is the effect of a change in home subsidies on prices in world equilibrium. Assume that $ds + dP > 0$. This assumption ensures that increases in the subsidy rate will not lead to a decrease in the domestic price of the traded good. This condition is a simply adaptation of the *Metzler-Paradox* result applied to the case of production subsidies inclusive of increasing returns to scale, rather than the original context of import tariffs under CRS. Substituting this expression for *dP* into (4) we have the final expression for the change in home welfare

$$dy = \begin{bmatrix} (g_a a_P - m - s\hat{x}_p)\left[c_I(g_a a_P - m - s\hat{x}_p) + C_I(G_a a_P - M) - (\psi + \Psi)\right]^{-1} \\ \left[\hat{x}_S + G_{Pa}a_S - c_I(g_a a_S - s\hat{x}_S) - C_I G_a a_S\right] + (g_a a_S - s\hat{x}_S) \end{bmatrix} ds . \qquad (7)$$

It is to be noted that, in this large country case, for the stability of world equilibrium, a sufficient condition is that the matrix $d[(e_p - g_p) + (E_P - G_P)]/dP$ be negative definite, or that $(\psi + \Psi)$ be positive definite. Of course, if the returns to scale are constant, $\psi + \Psi = (\hat{x}_p - e_{PP}) + (\hat{X}_P - E_{PP}) = (g_{pp} - e_{PP}) + (G_{PP} - E_{PP})$ is positive definite as in Neary (1995). This requirement is none other than the multivariate version of the *Marshall-Lerner* condition.

Contrasting Equation (7) with CFN's Equation (4), which is $dy = (g_a a_s - s\hat{x}_s)ds$, indicates that when scale effects are driven by world outputs, $g_a a_s$ approaches zero since domestic output makes up a negligible fraction of world output. The beneficial scale effect is then overwhelmed by the subsidy cost burden, $-s\hat{x}_s$, reducing the home country's welfare. For a large country, the expression for a change in welfare is considerably more complex. However, a careful examination of (7) reveals an array of economic forces, some of which pull in different directions. In general, these effects are the marginal subsidy costs, the marginal scale benefits of decreasing average costs due to expanded output and, for the large country, the terms of trade effects.

In contrast with a small open economy, a large country can affect world output and therefore economies of scale driven by world outputs, so that, $g_a a_s$ does not approach zero. However, any change in ROW prices and, therefore, output resulting from the subsidy to the increasing returns to scale sectors also results in a deteriorating terms of trade for the large country, $g_a a_P$. The economic force of a large country's monopoly power in trade calls for an export tax to improve its terms of trade rather than a production subsidy. Regardless whether national or world markets drive these scale effects, both effects are present and are likely to at least partially offset one another. Also, in order for a production subsidy to the increasing returns to scale sectors to produce a net improvement in the large country's welfare, the beneficial expansion of output from the subsidy must counteract *both* the cost of the subsidy *and* the terms of trade effects. It should be noted that symmetric supply and demand conditions ($c_I = C_I$, $g_a a_s = G_a a_s$, etc.) are not being considered in this exercise. While it would have an effect on the home country's welfare, such conditions are a special case of the full model. According to Neary (1988), "…the encouragement of exports may form part of the first-best package of intervention in a large open economy. Such as outcome is more likely if demand and supply conditions differ between home and foreign countries."

Although both the terms of trade effect and scale effects are present for a large country when world or national output driven scale effects, the size of the subsidy-cost burden remains the same. Therefore, world markets dilute the output supply response of a production subsidy to the increasing returns to scale sectors in the case of world output driven scale effects. And it is much more likely the cost of the subsidy and the terms of trade effects will outweigh the positive output supply effects of the subsidy. In summary, we find:

Optimal Trade Policy

	National IRS	World IRS
Small Country	Production Subsidy to Increasing Returns to Scale Sectors	Free Trade
Large Country	Free Trade: Welfare effects of Subsidy Ambiguous	Free Trade: Welfare effects of Subsidy Ambiguous Subsidy less likely than with National IRS

4. Conclusion

We note that in a free trade equilibrium, the national increasing returns to scale sectors will under produce goods relative to their Pareto optimal levels, which, in turn, calls for a production subsidy to these sectors. On the other hand, monopoly power of the large country in world markets calls for taxation of all exported goods. This taxation improves the domestic terms of trade by restricting the supply of exports to the world markets, so as to cause the world prices of domestic exports to go up. Furthermore, if some of the exports are subject to increasing returns to scale, two opposing forces will be at work: the scale effect will ask for an export subsidy, but the terms-of-trade effect will want to tax the exporters of these commodities. As a result, the final outcome is ambiguous. In fact, we can conclude from (7) that in a stable equilibrium, the terms-of-trade effect will likely dominate, such that export taxes, and not subsidies, would be optimal for the large country. This result may be compared with CFN (2002), who show that free trade is the optimal policy for a small country subject to world increasing returns to scale.

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