ELSEVIER Journal of International Economics 43 (1997) 1–27

Journal of INTERNATIONAL ECONOMICS

Quota licenses for imported capital equipment: Could bureaucrats ever do better than the market?

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Abstract

Despite valid criticisms, many developing countries have issued non-transferable import licenses to a limited number of final-good producers so as to restrict imports of an input, such as capital equipment. This paper demonstrates that for a given import quota, such licensing restrictions can actually increase domestic production of both the input and the final product, but at the cost of reduced quota rents. Under pure competition, domestic welfare falls relative to the use of marketable quota licenses, but if foreigners would get the quota rents, or if external economies cause decreasing costs, then bureaucratic allocation can dominate.

Keywords: Non-transferable licenses; Import licensing; Marketable quota licenses; Quota rents; Capital good imports; Import restrictions and economic development

JEL classification: F13

1. Introduction

Bureaucratic licensing schemes have frequently been used to restrict imports of intermediate goods, such as capital equipment and machinery, in developing countries, most notably India and Brazil, but also in more successful countries such as Taiwan.[1] These restrictions have been imposed with the idea of developing a domestic manufacturing base in capital goods with appeal typically being made

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[1] In the 1950s and 1960s in Taiwan, firm specific approval was required to import products placed on the 'controlled import items' list to encourage domestic manufacture (see Wade, 1990, pp. 122–126).

PII S0022-1996(96)01457-2

to the 'infant industry argument for protection'. Even if one accepts the argument for infant industry protection, the development of a bureaucracy to directly allocate import licenses seems hard to justify or even comprehend from a standpoint of promoting economic welfare. Not only is the policy instrument far from transparent, the need to negotiate what often seem to be byzantine bureaucratic rules typically results in significant misallocation and higher dead-weight losses. Other more market based policy instruments, such as marketable quota licenses or a tariff, are both more transparent and allocate imports to the highest value use. Assuming policy makers have a genuine desire to promote development, is there any offsetting advantage that might help explain this choice of policy instruments?

This paper examines the implications of bureaucratic import licensing restrictions by focusing on two commonly observed features of such schemes. First, import licenses are allocated only to established producers that directly use the imported input. The import licenses cannot be sold or transferred and, moreover, resale restrictions apply to the imported goods. This non-transferability has often been supported by the use of foreign exchange controls that selectively allocate foreign exchange to individual firms. The second typical feature that proves significant is the tendency for bureaucrats to accept only a proportion of license applications (or of foreign exchange applications), rejecting others, even though the rejected applications are essentially no different. This could be viewed as inequitable for those firms, the non-license holders, that fail to receive any import quota. However, although domestic welfare is reduced if domestic production costs remain constant, a licensing scheme incorporating both features has some perhaps surprising implications for the size of the intermediate-good industry created by import replacement. Specifically, for a given import quota, such a scheme can boost the domestic outputs of both the intermediate and final products above the levels that would be achievable with marketable quota licenses or an equally restrictive tariff.[2]

To achieve this increase in output requires that the firm-level quota allocated to each license holder be raised above the level of the input the firm would purchase if it had to pay the higher domestic price. This reduces the marginal valuation of a license to a license holder (the value of being able to import one more unit) below the marginal valuation of a non-license holder, given by the excess of the domestic price over the import price of the input. Thus, a 'dual-price' market is created in which license holders face a lower implicit price or marginal cost for own use of the input causing them to use their quota allocation so as to produce a higher output than do non-license holders.[3] By contrast, if licenses were marketable, or if

[2]Under pure competition, a quota implemented with marketable licenses is equivalent to a tariff restricting imports to the same level.

[3]A dual-price market could also arise if only exporters can import intermediate inputs duty free up to some limit and resale is prevented. See Rodrik (1994) for examples relating to Taiwan and Korea.

a tariff were used, this equalizes marginal costs across firms, reducing the output of license holders to the same lower level as non-license holders. Since aggregate imports are unchanged, domestic production of the input falls together with final-good output.

Since the distortion caused by the import quota reduces final-good output, raising this output is beneficial. However, output is increased by the use of non-transferable licenses only by driving a wedge between the valuations of different groups of users. This amounts to a further distortion, which lowers welfare by reducing quota rents. The reduced marginal value of an import license to license holders arising from an increase in the firm-level quota, directly lowers the value of quota rents. Since, for a given total quantity of imports, a higher firm-level quota raises the proportion of non-license holders with no choice but to buy domestic, it also raises domestic production of the input. As a consequence, licensing schemes associated with larger increases in domestic output also cause a greater loss in quota rents. Indeed, output is highest under a 'zero-rent' licensing scheme in which license holders are allocated a quota equal to what they would import under free trade and no quota rents are generated.

It is comforting for the standard prescription in favor of marketable licenses that this loss in rents is sufficiently large[4] that, at least in a small country, perfectly competitive setting, the use of marketable quota licenses always dominates bureaucratic allocation when import prices and domestic production costs remain constant. However, if foreign firms would anyway extract the quota rents[5] as occurs when a VER (voluntary export restraint) is the alternative, a 'zero-rent' licensing scheme becomes optimal in a broad class of cases. Viewing this last result in the light of the theory of domestic distortions,[6] it is not so surprising that a seemingly inefficient regulation preventing the formation of a market in licenses can be beneficial in a third best world in which there is both an import restriction and a domestic loss of quota rent. Nevertheless, since VERs are quite common, this result could have some empirical relevance.

A further and perhaps more significant result arises when the domestic costs of intermediate-good production fall with expansion of industry output. Consideration of decreasing costs is natural in this context, since the existence of external economies arising from hands on learning by doing is typically part of the infant industry justification for protection.[7] Given the central result that non-tradable quota licenses can raise domestic output, one might expect that the second best optimal policy would be to institute a bureaucratic scheme at some sufficiently

[4]That quota rents are large is supported by a number of studies (see Feenstra, 1992) showing that the loss of quota rents is a significant part of the cost of a VER.

[5]This is more likely if the foreign suppliers are imperfectly competitive. Imperfect competition in input supply would not fundamentally change the output results.

[6]See Bhagwati et al. (1969).

[7]Gains in experience by workers and managers are not fully captured by individual firms since personnel are free to move to other firms or start up new firms.

large rate of decrease in cost. What is perhaps surprising is that this result holds for any, even a very small, rate of decrease in costs. This suggests that the efficiency argument in favor of marketable quota licenses has something of a knife-edge character.

The above discussion indicates that in a second best context there are legitimate efficiency arguments for the use of bureaucratic licensing schemes and it is possible that policy makers had these ideas in mind when choosing the bureaucratic route. However, these arguments abstract from other costs associated with bureaucratic schemes such as rent-seeking[8] and the cost of the bureaucracy itself. Since, in addition, induced changes in the structure of the industry, such as merger between license holders and non-license holders, could undo the output gains in the long run, there is no implied policy conclusion in favor of bureaucratic schemes.

At a more fundamental level, the paper contributes a new theoretical argument showing that in a setting where the quantity of an input is restricted, the use of licensing regulations to create different prices for different groups of users can at least partly be understood on the basis of output effects in the industry. For example, suppose that a limit is set on the total amount of a polluting chemical, such as refrigerants containing CFCs, that can be used in the products of a particular industry. The desire to limit losses in output and employment might then help explain the use of command and control methods with different levels of enforcement across firms as opposed to issuing marketable permits.

Despite widespread use, as shown by the surveys of trade practices in Trela and Whalley (1991) and Erzan et al. (1989), non-transferable quota licenses have received little attention in the academic literature. Trela and Whalley (1991) also estimate the costs imposed by non-transferable export quota licenses in 'locking out' newer lower cost producers. In Anderson (1987), the non-transferability of export quotas between counties reduces world welfare because it prevents arbitrage in a situation of demand uncertainty. Finally, Krishna and Tan (1996) consider the effects of non-transferability of quota licenses when licenses are sold by the government prior to the revelation of demand uncertainty. Although non-transferability can increase the market price, welfare nevertheless falls when equal weights are given to consumer surplus and revenue. Related work dealing with other trade restrictions applying to intermediate goods includes Grossman (1981) and Vousden (1987), who consider the output and welfare effects of domestic content protection under pure competition.

The paper is organized as follows. Section 2 presents the fundamental insight as to why non-transferability of licenses can raise domestic output. The paper then develops a model to show the implications of this insight for import licensing

[8]Spencer (1996) extends the model to consider rent-seeking in the context of 'Law of the Similars' type schemes in which imports are permitted only if they are sufficiently different from locally produced products.

restrictions applied to intermediate goods. Section 3 provides an overview of the model, Section 4 develops the model and Section 5 explores the central output result. Section 6 then examines welfare effects, with particular attention given to the roles played by quota rents and by decreasing costs in the domestic intermediate goods industry. Finally Section 7 contains concluding remarks.

2. The fundamental idea

To further explain why non-transferable quota licenses can increase domestic output, suppose that the intermediate good can be imported at a price r^F (F for foreign) or produced domestically, but at a strictly higher price r^D (D for domestic). Only a subset of firms (the license holders) receive the non-transferable licenses restricting imports to the quota Q. As illustrated in Fig. 1, under a 'dual-price' licensing scheme, the firm-level quota, denoted $\bar{y}$ exceeds the quantity of the input that the firm would purchase as a non-license holder, reducing the value, denoted λ, of an additional license to a license holder below the value, $\gamma \equiv r^D - r^F$ to a non-license holder. License holders expand production (shown at point B) above the output $y(r^D)$ of a non-license holder (shown at point A).

Suppose now that the licenses are made marketable. If the quota Q is sufficiently restrictive to induce domestic production of the input, a license will command a price $\gamma \equiv r^D - r^F$. Consequently, the marginal cost r^D of the input to (previous) non-license holders is unchanged and hence the output produced by these firms is also unchanged. However, since λ rises to equal γ, this gives rise to a 'unified market' in which license holders also face a marginal opportunity cost $(r^F + \lambda)$ of production equal to r^D. Thus license holders sell licenses so as to reduce output from $\bar{y}$ to $y(r^D)$ (see Fig. 1) causing an unambiguous fall in domestic final-good output. Domestic production of the input also falls since the

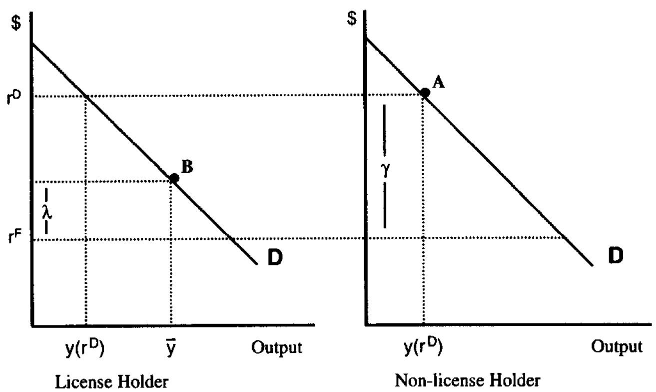

Fig. 1. Intermediate-good market.

purchase of licenses by (previous) non-license holders reduces their demand for the domestically produced input, while (previous) license holders continue to use only imports.[9]

The above argument is very general. It does not depend on particular demand or market conditions and as previously mentioned, it has implications for the use of quota-licenses in other areas, such as pollution control. However, the need to create and maintain dual prices in equilibrium imposes restrictions on the model. The next section further develops the analysis, both to give an understanding of these restrictions and to explore implications for output and welfare.

3. Model overview

A competitive industry consisting of n firms located in the domestic country (the LDC) produces a final good Y, both for export and domestic consumption. The industry is small in world markets and thus is unable to affect the world price p for good Y or the import price r^F of an intermediate good X, such as capital equipment.[10] Three inputs are used to produce good Y: good X, labor L and a specific factor T, which could represent the limited pool of managers with the necessary talent to operate a firm in the industry or, alternatively, some scarce natural resource such as land of a particular type. Capital equipment X is produced domestically by a competitive industry using labor alone at an average cost r^D and, since $r^D > r^F$, it would all be imported under free trade.[11] To close the model, a second (traded) final good Z, also produced by a competitive industry with labor alone, acts as a numeraire. Since labor has a constant marginal product in producing Z, the domestic wage, denoted by w, remains constant.

The fact that only a fixed quantity T^0 of the specific factor is available in the domestic economy creates diminishing returns to labor, making the aggregate output of good Y determinate, even given the small country assumption. The analysis is simplified in the main text by assuming that each final-good producer requires just one (lumpy) unit of the specific factor, which becomes sunk at the time of entry into the industry. This fixes the number $n = T^0$ of domestic final-good producers and also provides a mechanism by which firms can prove they have a legitimate commitment to the industry so as to qualify to apply for an import license. Also for simplicity, production of Y requires the intermediate good X be used in fixed proportion,[12] with the units chosen so that one unit of X is

[9] I am indebted to a referee for suggesting Fig. 1 and this way of explaining the issue.

[10] If $p = p(Y)$ where $p' < 0$, domestic output Y would still increase under 'dual-price' schemes, but by a smaller amount. The terms of trade effect from the fall in p would raise welfare if the good is imported but reduce welfare to the extent that the good is exported.

[11] Domestic and foreign produced units of the input X are homogeneous.

[12] If firms could substitute away from the input, this would reduce the magnitude of the increase in output from a dual-price scheme, but not fundamentally change results.

required for each unit of Y. Hence, assuming that labor exhibits diminishing marginal productivity when combined with one unit of T and using subscripts to represent partial derivatives, the production function is given by

$$Y = \min[X, f(L,1)], \quad \text{where } f_L > 0 \text{ and } f_{LL} < 0. \tag{1}$$

A more realistic and more general, but also more complicated model in which firms can be of different sizes determined by the quantity of their investments in the specific factor, is developed in Appendix A. An ability to handle different sizes of firms is obviously important when considering real world licensing schemes and all the results are shown to carry over. A further contribution is to show the critical importance of the sunk nature of the specific factor in maintaining the dual-prices necessary for the bureaucratic scheme to raise output. As Appendix A shows, if the specific factor were not sunk, it would be sold by non-license holders to licence holders to the point that output is reduced to the same level as under a marketable license scheme. In effect, making the specific factor non-lumpy and fully tradeable has the same implication for overall output as if the import licenses themselves were tradeable. Although the fundamental effect driving these results is not limited to the particular model developed here, this suggests that any long run changes that allow license holders to gain access to the resources of non-license holders would negate the beneficial output effects.

The bureaucratic licensing scheme implementing the import quota Q for the intermediate good involves a lottery in which only a proportion s (s for success) of the identical final-good producers are successful in obtaining import licenses. Import licenses are allocated free of charge to the winners of the license lottery. So as to rule out rent-seeking, s is assumed constant. Thus firms have no influence on their individual probabilities of success. Also, resale of the imported input (or the license itself) is prohibited.[13] This restriction on resale places a natural limit on the quantity of the input that each license holder would want to import, but license holders are also limited by a firm-level quota, denoted

$$\bar{y} = \bar{y}(s,Q) \equiv Q/ns, \tag{2}$$

where $\bar{y}_s(s,Q) = -\bar{y}/s < 0$ and $\bar{y}_Q(s,Q) = 1/ns > 0$. Thus, a smaller firm-level quota is associated with an increase in the proportion s of license holders or a tightening in the overall quota Q.

If all final-good producers receive import licenses (i.e. if $s = 1$), then the marginal value of a quota license is the same across firms, giving rise to the same total levels of production as would be achieved if licenses were marketable.[14] This correspondence between the bureaucratic scheme at $s = 1$ and a marketable license

[13]Prohibitive fines could be imposed for non compliance. In the context of this model, all actions are observable so all violators would be caught.

[14]The licenses could be allocated to firms and then sold or be initially sold by the government.

scheme makes it a convenient base for comparison. Also, although s is treated as a continuous variable, this is not strictly necessary. For example, if there were just 4 equal size final-good firms, s could take the values 1/4, 1/2, 3/4 and 1, which is sufficient variation to show the results. However, if a firm were able to monopolize the market by cornering the entire supply of the specific factor, then with only one license holder, s only takes the value 1 and the model collapses.

There are three stages of decision for final-good producers. In stage 1, after the government announces the license allocation process together with the values of s and $\bar{y}$, firms decide whether to enter the domestic final-good industry taking into account the equilibrium outcomes of subsequent stages. To enter, each firm must purchase one unit of the specific factor which is available at a market clearing price. In stage 2, producers can choose to apply for import licenses and license allocation takes place as announced. In stage 3, the intermediate good is imported and produced domestically, the final good is produced and revenues are distributed.

4. Firm level decisions

This section develops the effects of the bureaucratic licensing schemes on the decisions of firms as to entry and output. Consideration is first given to the third stage competitive output equilibrium, before moving back to the license application stage and the decision to enter the market.

The respective outputs of a final-good producer with and without an import license are denoted by y^i for $i=\mathrm{F,D}$. Consider the case in which $\bar{y}$ is sufficiently large that license holders use only imported capital equipment (good X). Then, since one unit of X is needed to produce one unit of Y, it follows that in stage 3, license holders each import y^{F} units and non-license holders each purchase y^{D} units of (the identical) but more costly domestic equipment. Letting $C(y^i)\equiv wL^i$ denote the total cost of the labor L^i used at the firm level and σ, the price paid for the unit of the specific factor purchased in stage 1, the profit of a final-good producer using equipment only from source i for $i=\mathrm{F,D}$ is then

$$\pi^i = (p - r^i)y^i - C(y^i) - \sigma. \tag{3}$$

For non-license holders, output y^{D} is set to maximize profit, π^{D} as in Eq. (3), taking p and r^{D} as given. Assuming $p-r^{\mathrm{D}}-C'(0)>0$, then price exceeds marginal cost at $y^{\mathrm{D}}=0$ which implies $y^{\mathrm{D}}>0$. Hence the stage 3 equilibrium output, $y^{\mathrm{D}}=y(r^{\mathrm{D}})>0$ satisfies the first order condition

$$\partial\pi^{\mathrm{D}}/\partial y^{\mathrm{D}} = p - r^{\mathrm{D}} - C'(y^{\mathrm{D}}) = 0, \tag{4}$$

where the second order condition is satisfied, since $\partial^2\pi^{\mathrm{D}}/(\partial y^{\mathrm{D}})^2 = -C''(y^i)<0$

from diminishing marginal productivity ($f_{LL}<0$). To relate the size of the firm-level quota $\bar{y}(s,Q)$ to output $y(r^D)$, let $s=\hat{s}$ denote the value of s at which

$$\bar{y}(\hat{s},Q)=y(r^D). \tag{5}$$

It follows that if the firm-level quota $\bar{y}(s,Q)$ is set at or below $y(r^D)$, or equivalently if $s\geq\hat{s}$ (since $y_s<0$ from Eq. (2)), then after filling their quota, license holders would raise their output to the same level as non-license holders by purchasing the domestically produced input X at the margin, i.e.

$$y^F=y(r^D)\geq\bar{y}(s,Q)\quad \text{if } s\geq\hat{s}. \tag{6}$$

However, if the quota Q is sufficiently generous to make $\bar{y}(s,Q)\geq y(r^D)$, then recalling that $s\leq 1$, license holders will purchase imports alone for $s\leq\min[\hat{s},1]$. At the extreme it is possible that $\bar{y}(1,Q)>y(r^D)$ when all firms are license holders (i.e. for $s=1$). In this case, referred to as $\hat{s}>1$, license holders purchase imports alone, whatever the value of s.

Supposing that $s\leq\min[\hat{s},1]$, in stage 3 each license holder sets its output y^F to maximize π^F as in Eq. (3) subject to $y^F\leq\bar{y}(s,Q)$. Forming the Lagrangian $\mathscr{L}\equiv\pi^F+\lambda(\bar{y}(s,Q)-y^F)$, the Lagrange multiplier λ is the value of relaxing $\bar{y}$ through an additional import license (as introduced in Section 2) or equivalently the marginal quota rent. Output y^F then satisfies the Kuhn–Tucker conditions:

$$d\mathscr{L}/dy^F=p-(r^F+\lambda)-C'(y^F)=0, \tag{7a}$$

$$d\mathscr{L}/d\lambda=\bar{y}(s,Q)-y^F\geq 0\quad \text{where } (d\mathscr{L}/d\lambda)\lambda=0. \tag{7b}$$

Letting $\rho^F\equiv r^F+\lambda$, ρ^F represents each license holder's marginal opportunity cost from the use of the intermediate input in production. From Eq. (7a), Eq. (7b) and Eq. (4), y^F can be written as $y^F=y(\rho^F)$ where $y(\cdot)$ is the same function defining $y^D=y(r^D)$. If $\lambda>0$, then the firm-level quota is binding so $y(\rho^F)=\bar{y}(s,Q)$. If $\lambda=0$ then $\rho^F=r^F$ and the license holder produces $y(r^F)$, its level of output at free trade.

An important role is played by the 'zero-rent' licensing scheme under which license holders can import as much as they want for own use, generating no quota rents. Nevertheless, imports are restricted because only a proportion of final-good producers, denoted by $s=\underline{s}$, receive import licenses. At $s=\underline{s}$, the firm-level quota equals the quantity of the input the firm would import at free trade, i.e.

$$\bar{y}(\underline{s},Q)=y(r^F) \text{ and } \lambda=0. \tag{8}$$

For the subsequent analysis, attention is restricted to the region of interest in which the firm-level quota is binding (i.e. $s\geq\underline{s}$). In this region, using Eq. (6) and Eq. (8), license-holder output satisfies

$$y(\rho^F)=\begin{cases}\bar{y}(s,Q)\geq y(r^D) & \text{for } s\in[\underline{s},\min[\hat{s},1]]\\ y(r^D)\geq\bar{y}(s,Q) & \text{for } s\in[\hat{s},1] \text{ and } \hat{s}\leq 1.\end{cases} \tag{9}$$

Also, since the marginal quota rent λ can be expressed as[15]

$$\lambda = \lambda(s,Q) = \begin{cases} p - r^{\mathrm{F}} - C'(\bar{y}(s,Q)) & \text{for } s \in [\underline{s}, \min[\hat{s},1]] \\ r^{\mathrm{D}} - r^{\mathrm{F}} & \text{for } s \in [\hat{s},1] \text{ and } \hat{s} \leq 1, \end{cases} \tag{10}$$

it follows, using Eq. (2), that

$$\lambda_s = C''(\bar{y})\bar{y}/s > 0 \quad \text{for } s \in [s, \min[\hat{s},1]]. \tag{11}$$

Thus, an increase in s raises λ from zero at $\underline{s}$ to a maximum of $r^{\mathrm{D}} - r^{\mathrm{F}}$ at $\hat{s}$ for $\hat{s} \leq 1$.

In demonstrating that the bureaucratic scheme can increase domestic output, an important step is to show that firms failing to obtain a license stay in business. Letting $\rho^{\mathrm{D}} \equiv r^{\mathrm{D}}$ for notational convenience, this result follows because the stage 3 variable profit

$$V(\rho^i) \equiv (p - \rho^i)y(\rho^i) - C(y(\rho^i)), \tag{12}$$

earned from producing output $y(\rho^i)$, for $i = \mathrm{D,F}$, is strictly positive.[16] With marginal cost increasing once the specific factor has been committed, even non-license holders earn rents on infra-marginal units of output. As illustrated in Fig. 2, a non-license holder would produce output y^D at point A, equating price p with marginal cost based on the price r^{D} for the input so as to earn infra-marginal rents (variable profit) as shown by the hatched area. As for license holders, the lower price r^{F} paid for imports, shifts down the marginal cost curve. Under a

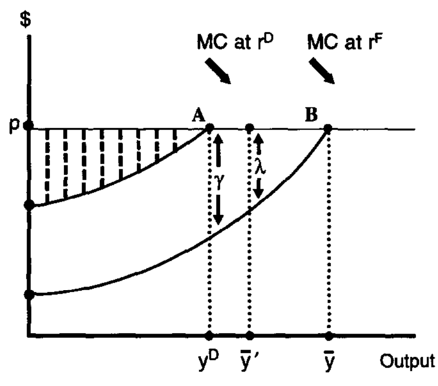

Fig. 2. Firm-level outputs and inframarginal rents.

[15]Since $C'(\bar{y}(\hat{s},Q)) = p - r^D$ from Eq. (5) and Eq. (4), it follows, using Eq. (7a) and Eq. (6), that $\lambda(\hat{s},Q) = r^D - r^F$ for $s \in [\hat{s},1]$. The other part of Eq. (10) follows from Eq. (7a) and $y^F = \bar{y}$.

[16]This follows since $V(\rho^i) = \int_0^{y(\rho^i)}[p - \rho^i - C'(y)]dy > 0$ from Eq. (12), $C''(y) > 0$ and $p - r^{\mathrm{D}} - C'(0) > 0$.

zero-rent scheme, license holders are unconstrained by the firm-level quota $\bar{y}$ and hence each produces its free-trade level of output shown at point B. However, a more restrictive firm-level quota shown at $\bar{y}'$ would constrain the firm to produce where price exceeds marginal cost, reducing infra-marginal rents and making the marginal value λ of an import license positive. If $\bar{y}$ were set equal to y^{D} (or below y^{D}), then λ would increase to equal $\gamma \equiv r^{\mathrm{D}} - r^{\mathrm{F}}$.

Turning to the stage 2 decision to apply for an import license, the overall profit of a license holder and non-license holder respectively can be expressed as

$$\pi^{\mathrm{F}} = V(\rho^{\mathrm{F}}) + \lambda(s,Q)\bar{y}(s,Q) - \sigma \text{ and } \pi^{\mathrm{D}} = V(r^{\mathrm{D}}) - \sigma. \tag{13}$$

Thus, from Eq. (13) the gain $G \equiv \pi^{\mathrm{F}} - \pi^{\mathrm{D}}$ from a successful license application is given by

$$G = G(s,Q) = V(\rho^{\mathrm{F}}) - V(r^{\mathrm{D}}) + \lambda(s,Q)\bar{y}(s,Q), \tag{14}$$

where $\rho^{\mathrm{F}} = r^{\mathrm{F}} + \lambda(s,Q)$. Since $\lambda > 0$ for $\rho^{\mathrm{F}} = r^{\mathrm{D}}$ and $V(\rho^{\mathrm{F}}) - V(r^{\mathrm{D}}) > 0$ for $\rho^{\mathrm{F}} < r^{\mathrm{D}}$, it follows from Eq. (14) that $G > 0$. Taking into account that G is earned with probability s, each final-good producer will apply for a license if and only if its expected profit, denoted $E\{\pi\}$, equals or exceeds its known profit from just buying domestic equipment, i.e. if and only if

$$E\{\pi\} \equiv sG + \pi^{\mathrm{D}} \geq \pi^{\mathrm{D}}. \tag{15}$$

Since the gain G is always positive, all final-good producers make applications for import licenses.

In stage 1, firms competing to enter the industry bid up the price of the specific factor to the point that $E\{\pi\} = 0$, which from Eq. (13) and Eq. (15) implies that

$$\sigma = V(r^{\mathrm{D}}) + sG. \tag{16}$$

Hence the specific factor earns rents $\sigma T^0 = nV(r^{\mathrm{D}}) + nsG$, where $T^0 = n$. Firms that subsequently obtain an import license earn positive profits, but non-license holders do not fully recover their sunk investment in the specific factor, i.e. using Eq. (13), Eq. (14) and Eq. (15),

$$\pi^{\mathrm{F}} = (1 - s)G > 0 \text{ for } s < 1 \text{ and } \pi^{\mathrm{D}} = -sG < 0 \text{ for } s > 0. \tag{17}$$

5. Import licensing schemes and aggregate domestic output

As previously mentioned, a critical distinction is between 'dual-price' licensing schemes and licensing schemes in which there is a 'unified market' for the input (marginal costs are equalized). Under a dual-price scheme, the value λ of an additional license to a license holder is below the value $\gamma \equiv r^{\mathrm{D}} - r^{\mathrm{F}}$ to a non-license holder and there are some non-license holders (i.e. $s < 1$). Since $\lambda < r^{\mathrm{D}} - r^{\mathrm{F}}$ is equivalent to $\rho^{\mathrm{F}} < r^{\mathrm{D}}$, license holders then face a lower marginal opportunity cost for own use of the input and hence produce a higher output than non-license holders. Given $s \geq \underline{s}$, it follows from Eq. (9), that dual-price licensing schemes are represented by the region

$$s \in [\underline{s}, \min[\hat{s},1]),$$

where $\bar{y}(s,Q) = y(\rho^{\mathrm{F}}) > y(r^{\mathrm{D}})$. Since $\lambda = r^{\mathrm{D}} - r^{\mathrm{F}}$ for $s \in [\hat{s},1]$ and there are no non-license holders at $s=1$, markets are unified in the remaining region $s \in [\min[\hat{s},1],1]$.

Now considering total production levels, let $A(r^i) \equiv ny(r^i)$ (A for aggregate) represent aggregate final-good output and demand for the input, when all producers face the same price r^i for use of the input. Thus, $A(r^{\mathrm{D}})$ represents aggregate domestic production of both the final and intermediate goods at a prohibitive quota $Q=0$ and $A(r^{\mathrm{F}})$, the aggregate quantity of domestic final-good output and intermediate imports at free trade. Using $\bar{y}(s,Q) = Q/ns$ in Eq. (8) and Eq. (5) respectively, we obtain

$$\underline{s} = Q/A(r^{\mathrm{F}}) \text{ and } \hat{s} = Q/A(r^{\mathrm{D}}). \tag{18}$$

Since a binding quota implies $Q < A(r^{\mathrm{F}})$, it follows from Eq. (18) that $\underline{s} < 1$. If $Q \leq A(r^{\mathrm{D}})$, i.e. if intermediate imports are restricted at or below the level that would be produced domestically at $Q=0$, then $\hat{s} \leq 1$ from Eq. (18) and for $s \in [\hat{s},1]$, license holders would purchase the domestically produced input at the margin, unifying the markets with $\lambda = r^{\mathrm{D}} - r^{\mathrm{F}}$. However, it is also possible that $A(r^{\mathrm{D}}) < Q < A(r^{\mathrm{F}})$ making $\hat{s} > 1$. In this case, $\lambda(1,Q)$ is strictly below $r^{\mathrm{D}} - r^{\mathrm{F}}$, so such a quota is not sufficiently restrictive to induce domestic production of the input when all firms receive import licenses at $s=1$.

Next, taking into account that non-license holders constitute $1-s$ of firms, if only non-license holders purchase the domestically produced input, then the total domestic production of the input, denoted by X^{D}, is given by $X^{\mathrm{D}}(s) = (1-s)A(r^{\mathrm{D}})$. This applies for $s \in [\underline{s}, \min[\hat{s},1]]$, that is for dual-price schemes and also at the boundary where $s = \min[\hat{s},1]$. With respect to this boundary, it can be seen that if $\hat{s} \geq 1$ and $s=1$, then $X^{\mathrm{D}}(1)=0$ as previously discussed. However, if $\hat{s} < 1$ and $s \in [\hat{s},1]$, so license holders also purchase the input domestically, then X^{D} is constant at $X^{\mathrm{D}}(s) = (1-\hat{s})A(r^{\mathrm{D}})$. Since $\rho^{\mathrm{F}} = r^{\mathrm{D}}$ for unified schemes with $\hat{s} < 1$, it follows that shifting more firms into the license holder category by increasing s above can have no effect on final-good output or demand for the input. In summary:

$$X^{\mathrm{D}}(s) = \begin{cases} (1-s)A(r^{\mathrm{D}}) & \text{for } s \in [\underline{s}, \min[\hat{s},1]] \\ (1-\hat{s})A(r^{\mathrm{D}}) & \text{for } s \in [\hat{s},1] \text{ and } \hat{s} \leq 1. \end{cases} \tag{19}$$

As for the total domestic production of the final good, denoted by $Y = Y(s,Q)$, this is just the sum of $X^{\mathrm{D}}(s)$ and the quantity of output Q produced using the imported input, i.e.

$$Y = Y(s,Q) = X^{\mathrm{D}}(s) + Q. \tag{20}$$

Since from Eq. (19) and Eq. (20), $\mathrm{d}X^{\mathrm{D}}/\mathrm{d}s = \mathrm{d}Y/\mathrm{d}s = -A(r^{\mathrm{D}}) < 0$ for $s \in [\underline{s}, \min[\hat{s},1]]$, an increase in s above $\underline{s}$ causes the outputs of both products to fall until s reaches $\min[\hat{s},1]$, the point at which the market becomes unified. For $\hat{s} < 1$, further increases in s above $\underline{s}$ have no effect on output. Fig. 3 illustrates these results for the case $\hat{s} < 1$ (i.e. for $Q < A(r^{\mathrm{D}})$). Final-good output is shown by the dashed line and intermediate good output by the solid line.

If quota licenses were made marketable, this would cause the marginal costs facing final-good producers to be equalized at $\rho^{\mathrm{F}} = r^{\mathrm{D}}$ for $Q \le A(r^{\mathrm{D}})$ and at $\rho^{\mathrm{F}} = r^{\mathrm{F}} + \lambda(1,Q) < r^{\mathrm{D}}$ for $A(r^{\mathrm{D}}) < A(r^{\mathrm{F}})$, just as under the bureaucratic scheme with market unification.[17] Thus total domestic output would be the same as achieved from market unification under the bureaucratic scheme. Proposition 1 follows.

Proposition 1. For a given import quota Q on an intermediate product,

(i) *a bureaucratic licensing scheme raises the domestic outputs of both the final and intermediate products relative to the use of marketable quota licenses if and only if a dual-price market is created in which* $\lambda < \gamma \equiv r^{\mathrm{D}} - r^{\mathrm{F}}$ *and there are some non-license holders;*
(ii) *the domestic outputs of both the final and intermediate products are maximized by a zero-rent licensing scheme and minimized by the use of marketable licenses.*

Proof. Follows from the text.

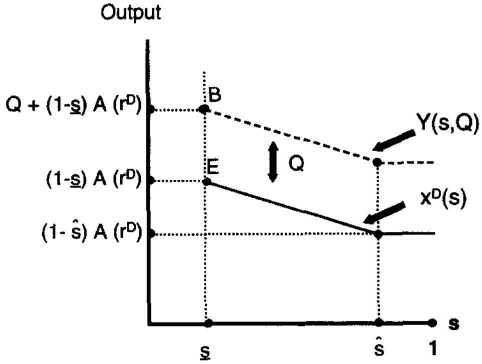

Fig. 3. Variation in aggregate output with s.

[17]The price of a license is $\lambda = r^{\mathrm{D}} - r^{\mathrm{F}}$ for $Q \le A(r^{\mathrm{D}})$ and $\lambda = \lambda(1,Q)$ for $A(r^{\mathrm{D}}) < Q < A(r^{\mathrm{F}})$.

The idea driving Proposition 1(i) was previously explained in Section 2. Recalling that $\bar{y}>y(r^{\mathrm{D}})$ creates a dual-price market, making quota licenses marketable causes each license holder to sell some of its quota to non-license holders, reducing its own output so as to equalize production incentives across firms. For $Q \leq A(r^{D})$, the input is produced domestically so outputs are equalized at $y(r^{\mathrm{D}})$. Since previous non-license holders now buy less of the domestic input, it follows that the domestic output of both the intermediate and final goods must fall. For $A(r^{\mathrm{D}})<A(r^{\mathrm{F}})$, previous non-license holders switch entirely to using imports and output is equalized at $y=y(\rho^{F})$, where $\rho^{F}=r^{F}+\lambda(1,Q)$. Since the quota Q remains constant and the input is produced domestically under a dual-price licensing scheme, but not when licenses are marketable, it again follows that marketability reduces the output of both goods. As for part (ii) of Proposition 1, since under a zero-rent licensing scheme the proportion of firms receiving import licenses is at the minimum necessary to exhaust the import quota Q, this maximizes the proportion of non-license holders, and hence, the total amount of the input produced domestically. Also, since Q is fixed and independent of s, domestic production of the final good is also at a maximum.

At a deeper level, a dual-price licensing scheme raises domestic output by increasing the overall intensity of use of the specific factor. When the firm-level quota allocation exceeds the quantity of the input the firm would use at the domestic price r^{D}, this induces the firm to hire more labor so as to use the specific factor more intensively than it would as a non-license holder. At the extreme, under a zero-rent licensing scheme, firms winning the quota lottery are allocated a quota that enables them to operate at the same labor to specific factor ratio as at free trade. In effect, non-marketability makes the quota allocation lumpy, which raises output by forcing license holders to increase their intensity of use of the specific factor so as to use all of the quota allocation. By contrast, if initial quota allocations can be split up and sold, trading in quota licenses would equalize the intensity of use of the specific factor across all final producers, but at a lower output level. If $Q<A(r^{\mathrm{D}})$, all final producers would operate at the low factor intensity associated with the domestic price r^{D} for capital equipment, the same factor intensity associated with non-license holders under a dual-price bureaucratic scheme. If $A(r^{\mathrm{D}})<Q<A(r^{\mathrm{F}})$, then since only Q units of the final good are produced when quota licenses are marketable and Q units are produced by licenses holders alone under a dual-price scheme, the specific factor is again used less intensively under the marketable license scheme.

Consideration of the effect of varying the size of the quota Q provides some further insight into the implications of dual-price licensing schemes for the magnitude of domestic output. These effects are illustrated in Fig. 4 for a zero-rent licensing scheme with $s=\underline{s}$ (shown as solid lines) and a marketable license scheme with $s=1$ (shown as dashed lines). Starting at free trade (point F), the domestic country uses the imports $A(r^{\mathrm{F}})$ of the intermediate input to produce $A(r^{\mathrm{F}})$ of the final product. With marketable licenses, a small reduction in the quota below free

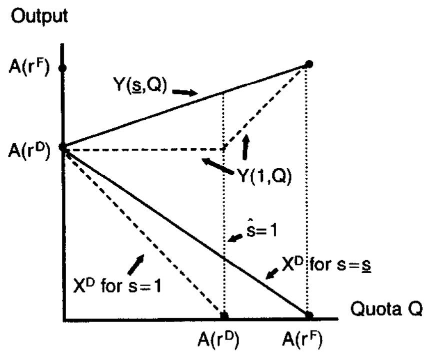

Fig. 4. Aggregate output and quota size.

trade results in an equal decrease in final-good output (see the line $Y(1,Q)$), whereas (as shown by the line $Y(\underline{s},Q)$), output falls by less if $s=\underline{s}$. As previously explained, since non-license holders have no choice but to buy the domestic input, even a mildly restrictive quota (in the region $A(r^D)<Q<A(r^F)$) creates a domestic industry producing capital equipment when $s=\underline{s}$, but not when quota licenses are marketable.

A quota set at $Q=A(r^D)$ in Fig. 4 marks the point at which domestic production of the intermediate good commences under a marketable license scheme. Any further reduction in the quota is matched by an equal increase in domestic production of the input, with the result that final-good output remains constant at $A(r^D)$, the output corresponding to a prohibitive quota. Essentially, once the input is produced domestically under a unified scheme, the size of the quota has no effect on final-good output since all producers use the domestically produced input at the margin. By contrast, if $s=\underline{s}$, firms shifted into the non-licence holder category by a reduction in Q produce less than they did as licence holders, causing aggregate output of the final good to continue to fall. Although more of the input is produced domestically, the increase is less than the reduction in the quota. Finally, at a prohibitive quota, $Q=0$, the licensing scheme becomes irrelevant and the domestic outputs of both the intermediate and final products are equalized at $A(r^D)$.

6. Welfare comparisons

In developing the welfare effects, three different settings are considered. The first is the case already considered in which the prices r^D and r^F are constant. With r^F unaffected by the quota, all quota rents go to the domestic country. In the second setting, foreign suppliers are assumed to raise r^F in response to the quota so as to collect all quota rents. Finally, consideration is given to the possibility that the domestic intermediate-good industry experiences decreasing costs causing r^{D} to fall as output expands.

Domestic welfare is made up of the utility $U(Y^c)$ from consumption Y^c of the final good plus consumption Z^c of the numeraire commodity. Since both the price of the final good and the wage are constants, consumption Y^c and labor income wL, where L represents the total labor used in the production of the three goods, are not affected by the licensing scheme. Thus setting total domestic income, given by $wL+nE\{\pi\}+\sigma T^0$ equal to expenditure, pY^c+Z^c, welfare can be expressed as

$$W=U(Y^c)+Z^c=\alpha+nE\{\pi\}+\sigma T^0, \tag{21}$$

where $\alpha\equiv U(Y^c)-pY^c+wL$ is constant. Using $E\{\pi\}=0$, $T^0=n$ and Eq. (16), it then follows that

$$W=W(s,Q)=\alpha+\sigma T^0=\alpha+nV(r^{\mathrm{D}})+nsG(s,Q), \tag{22}$$

where $G(s,Q)=V(\rho^{\mathrm{F}})-V(r^{\mathrm{D}})+\lambda(s,Q)\bar{y}$ from Eq. (14). Since standard surplus analysis is used, quota rents count equally towards domestic welfare regardless of recipient. Thus, welfare comparisons are unaffected if the government collects the quota rents as would be the case if the government auctions off the marketable licenses or if it uses a tariff that is equally restrictive as the quota.

Proposition 2 compares domestic welfare under a marketable license scheme with welfare under dual-price bureaucratic schemes.

Proposition 2. Suppose r^{D} and r^{F} are constant. For a given quota Q, domestic welfare is maximized by use of a marketable license scheme. If the proportion of licenses issued is reduced under a bureaucratic scheme so as to create a dual-price market, this lowers the marginal quota rent λ, reducing welfare. Welfare reaches its minimum under a zero-rent licensing scheme.

Proof. From Eq. (14), Eq. (2) and $V'(\rho^{\mathrm{F}})=-\bar{y}$ (see Eq. (12)), we obtain $\mathrm{d}G/\mathrm{d}s=-\lambda\bar{y}/s$. Hence from Eq. (22),

$$\mathrm{d}W(s,Q)/\mathrm{d}s=n[G+s\,\mathrm{d}G/\mathrm{d}s]=n[V(\rho^{\mathrm{F}})-V(r^{\mathrm{D}})]. \tag{23}$$

Since $\rho^{\mathrm{F}}<r^{\mathrm{D}}$ for $s\in[\underline{s},\min[\hat{s},1])$ and $\rho^{\mathrm{F}}=r^{\mathrm{D}}$ for $s\in[\hat{s},1]$, Eq. (23) implies $\mathrm{d}W/\mathrm{d}s>0$ for $s\in[\underline{s},\min[\hat{s},1])$ and $\mathrm{d}W/\mathrm{d}s=0$ for $s\in[\hat{s},1]$. Hence, welfare is at a maximum at $s=\min[\hat{s},1]$, corresponding to welfare under a marketable license scheme, and decreases in s until it reaches its minimum at $\underline{s}$. Since from Eq. (11), $\lambda_s>0$ for $s\in[\underline{s},\min[\hat{s},1]]$ and λ is constant for $s\in[\hat{s},1]$, the result follows. □

As Proposition 2 shows, the creation of a dual-price market through the use of non-transferable licenses always reduces welfare if r^{D} and r^{F} are constant. In this second best context caused by the quota, the beneficial output effects arising from dual-prices are gained by generating a second distortion in which the marginal evaluation of a license by license holders is reduced below that of non-license holders. This causes a loss of quota rents, which, with r^F constant, is suffered by the domestic country in the form of a lower return σ to the specific factor. The increased output arising from dual-prices tends to raise the return σ, but domestic welfare falls because the loss of quota rents dominates. In effect, the loss in quota rents is (inefficiently) translated into higher domestic output, causing domestic welfare to fall.

But what if the domestic country would not enjoy the quota rents? Consider a setting in which a foreign monopoly supplies the input. If the monopolist can price discriminate between countries, profit maximization would lead it to extract all the quota rent by raising its export price, denoted r^{F*}, to equal $\rho^F = r^F + \lambda$. Thus, as first shown by Shibata (1968) and explored by Krishna (1990), a government that attempted to auction import licenses with prices determined endogenously would find that the price of a license is zero and the auction raises no revenue. From Eq. (14), Eq. (22), it follows that without quota rents, domestic welfare, denoted $W^0(s,Q)$, is given by

$$W^0(s,Q) = \alpha + nV(r^D) + nsG \quad \text{for } G = V(r^{F*}) - V(r^D) \text{ and } r^{F*} = \rho^F, \tag{24}$$

where $r^{F*} < r^D$ and $s < 1$ under a dual-price scheme.

If quota rents are captured by foreign firms, the outcome under a licensing scheme with unified markets is the same as an equally restrictive VER (voluntary export restraint). This makes a VER the natural base for comparison. If the input is produced domestically under a VER (i.e. if $Q \leq A(r^D)$) then $\rho^{F*} = r^D$ for $s \in [\hat{s},1]$ implies $G=0$ and from Eq. (24), domestic welfare is given by

$$W^0(s,Q) = \alpha + nV(r^D) \quad \text{for } s \in [\hat{s},1]. \tag{25}$$

Thus, domestic welfare under the VER is the same as if the quota were prohibitive. Imports of the input fall as Q is reduced from $Q = A(r^D)$ to $Q = 0$, but welfare as in Eq. (25) is unaffected since substitution of domestic equipment involves no further loss of efficiency. For a less restrictive quota, $A(r^D) < Q < A(r^F)$, markets are unified only at $s=1$ and from Eq. (22) and Eq. (24), welfare under the VER is given by

$$W^0(1,Q) = \alpha + nV(r^{F*}), \quad \text{where } r^{F*} = r^F + \lambda(1,Q) < r^D. \tag{26}$$

Now comparing a VER with dual-price licensing schemes, the fact that any loss of quota rents is a loss to foreigners, significantly changes the welfare ranking from the domestic viewpoint.

Proposition 3. If foreign suppliers capture all quota rents, use of any dual-price licensing scheme increases domestic welfare relative to a VER.

Proof. For $Q \leq A(r^D)$, since $r^{F*} = \rho^F < r^D$ makes $G > 0$ for $s \in [\underline{s}, \hat{s})$, the result follows comparing Eq. (24) with Eq. (25). For $A(r^D) < Q < A(r^F)$, rearranging Eq. (24), we obtain $W^0(s,Q) = \alpha + nsV(r^{F*}) + n(1-s)V(r^D)$ for $r^{F*} = r^F + \lambda(s,Q)$. Since $\lambda(s,Q) < \lambda(1,Q)$ and $n(1-s)V(r^D) > 0$ for $s < 1$, the result follows comparing $W^0(s,Q)$ for $s < 1$ with $W^0(1,Q)$ as in Eq. (26). □

If quota rents go to foreigners, Proposition 3 has shown that the favourable output effects from the use of a dual-price licensing scheme are sufficient to raise domestic welfare above the level achievable with a VER. However, if favorable output effects are causing the result, the question arises as to why it is not necessarily optimal to maximize the domestic output of both the intermediate and final products through the use of a zero-rent licensing scheme (with $s = \underline{s}$).

Further examination of this issue reveals that the optimal licensing scheme is influenced by variations in the rate of increase of marginal cost. As Proposition 4 shows, for the zero-rent scheme to dominate both other licensing schemes and a VER, it is sufficient that the third derivative $C'''(y)$ of the cost of labor function be positive or zero. Since $C''(y) > 0$ because of diminishing marginal productivity, having $C'''(y) > 0$ magnifies the rate of increase in marginal labor costs as output increases. This favors a reduction in the proportion s of license holders (moving s towards $\underline{s}$), because quota rents, and hence the price r^{F*} paid for the input, then increase at an increasing rate with s.[18] Proposition 4 is nevertheless fairly general, since the condition $C'''(y) \geq 0$ holds for a wide class of production functions.[19]

Proposition 4. Suppose foreign suppliers capture all quota rents and $C'''(y) \geq 0$. For a given quota Q, domestic welfare is maximized by the use of a zero-rent licensing scheme. Welfare falls in the dual-price region as the proportion of licenses issued is increased reaching a minimum when the market becomes unified, the outcome corresponding to a VER.

Proof. Since $dG/ds = -\bar{y}(dr^{F*}/ds)$ it follows from Eq. (24) that for $s \in [\underline{s}, \min[\hat{s}, 1])$,

$$dW^0/ds = n[V(r^{F*}) - V(r^D) - s\bar{y}(dr^{F*}/ds)], \tag{27}$$

and $dW^0/ds = 0$ otherwise. Since $V'(\rho^F) = -y(\rho^F)$ from Eq. (12) and Eq. (7a), this implies $V''(\rho^F) = -y'(\rho^F) > 0$ and hence that $V(r^{F*}) - V(r^D) \leq V'(r^{F*})(r^{F*} - r^D) = \bar{y}(r^D - r^{F*})$. Similarly, using $r^{F*} = p - C'(\bar{y})$ it follows from $C'''(y) \geq 0$ that $r^D - r^{F*} = C'(\bar{y}) - C'(y^D) \leq C''(\bar{y})(\bar{y} - y^D)$. Hence,

$$V(r^{F*}) - V(r^D) \leq \bar{y}C''(\bar{y})(\bar{y} - y^D). \tag{28}$$

[18] This follows, since using Eq. (11) and Eq. (2), $d^2r^{F*}/(ds)^2 = \lambda_{ss}(s,Q) = (\bar{y}/s)C'''(\bar{y}) \geq 0$ if $C''' \geq 0$.
[19] Since $y = f(L,1)$, marginal labor cost is $C'(y) = w/f_L$. Hence, $C''(y) = -wf_{LL}/(f_L)^3 > 0$ and $C'''(y) = w[3(f_{LL})^2 - f_L f_{LLL}]/(f_L)^5$. Thus, $C'''(y) \geq 0$ if $f_{LLL} \leq 0$ or if $f_{LLL} \leq 3(f_{LL})^2/f_L$.

Now, combining Eq. (28) with Eq. (27) and using $\mathrm{d}r^{F*}/\mathrm{d}s=\lambda_s=C''(\bar{y})\bar{y}/s$ from Eq. (11), we obtain

$$\mathrm{d}W^0/\mathrm{d}s \leq -n\bar{y}C''(\bar{y})y^{D}<0 \quad \text{for } s\in[\underline{s},\min[\hat{s},1]].$$

Hence, welfare is at its maximum at $\underline{s}$ and decreases with s until it reaches its minimum at $s=\min[\hat{s},1]$, the point corresponding to a VER at which the market becomes unified. □

The next task is to consider the possibility that the increased output induced by the quota actually causes the domestic intermediate-good industry to become more efficient leading to a reduction in the price r^D. These gains arising, for example, from positive externalities associated with greater experience in production are assumed to apply only to the domestic industry, the more efficient foreign industry having already achieved them. If the model were generalized to an imperfectly competitive setting, the decreasing costs could be due to economies of scale. Writing $r^D=h(X^D)$ where $h'(X^D)<0$ to capture this cost reduction and using $X^D=X^D(s)$ from Eq. (19), this defines $r^D=h(X^D(s))=r^D(s)$, where

$$\mathrm{d}r^D/\mathrm{d}s=h'(X^D)\mathrm{d}X^D/\mathrm{d}s=-h'(X^D)A(r^D)/[1-(1-s)h'(X^D)A'(r^D)] > 0 \tag{29}$$

in the dual-price region $s\in[\underline{s},\min[\hat{s},1])$. Since increases in s above $\hat{s}$ have no effect on output, $r^D=r^D(s)$ is constant for $s\in[\hat{s},1]$.

If the quota is below $A(r^D)$, Proposition 5 shows the strong result that any reduction in r^D, however small, shifts the optimal licensing scheme into the dual-price region. Since it is assumed that the domestic country would get the quota rents, this provides a case in which bureaucratic allocation of non-transferable licenses actually dominates the use of marketable quota licenses or an equivalent tariff.

Proposition 5. Suppose the domestic country captures the quota rents (r^F is constant) and $Q\leq A(r^D)$. If r^D declines with industry output, then domestic welfare is increased (relative to using marketable licenses) by reducing the proportion of licenses issued to the point that a dual-price domestic market is created. Welfare is at a maximum under some dual-price bureaucratic scheme.

Proof. From Eq. (14), using Eq. (2) and $\mathrm{d}V(r^D(s))/\mathrm{d}s=-y^D(\mathrm{d}r^D/\mathrm{d}s)$ from Eq. (12) and Eq. (4), we obtain $\mathrm{d}G/\mathrm{d}s=-\lambda\bar{y}/s+y^D(\mathrm{d}r^D/\mathrm{d}s)$. Hence, from Eq. (22) using $ny(r^D)=A(r^D(s))$,

$$\mathrm{d}W(s,Q)/\mathrm{d}s=n[V(\rho^F)-V(r^D(s))]-(1-s)A(r^D(s))\mathrm{d}r^D/\mathrm{d}s. \tag{30}$$

For $Q\leq A(r^D)$, setting $\rho^F=r^D(\hat{s})$ in Eq. (30) implies $\mathrm{d}W(\hat{s},Q)/\mathrm{d}s=-(1-\hat{s})A(r^D(\hat{s}))\mathrm{d}r^D/\mathrm{d}s$. Hence, from Eq. (29), $\mathrm{d}W(\hat{s},Q)/\mathrm{d}s<0$ for $s\in[\underline{s},\hat{s}]$ and

$dW/ds=0$ for $s \in [\hat{s},1]$. Since marketable licenses correspond to $s=[\hat{s},1]$, and welfare is increased by reducing s below $\hat{s}$, the Proposition follows. □

It should be remembered that the above results concern a welfare comparison of the different ways of implementing a given quota, not a justification for the imposition of the quota itself. Whether or not import licensing is used, for a temporary quota to be justified under the infant industry argument for protection, the learning by doing or other process that underlays the externality needs to lead to a permanent reduction in costs sufficient to bring domestic costs down to world levels so the industry can eventually compete. If there were no cost reduction from expansion of the intermediate good industry, as in the first two settings considered, the quota clearly reduces domestic welfare and if the domestic country does not get the quota rents, the fall in domestic welfare is even greater.

7. Concluding remarks

This paper has shown that when imports of an intermediate good are restricted by a quota, then the use of non-transferable quota licenses can increase domestic production of both the intermediate and final goods above the levels achievable with either marketable licenses or an equally restrictive tariff. For this to occur, the bureaucratic rules must act to create a dual-price market in which license holders face a lower marginal opportunity cost for own use of the input than do non-license holders. These output effects are maximized by a zero-rent licensing scheme in which firm-level quotas are set equal to the quantity each firm would import at free trade. These effects might help explain some of the typical rules associated with import licensing schemes in developing countries, such as the allocation of licenses to a limited subset of final good producers and the rules prohibiting resale. Since import licensing restrictions can be enforced by selectively allocating foreign exchange to particular firms, this might also help explain the widespread use of exchange controls by developing countries.

The fundamental idea driving the results is quite robust. The effect of dual prices in raising the domestic outputs of both goods does not depend on the nature of demand and, although pure competition is assumed so as to illustrate the output effects in their simplest form, similar effects would apply under imperfect competition in intermediate good supply, such as Cournot or Bertrand competition. Also, if dual prices could be maintained between different groups of final-good consumers,[20] the fundamental idea should also extend to quota licenses limiting imports of a final product. In this case, for a given import quota, use of dual prices would increase total domestic production and consumption of the final-good, again

[20]However, it is likely to be substantially more difficult to monitor numerous final-good consumers to prevent resale (and the break down of the dual-price market) than it is to monitor final-good producers.

at the cost of a loss of quota rents. In addition, as shown in Appendix A, dual-price licensing schemes can be designed to handle the differing import needs of firms of different sizes. This involves the allocation of firm-level quotas in proportion to the size of the firm as measured by the firm's investment in the specific factor. It does not matter for the results whether the firms invest in the specific factor, anticipating the imposition of the quota, or whether the size distribution of firms is historically given based on past investments.

Considering the broader implications of import restrictions applied to capital goods, the economic development literature linking the level of investments in capital by downstream industries to economic growth would suggest that any policy that reduces investment in capital equipment, including import restrictions, can only worsen growth performance.[21] This is particularly the case if by forgoing imports, the developing country fails to take advantage of new technology and new ideas being developed abroad. However, Romer (1993) argues persuasively that ideas are central to economic development, but that there are two rather different strategies. The first involves a policy of openness to trade and foreign direct investment so as to obtain the latest goods and technology developed abroad as quickly as possible. The second involves judicious restrictions on trade and investment (Taiwan is an example) so as to encourage the development of local human capital in manufacturing and the eventual production of new technology incorporating locally produced ideas. With respect to this latter strategy, it is possible that the extra experience in manufacturing gained from a dual-price scheme could favor use of such a scheme, but the long run practical difficulties involved in implementing and maintaining such a scheme suggest that extreme caution is warranted.

Maintenance of a dual-price licensing scheme requires not only that the authorities be successful in preventing resale of the licenses and the imports themselves, but also that license holders not be able to access the resources of non-license holders through long run changes in the structure of the industry, such as merger. As modelled, this latter problem is reflected in the need to prevent reallocation of the specific factor from non-license holders to license holders. If over time the specific factor were to depreciate substantially or if licence holders were able to merge with non-license holders, combining their supplies of the specific factor, this would cause the eventual collapse of dual prices. A new lottery for licenses would then be required to again create dual-prices and the associated higher output. However, given the political difficulties likely involved in taking licenses away from established firms, the final outcome could easily be a break down in the dual-price market, yet the maintenance of an expensive bureaucracy which encourages rent-seeking and stifles genuine new initiatives.

In summary, it is important to emphasis that this paper does not advocate the use of bureaucratic import licensing rules. Rather the idea is to help explain why

[21]See, for example, Rodrik (1994) and Lee (1994) for development of this argument.

such practices may have come into effect, particularly in an environment, as was the case 20 years ago, in which import substituting investment in capital equipment was viewed as a main road to economic development in manufacturing.

Acknowledgments

I would particularly like to thank Magnus Blomström for his significant help and suggestions and Aaron Tornell for his very useful comments. The paper has also benefitted from suggestions made by two excellent referees as well as from seminar participants at the 1994 NBER Summer Institute in International Trade, the University of British Columbia, Harvard University and the Universities of Alberta and Calgary. Financial support from the SSHRC in Canada and C.I.B.S. at UBC is gratefully acknowledged.

Appendix A

Firms of different sizes

This appendix develops a more general model in which firms can vary in size because of different levels of investment T^j for $j \in [1 \ldots n]$ in the specific factor. The production function becomes

$$Y = \min[X, f(L,T^j)], \tag{A.1}$$

where $f(L,T^j)$ is assumed to be linearly homogenous. Since most features of the model are unchanged from the 'main model' in the text, I will mostly just highlight the new features.

Letting n^Q denote the number of license holders, each final-good firm faces an equal probability $s = n^Q/n$ of receiving an import license as before. However, the firm-specific quota, denoted $\bar{y}^j$ is set proportionate to firm j's investment T^j in the specific factor. Noting that Q now represents the planned or expected level of imports of X and that $\delta \equiv Q/sT^0$ is a constant, we have

$$\bar{y}^j = \bar{y}(s,Q,T^j) = \delta T^j \quad \text{for } \delta \equiv Q/sT^0, \tag{A.2}$$

where, as in the main model, $\bar{y}_s(s,Q,T^j) = -\bar{y}^j/s < 0$.

The actual quantity of imports denoted by $Q^A = \Sigma_{j=1}^{n^Q} \bar{y}^j = \delta \Sigma_{j=1}^{n^Q} T^j$ will vary depending on the actual sizes of the firms picked in the lottery. However, if $T^j = T^0/n$ is constant across firms, then Eq. (A.2) implies $\bar{y}^j = Q/sn$ where $Q = Q^A$, as in the 'main model' and the quota Q can be implemented exactly. Also $Q = Q^A$ if all firms get import licenses (i.e. if $s = 1$). In the general case, planned $Q = E\{Q^A\} = n^Q \delta E\{T^j\} = sT^0\delta$, where $E\{T^j\} = T^0/n$ represents the average quantity of the specific factor per firm. Thus the difference between $Q=E\{Q^A\}$ and Q^A tends to zero as the number of final-good producers increases. Consequently, although licensing schemes are compared ex-ante based on the expected level of Q, an ex-post comparison based on the actual level of Q would typically be very little different.

The nature of the lottery together with the values of s and δ are announced by the government prior to the three stages of decision by final-good producers, constituting a sub-game perfect equilibrium. In stage 1, knowing s and δ, each potential final-good producer decides on its level of investment in the specific factor, which becomes sunk at this stage. Any $T^j>0$ gives a firm the right to apply for an import license in stage 2 and stages 2 and 3 are as before.

Using a superscript j to index variables that depend on T^j, linear homogeneity allows the production function $y^{ij}=f(L^{ij},T^j)$ to be expressed in the form $y^{ij}=f(\ell^i,1)T^j$ where $\ell^i\equiv L^{ij}/T^j$ denotes the labor to specific factor ratio. Hence, supposing that firms purchase equipment from only one source, the profit of firm j using equipment from source i, for $i=\mathrm{F,D}$, can be written as

$$\pi^{ij}=[(p-r^i)f(\ell^i,1)-w\ell^i-\sigma]T^j, \tag{A.3}$$

where $f_{\ell\ell}<0$ (from linear homogeneity) implies π^{ij} is strictly concave in ℓ^i. At the stage 3 competitive equilibrium, maximizing π^{jD} taking the prices p and r^{D} as given, a non-license holder would increase its labor input to the point that ℓ^{D} satisfies the first order condition

$$\partial\pi^{\mathrm{D}j}/\partial\ell^{\mathrm{D}}=[(p-r^{\mathrm{D}})f_\ell(\ell^{\mathrm{D}},1)-w]T^j=0, \tag{A.4}$$

which defines ℓ^{D} as a function $\ell^{\mathrm{D}}=\ell(r^{\mathrm{D}})$ in equilibrium. It is important to notice that ℓ^{D} is independent of T^j. Firm j's equilibrium level of output is then given by

$$y^{\mathrm{D}j}=y(r^{\mathrm{D}},T^j)=f(\ell(r^{\mathrm{D}}),1)T^j. \tag{A.5}$$

Next, defining $\hat{s}$ to satisfy $\bar{y}(\hat{s},Q,T^j)=y(r^{\mathrm{D}},T^j)$, it follows, using Eq. (A.2) and Eq. (A.5), that $\hat{s}$ is independent of T^j. Since $\bar{y}_s<0$, it also follows (as in the main model) that each license holder j uses only the imported input if $s\le\min[\hat{s},1]$, but purchases domestic equipment at the margin so as to produce the same output $y^{\mathrm{F}}=y(r^{\mathrm{D}},T^j)$ as it would as a non-license holder if $s\in(\hat{s},1)$.

For $s\le\min[\hat{s},1]$, each license holder j sets ℓ^{F} to maximize the Lagrangian $\mathscr{L}^j\equiv\pi^{\mathrm{F}j}+\lambda(\bar{y}(s,Q,T^j)-y^{\mathrm{F}j})$, where the Lagrange multiplier, λ, represents the marginal quota rent. Letting $\rho^{\mathrm{F}}\equiv r^{\mathrm{F}}+\lambda$ and using Eq. (A.3) and $y^{\mathrm{F}j}=T^jf(\ell^{\mathrm{F}},1)$, ℓ^{F} satisfies the Kuhn–Tucker conditions:

$$\mathrm{d}\mathscr{L}/\mathrm{d}\ell^{\mathrm{F}}=[(p-\rho^{\mathrm{F}})f_\ell-w]T^j=0; \tag{A.6a}$$

$$\mathrm{d}\mathscr{L}/\mathrm{d}\lambda=\bar{y}(s,Q,T^j)-y^{\mathrm{F}j}=[\delta-f(\ell^{\mathrm{F}},1)]T^j\ge 0 \quad \text{where}$$

$$(\mathrm{d}\mathscr{L}/\mathrm{d}\lambda)\lambda = 0. \tag{A.6b}$$

As can be seen from Eq. (A.6a) and Eq. (A.6b), ℓ^{F} can be written as $\ell^{\mathrm{F}} = \ell(\rho^{\mathrm{F}})$, where λ and hence $\rho^{\mathrm{F}} \equiv r^{\mathrm{F}} + \lambda$ is independent of T^j. Hence, analogous to Eq. (A.5), each license holder j produces output

$$y^{\mathrm{F}j} = y(\rho^{\mathrm{F}}, T^j) \equiv f(\ell(\rho^{\mathrm{F}}), 1)T^j, \tag{A.7}$$

where $\ell'(\rho^{\mathrm{F}}) = (f_\ell)^2 / w f_{\ell\ell} < 0$. Now, letting $\underline{s}$ satisfy $\bar{y}(\underline{s}, Q, T^j) = y(r^{\mathrm{F}}, T^j)$, it follows from Eq. (A.2) and Eq. (A.7) that $\underline{s}$ is independent of T^j. Assuming that firm-level quotas are binding, just as in the main model $s \in [\underline{s}, \min[\hat{s}, 1])$ represents the dual-price region in which $\lambda < r^{\mathrm{D}} - r^{\mathrm{F}}$ and $y(\rho^{\mathrm{F}}) = \bar{y}(s, Q) > y(r^{\mathrm{D}})$ and $s \in [\min[\hat{s}, 1], 1]$ represents the region of market unification.

To extend the central output result (Proposition 1) to this more general model, let $A(r^i) \equiv \Sigma_{j=1}^{n} y(r^i, T^j)$ represent aggregate domestic output when all final-good firms pay r^i for the input (as before). Since $A(r^i) = f(\ell(r^i), 1)T^0$ from Eq. (A.5) and Eq. (A.7), $A(r^i)$ is independent of the distribution of the specific factor T^j across firms. Hence, following the same reasoning as in the text, the expected total domestic production X^{D} of the intermediate good is given by $X^{\mathrm{D}} = X^{\mathrm{D}}(s)$ as in Eq. (19). The expectation is required because if variation in T^j makes $Q^A \neq Q$, then actual output $X^{\mathrm{DA}} \equiv \Sigma_{j=nQ}^{n} y(r^{\mathrm{D}}, T^j)$ can differ from $X^{\mathrm{D}} = E\{X^{DA}\}$. Since the expected total domestic output of the final-good is given by $Y(s, Q) = X^{\mathrm{D}}(s) + Q$ as before and $\mathrm{d}X^{\mathrm{D}}/\mathrm{d}s = -A(r^{\mathrm{D}}) < 0$, for $s \in [\underline{s}, \min[\hat{s}, 1])$, Proposition 1 follows.

Examination of the stage 2 decision to apply for an import license requires expressions for profit. Letting $\rho^{\mathrm{D}} \equiv r^{\mathrm{D}}$, the stage 3 variable profit earned by firm j evaluated at ρ^i is given by

$$V(\rho^i, T^j) = [(p - \rho^i) f(\ell(\rho^i), 1) - w\ell(\rho^i)]T^j. \tag{A.8}$$

Since $s \geq \underline{s}$, using Eq. (A.3), Eq. (A.8) and $\rho^{\mathrm{F}} = r^{\mathrm{F}} + \lambda$, firm j's profit can be expressed as

$$\pi^{\mathrm{F}j} = V(\rho^{\mathrm{F}}, T^j) + \bar{y}\lambda^j - \sigma T^j \quad \text{for } \bar{y}^j = \delta T^j \text{ and}$$

$$\pi^{\mathrm{D}j} = V(r^{\mathrm{D}}, T^j) - \sigma T^j. \tag{A.9}$$

Hence, since $\lambda > 0$ if $\rho^{\mathrm{F}} = r^{\mathrm{D}}$ and $V(\rho^{\mathrm{F}}; T^j) - V(r^{\mathrm{D}}; T^j) > 0$ if $\rho^{\mathrm{F}} < r^{\mathrm{D}}$, the gain, denoted by $G^j \equiv \pi^{Fj} - \pi^{Dj}$ from a successful license application is always strictly positive, i.e.

$$G^j = \pi^{\mathrm{F}j} - \pi^{\mathrm{D}j} = V(\rho^{\mathrm{F}}; T^j) - V(r^{\mathrm{D}}; T^j) + \lambda\delta T^j > 0. \tag{A.10}$$

Since firm j gains $G^j > 0$ with probability $s > 0$, its expected profit, denoted $E\{\pi^j\}$, from making a license application always exceeds its known profit π^{Dj} from just buying domestic equipment, i.e.

$$E\{\pi^j\} \equiv sG^j + \pi^{Dj} > \pi^{Dj}. \tag{A.11}$$

Hence, having sunk T^j in stage 1, all final-good firms choose to apply for import licenses in stage 2.

Turning to the stage 1 choice of T^j, we first define $M^i \equiv -(\mathrm{d}L^i/\mathrm{d}T^j\,|_{y^{ij}} > 0$ to represent the MRS (marginal rate of substitution) between labor and the specific factor for firm j at output y^{ij} for $i = \mathrm{D,F}$. It then follows from linear homogeneity of the production function that

$$M^i = (\partial y^{ij}/\partial T^j)/(\partial y^{ij}/\partial L^{ij}) = [f(\ell(\rho^i),1) - \ell(\rho^i)f_\ell]/f_\ell. \tag{A.12}$$

Hence, using Eq. (A.8), Eq. (A.12) and $p-\rho^i = w/f_\ell(\ell(\rho^i),1)$ from Eq. (A.4) and Eq. (A.6a), variable profit becomes

$$V(\rho^i,T^j) = (w/f_L)[f(\ell(\rho^i),1) - \ell(\rho^i)f_\ell]T^j = wM^iT^j > 0, \tag{A.13}$$

and, from Eq. (A.11), using Eq. (A.9), Eq. (A.10) and Eq. (A.13), firm j's expected profit can be expressed as

$$E\{\pi^j\} = sG^j + (wM(r^{\mathrm{D}}) - \sigma)T^j \text{ where}$$

$$G^j = [w(M^{\mathrm{F}} - M^{\mathrm{D}}) + \lambda\delta]T^j > 0. \tag{A.14}$$

In stage 1, maximizing $E\{\pi^j\}$ taking s, δ and the price σ as given, T^j satisfies

$$\mathrm{d}E\{\pi^j\}/\mathrm{d}T^j = s(\mathrm{d}G^j/\mathrm{d}T^j) + wM^{\mathrm{D}} - \sigma = 0, \tag{A.15}$$

where, from Eq. (A.14), $\mathrm{d}G^j/\mathrm{d}T^j = G^j/T^j = w(M^{\mathrm{F}} - M^{\mathrm{D}}) + \lambda\delta > 0$ is independent of T^j. Hence, it follows that $\mathrm{d}^2E\{\pi\}/(\mathrm{d}T^j)^2 \equiv 0$ making the actual level of T^j and the equilibrium number of firms n indeterminate. At free trade, setting $\rho^{\mathrm{F}} = r^{\mathrm{F}}$, $\lambda = 0$ and $s = 1$ in Eq. (A.15) implies that $M^{\mathrm{F}} = \sigma/w$, which is just the familiar result that the MRS equals the factor price ratio. However, a binding import quota causing $\lambda > 0$ distorts this efficiency condition.

Using Eq. (A.13) and $\mathrm{d}G^j/\mathrm{d}T^j = G^j/T^j$ in Eq. (A.15), each firm j pays $\sigma T^j = sG^j + V(r^{\mathrm{D}};T^j)$ for the specific factor, reducing $E\{\pi^j\}$ to zero (see Eq. (A.14)) and generating rents for the specific factor equal to $\sigma T^0 = \Sigma_{j=1}^n[sG^j + V(r^{\mathrm{D}};T^j)]$. The equilibrium profits of firm j are as in Eq. (17): i.e. from Eq. (A.9) and Eq. (A.10) $\pi^{Fj} = (1-s)G^j > 0$ for $s < 1$ and $\pi^{Dj} = -sG^j < 0$ for $s > 0$. Thus, it is not hard to see that adjusting for the indexing of variables by T^j, all the subsequent welfare results also hold for this expanded model.

Importance of the sunk nature of the specific factor

To see the role played by the assumption that T is sunk prior to license allocation, suppose that licenses are instead allocated in stage 1 prior to the choice of T in stage 2 and stage 3 is unchanged. Since no commitment has been made to production, all license applicants are identical. Thus in stage 1, the government could allocate $\bar{y}=Q/ns$ to a proportion s of the n applicants as in Eq. (1) of the main model.

Indexing T by i, for $i=\mathrm{D,F}$, and using Eq. (A.13), stage 3 profits are:

$$\pi^{\mathrm{F}}=[wM^{\mathrm{F}}-\sigma]T^{\mathrm{F}}+\lambda\bar{y} \text{ and } \pi^{\mathrm{D}}=[wM^{\mathrm{D}}-\sigma]T^{\mathrm{D}}, \tag{A.16}$$

where $T^0=n(sT^{\mathrm{F}}+(1-s)T^{\mathrm{D}})$. Since at stage 2, firms know whether or not they hold an import license, $T^{\mathrm{F}}>0$ and $T^{\mathrm{D}}\geq 0$ respectively satisfy, from Eq. (A.16),

$$\begin{aligned} \mathrm{d}\pi^{\mathrm{F}}/\mathrm{d}T^{\mathrm{F}} &= wM^{\mathrm{F}}-\sigma=0 \text{ and } \mathrm{d}\pi^{\mathrm{D}}/\mathrm{d}T^{\mathrm{D}}=wM^{\mathrm{D}}-\sigma \\ &\leq 0 \quad (=0 \text{ if } T^{\mathrm{D}}>0). \end{aligned} \tag{A.17}$$

From Eq. (A.17), non-license holders set $T^{\mathrm{D}}>0$ if and only if $M^{\mathrm{D}}=M^{\mathrm{F}}$, which implies (see Eq. (A.12)) that markets are unified with $\rho^{\mathrm{F}}=r^{\mathrm{D}}$. Since $\rho^{\mathrm{F}}<r^{\mathrm{D}}$ for all s when $A(r^{\mathrm{D}})<Q<A(r^{\mathrm{F}})$, σ is then too high for non-license holders to enter and $T^{\mathrm{D}}=0$. License holders, using imports alone, then produce the same output as if $s=1$. If $\rho^{\mathrm{F}}=r^{\mathrm{D}}$ when $Q<A(r^{\mathrm{D}})$, then non-license holders enter setting $T^{\mathrm{D}}>0$ so as to achieve the same labor to specific factor ratio as license holders (i.e $\ell(\rho^{\mathrm{F}})=\ell(r^{\mathrm{D}})$ from Eq. (A.12)), but they earn zero profit (see Eq. (A.16)). In both cases, total output is the same as if licenses were marketable. Hence, trading in the specific factor prior to the allocation of quota licenses gives rise to the same outcome as if the licenses themselves were tradeable.

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