Journal of International Economics 14 (1983) 103–114. North-Holland Publishing Company

INTERNATIONAL FACTOR MOBILITY AND NATIONAL ADVANTAGE

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Received December 1981, revised version received August 1982

In this paper we prove rigorously V.K. Ramaswami's proposition that in bilateral trade between two countries sharing the same technology represented by a strictly concave production function with positive marginal productivities of capital and labor, the policy-active country can gain more by importing monopsonistically the relatively scarce factor than by placing monopolistic restrictions on the export of the relatively abundant one. We show that what matters is not the location, but the constraints within which maximization takes place, hence the monopsonistic results can be replicated by appropriate export arrangements. The analysis is extended to consider the welfare implications to the policy-passive country.

In a brief, brilliant 1968 article, V.K. Ramaswami demonstrated that in bilateral trade a country can gain more through monopsonistic import of a relatively scarce factor than through monopolistic export of one that it has in relative abundance.[1] This startling proposition has received little attention in the literature, perhaps because of the stark simplicity of the model and total abstraction from commodity trade considerations.[2] Yet the Ramaswami inquiry is not irrelevant to a world in which serious political controversy surrounds the factor movement issue. To be sure, economic considerations alone do not explain why the United States resists the immigration of cheap foreign labor while Western Europe, until recently, welcomed 'guest workers'. Likewise, the different treatment of foreign capital on the part of various LDCs — ranging from strong encouragement to strict limitations and control — cannot be explained on purely economic grounds. It is interesting, nevertheless, to know where the purely economic interests lie. And while the Ramaswami model is far too simple to yield 'real world' answers, its simplicity makes it attractive as a starting point for such an inquiry. It is for this reason that we undertook to prove rigorously and to extend Ramaswami's results.

[1]See Ramaswami (1968).
[2]See, however, Webb (1970) and Bhagwati (1979).

Ramaswami analyzed a situation in which two countries, which he called Mancunia and Agraria, produce a single homogeneous product, and share the same technology represented by a strictly concave linear homogenous function with capital and labor as arguments both exhibiting positive marginal productivities. Mancunia has a higher (native) capital to (native) labor ratio than Agraria.

One of the two countries, say Mancunia, pursues a policy aiming at the maximization of income accruing in the aggregate to its factors, regardless of their location; the other permits free factor movements. At first, Mancunia follows an autarkic policy and prohibits capital exports as well as immigration. It then shifts to a policy of monopolistic capital export constraint, but continues to bar immigration of Agrarians. What Ramaswami shows is that income to Mancunian factors of production would be even higher if, instead, Mancunia prohibited capital exports, but permitted immigration of Agrarians and imposed on them a monopsonistic immigration tax:

> Suppose that Mancunia, having invested optimally abroad, withdraws its capital and permits immigration of the workers using Mancunian capital in Agraria. As the *per capita* capital stock in Agraria is unchanged, immigrants need only be paid the wage they received hitherto; and if they continue to work with the same amount of capital per head as was previously employed in Agraria, Mancunian natives are no better or no worse off. But Mancunian natives can become better off by adopting a *uniform* capital–labor ratio for all production in Mancunia, taxing the earnings of immigrants so as to keep their net wages constant and distribuing the tax proceeds among natives. Thus *some* tax rate on immigrant earnings exists which secures higher *per capita* income for Mancunian natives than would the optimal restriction of foreign investment.[3]

While the verbal argument is unexceptionable, we cannot be sure, for lack of rigorous proof, what the theorem hinges upon.[4] We do not know, for instance, whether the identical production function assumption is necessary. Would the theorem still hold if we made the reasonable assumption that the relatively capital-rich country also has the superior technology?

The absence of a formal proof may also lead to a misunderstanding of the nature of Ramaswami's policy implications. The optimal policy (for Mancunia) seems to call for discriminatory treatment of foreign labor, a practice once quite common, but now generally frowned upon. If discriminatory treatment of immigrants is ruled out, a closed door policy-

[3]Ramaswami (1968, pp. 309–310).

[4]Ramaswami displays the monopoly and monospony equilibrium conditions [our eqs. (9) and (10)]; however, as can be readily seen, these conditions do not, in themselves, indicate under which policy Mancunia derives the greater gain.

cum-monopolistic capital exports clearly dominates a policy of permitting immigration, while a policy permitting unrestricted immigration dominates one of immigration quotas.[5] It would thus seem that capital-rich countries seeking self-interest must settle for a policy of simple monopolistic capital restrictions.

A closer examination of the Ramaswami proposition reveals, however, that the results do not hinge on whether production takes place at home or abroad; what matters are the constraints within which optimization takes place. As we shall show, the Ramaswami solution can be duplicated without overt discrimination against foreign laborers — indeed, without having to admit any immigrants.

Our discussion falls into two parts. First, we give a mathematical proof which closely follows Ramaswami's line of reasoning. In order to better understand the nature of the solution, we then give a more general proof which we utilize to explore some major policy implications.

To start with, let us introduce some notation. Let $\bar{K}$ and $\bar{L}$ stand for Mancunia's endowment in capital and labor, and $\bar{K}^*$ and $\bar{L}^*$ for the Agrarian endowments (remember, we shall be concerned throughout with the returns accruing to a given country's factors regardless of their location). Let K and L stand for capital and labor employed in Mancunia, and K^* and L^* for capital and labor employed in Agraria. We shall write: $K_A = \bar{K} - K$ for the Mancunian capital employed in Agraria, and $L_A^* = \bar{L}^* - L^*$ for the Agrarian labor working with Mancunian capital. We shall designate by r, w, r^* and w^* the (competitively determined) wages of the two Mancunian and Agrarian factors, respectively.

The technology (which for the time being we shall assume to be common to both countries) is represented by $F(K, L)$, a homogeneous, concave function with positive marginal products to both factors. To insure the existence of interior solutions we shall also assume Inada's conditions.

We shall now prove a somewhat more general theorem than Ramaswami's.[6] The theorem will be stated in terms of capital-rich Mancunia but, mutatis mutandis, it applies, of course, to labor-rich Agraria.

We shall show that for any feasible capital export policy ($K_A > 0$) there exists an alternative policy involving no capital export, but calling for immigration of Agrarian labor. If under this alternative policy the immigrants are paid the Agrarian wage, Mancunians will receive at least as large an income as under the capital export policy.

Let R_c stand for the returns accruing to Mancunian factors under a capital export policy. R_c equals, of course, the sum of the returns to the factors exployed in Mancunia plus the income accruing to Mancunian capital in Agraria, or:

[5]The proof of this proposition is a straightforward application of MacDougall (1960).

[6]In our proof, in contrast to Ramaswami, we do not assume that the initial volume of capital was optimally chosen.

$$R_c = F(K, L) + r^* K_A, \tag{1}$$

where r^* is determined by the marginal product of capital in Agraria:

$$r^* = F_1(\bar{K}^* + K_A, \bar{L}^*). \tag{2}$$

By linear homogeneity and (2) we have:

$$F(K_A, L_A^*) = r^* K_A + w^* L_A^*; \tag{3}$$

hence, (1) can be expressed as:

$$R_c = F(K, L) + F(K_A, L_A^*) - w^* L_A^*, \tag{4}$$

i.e. the revenue accruing to Mancunian factors is equal to the sum of the production in Mancunia plus the production carried out in Agraria with Mancunian capital, minus wages paid in Agraria to workers employed by Mancunian capital.

We now perform the Ramaswami experiment, and repatriate the K_A Mancunian capital admitting, at the same time, the L_A^* workers who worked with it in Agraria. Since this operation does not change the factor proportions in the Agrarian economy, we can continue to pay the immigrant workers the same wage as before. Income accruing to Agrarian factors is therefore unaffected. Next, we reallocate all labor in Mancunia in an efficient fashion, so that all workers, regardless of their nationality, have the same marginal product. After the reallocation, the revenue accruing to Mancunian factors, R_M, is:

$$R_M = F(K + K_A, L + L_A^*) - w^* L_A^*. \tag{5}$$

But, by concavity,

$$F(K + K_A, L + L_A^*) \geqq F(K, L) + F(K_A, L_A^*); \tag{6}$$

hence,

$$R_M \geqq R_c. \tag{7}$$

Strict inequality prevails if

$$K/L \neq K_A/L_A^*, \tag{8}$$

that is if under the capital export policy the capital/labor ratios differ in the two countries. In the case examined by Ramaswami K_A is determined by the monopolistic optimum condition:

$$r=F_1(\bar{K}-K_A,L)=F_1(\bar{K}^*+K_A,\bar{L}^*)+K_AF_{11}(\bar{K}^*+K_A,\bar{L}^*), \tag{9}$$

and since $K_A>0$ (by assumption that Mancunia is the relatively capital rich country) while $F_{11}<0$ (by concavity assumption) (8) holds and therefore the 'repatriation policy' strictly dominates the monopolistic capital export policy.

There is no presumption, of course, that L_A^*, the optimal number of Agrarians hired by Mancunia under the monopolistic capital export regime equals L_A^{**}, the optimal number of Agrarian workers under the monopsony regime. The latter is determined by the condition

$$w=F_2(\bar{K},\bar{L}+L_A^{**})=F_2(\bar{K}^*,\bar{L}^*-L_A^{**})-L_A^{**}F_{22}(\bar{K}^*,\bar{L}^*-L_A^{**}). \tag{10}$$

In general, therefore, Mancunia can do even better by admitting fewer (or perhaps more) 'guest workers' than the number that would accompany the repatriated capital. We shall label the monopsonistic solution the 'Ramaswami policy'.

To gain a better understanding of the nature of the results — and to show that they can be attained without admitting any immigrants — we now offer an alternative proof of the Ramaswami proposition. As before we start with a capital export policy. For the sake of clarity of verbal exposition we shall assume that K_A is optimally chosen in accordance with (9) so that (8) holds; it is easy to verify, however, that a similar proposition can be proved even if K_A is not optimally chosen. The expatriated capital hires competitively Agrarian workers, thus determining L_A^*, the number of Agrarians employed in Agraria by Mancunians.

Mancunia now changes its factor trade regime: it orders a freeze on the hiring of Agrarians by Mancunian capital in Agraria, so that L_A^* is now fixed, but it entirely frees capital movements. In other words, Mancunian capitalists may increase or decrease their investment in Mancunia by any amount ΔK_A. It will be profitable for them to do so if (8) holds. In particular, $r^*>r$ if K_A was chosen in accordance with (9) to maximize monopoly profits; hence, in this case it will be profitable to invest more in Agraria, i.e. ΔK_A will be positive.

The new problem can be stated as follows:

$$R_N=\max_{\Delta K_A}\{F(K-\Delta K_A,\bar{L})+F(K_A+\Delta K_A,L_A^*)-w^*L_A^*)\}. \tag{11}$$

At optimum:

$$F_1(K-\Delta K_A,\bar{L})=F_1(K_A+\Delta K_A,L_A^*), \tag{12}$$

implying that capital/labor ratios will be the same in Mancunian operations in both countries. By linear homogeneity:

$$F(K+K_{\mathrm{A}},\bar{L}+L_{\mathrm{A}}^{*})=F(K-\Delta K_{\mathrm{A}},\bar{L})+F(K_{\mathrm{A}}+\Delta K_{\mathrm{A}},L_{\mathrm{A}}^{*}), \tag{13}$$

which means that for any given L_{A}^{*}, income in Mancunia is the same as if K_{A} capital were repatriated and L_{A}^{*} laborers were allowed to migrate to Mancunia and paid the Agrarian wage w^{*}. From this it immediately follows that

$$\max_{L_{\mathrm{A}}^{*}} R_{\mathrm{N}}=R_{\mathrm{M}}.$$

The above proof shows that the results of the 'repatriation policy' can be achieved without repatriation of capital and with a continuing bar on immigration. The proof also clarifies the question of why the monopoly solution is dominated by the 'repatriation' solution. The former involves maximization subject to (2); in the latter case, the constraint is removed. This removal means that it becomes possible to drive a 'wedge' between the marginal product of Agrarian workers employed by Mancunian capital and the Agrarian wage. Since now more Mancunian capital can be employed in Agraria without driving up the Agrarian wage, Mancunian capital can be employed efficiently, yielding the same return in Mancunia as in Agraria.

To be sure, the institutional arrangements indicated by Ramaswami, as well as our alternative arrangements for reaching the 'repatriation' results, are somewhat tortured. It is easy, however, to display an institutional set-up which yields the 'Ramaswami' solution, and avoids overt discrimination against Agrarian labor.

Imagine that Mancunian capitalists, who want to invest in Agraria, are required to join a capital exporters' cartel. The cartel, seeking to maximize its profits, will choose simultaneously the optimal volume of capital export, and the optimal number of Agrians employed on the exported capital, which means that it will determine L_{A}^{**} in accordance with (10) and investment abroad in accordance with (13). Thus, Mancunian capital will be allocated efficiently between domestic and foreign operations (with equality of capital/labor ratios) while Agrarian labor will be monopsonistically exploited. Notice, however, that there is no overt discrimination: Agrarians in Mancunia are paid the same wage by domestic and by foreign capitalists.

We can now also answer a question raised at the beginning of this paper, namely whether the results hold even if Mancunia and Agraria have different technologies. Notice that in our proofs we never used the equal technology assumption. The results would hold even if Mancunians had a different (say superior) technology which they could utilize either in their foreign or their domestic operations.

Ramaswami did not study the implications for Agraria of adopting the capital export or the optimal labor import policies. The issue turns out to be far from simple, because it involves comparing two second-best situations.

It is relatively straightforward to show (see the appendix for a proof) that Agrarians' income is an increasing function of the resulting capital labor ratio in Agraria, or, in other words, of the wage accruing to Agrarians. Unfortunately, however, we were not able to fully characterize the situations where the Ramaswami policy gives rise to a capital/labor ratio in Agraria that is larger than the one associated with the capital export policy, or vice versa.

We examined the above-mentioned issue at a less ambitious scale by (1) performing numerical experiments in terms of C.E.S. productions functions, and (2) analyzing the problem in a neighborhood of the situation where the two countries have identical capital/labor ratios. In respect to (1) we are able to report that in all our experiments we found that Agrarians were better, i.e. their income was the highest, when the capital export policy was adopted.[7]

With respect to (2), we will show in the appendix that if the countries are close enough in terms of initial capital/labor ratios, again the capital export policy is superior from Agrarians standpoint.[8]

Appendix

The main objective of this appendix is to prove the theorem stated at the end.

The first task will be to express the first-order conditions (9) and (10) in terms of capital/labor ratios only. Since our proofs will be carried out for a 'neighborhood' of the case where the two countries have the same capital/labor ratios, and, as it is easy to see, an equi-proportional

[7]Although in the Cobb–Douglas case we were able to obtain some closed-form expressions, a general proof, if there is one, eluded us. We were, however, able to show that, besides the local property to which we will refer under (2), it is also true for the Cobb–Douglas that Agrarians' income is larger under the capital export policy when the ratio of the capital/labor endowment ratios lies above a certain well-defined lower bound.

[8]We were not able to find an example of a simple production function where the 'Ramaswami' policy would make Agrarians better off than the monopolistic capital export policy. The most we could do in this respect was to examine a limit case where the relevant 'piece' of the unit isoquant for Mancunia was 'flat' — i.e. infinite elasticity of substitution — while that for Agraria corresponded to a quadratic production function. Utilizing the first-order conditions, we convinced ourselves that there were sufficient 'degrees of freedom' in order to permit us to exhibit a case in which the 'Ramaswami' policy dominates the capital export policy. It also seemed to us that there should be no problem in being able to 'draw' the rest of the isoquant in a convex manner. It should be noted, however, that our 'proof' is not complete because we did not attempt to show that the assumed configuration was consistent with our presumption that the first-order conditions were satisfied at a global maximum. In sum, then, we are prepared to offer a strong conjecture about the existence of cases where the Ramaswami policy makes Agrarians better off compared to the alternative, but from a rigorous point of view it must be admitted that the proposition still remains to be formally established.

enlargement of the two countries does not change the welfare ordering for either country of the Ramaswami and the monopolistic capital export policies, we lose no generality by assuming

$$\bar{K}^* = \bar{L} = \bar{L}^* = 1. \tag{A.1}$$

As in the text, we assume here that Mancunia is relatively capital-rich, i.e. recalling (A.1)

$$\bar{k} = \bar{K} > 1. \tag{A.2}$$

Let us define

$$f(k) \equiv F(k, 1), \qquad \text{(A.2)}$$

where

$$k \equiv K/L. \qquad \text{(A.2)}$$

As is well known, competitive factor returns satisfy:

$$r(k) = f'(k), \tag{A.3}$$

$$w(k) = f(k) - f'(k)k. \tag{A.4}$$

By (A.3) and (A.4):

$$w'(k) = -r'(k)k, \tag{A.5}$$

and, hence,

$$w''(k) = -r'(k) - r''(k)k. \tag{A.6}$$

By (A.1):

$$\text{Mancunia's capital export} = K_A = K^* - \bar{K}^* = k^* - 1 \tag{A.7}$$

and

$$\begin{aligned}&\text{Mancunia's labor import}\\ &\quad \text{under Ramaswami's policy} = L_A^{**} = \bar{L}^* - L^* = 1 - 1/k^*.\end{aligned} \tag{A.8}$$

We also notice that, by (A.2) and (A.3):

$$F_{11}(K, L) = f''(k) = r'(k), \tag{A.9}$$

and, by (A.2), (A.3) and (A.5):

$$F_{22}(K,L)=f''(k)k^2/L=-w'(k)k/L. \tag{A.10}$$

Therefore, recalling (A.7) and (A.9), the first-order condition for the optimal capital export policy (CAPEX), given by (9), can be expressed as

$$-r(k)+r(k^*)+r'(k^*)(k^*-1)=0. \tag{A.11}$$

Also, the first-order condition for the Ramaswami policy (RAMA) is, by (10), (A.1), (A.4) and (A.10):

$$w(k)-w(k^*)-w'(k^*)k^*(k^*-1)=0. \tag{A.12}$$

In order to simplify the exposition we assume the existence of a unique maximum for both CAPEX and RAMA.

Clearly, if $\bar{k}=1$ (i.e. countries have the same capital/labor ratio), for both RAMA and CAPEX, we have $k=k^*=1$, i.e. the status quo is the optimal policy. In order to characterize solutions for a neighborhood of the status quo point we will differentiate (A.11) and (A.12). Thus,

$$\frac{\mathrm{d}k_C}{\mathrm{d}k^*}=\frac{2r'(k^*)+r''(k^*)(k^*-1)}{r'(k)}, \tag{A.13}$$

$$\frac{\mathrm{d}k_R}{\mathrm{d}k^*}=\frac{2w'(k^*)+w''(k^*)(k^*-1)}{w'(k)}k^*, \tag{A.14}$$

where subindices C and R stand for CAPEX and RAMA, respectively.

By (A.13) and (A.14), at the status quo point,

$$\frac{\mathrm{d}k_C}{\mathrm{d}k^*}=\frac{\mathrm{d}k_R}{\mathrm{d}k^*}=2. \tag{A.15}$$

Differentiating (A.13) and (A.14) once more we get

$$\frac{\mathrm{d}^2k_C}{\mathrm{d}k^{*2}}$$

$$=\frac{[3r''(k^*)+r'''(k^*)(k^*-1)]r'(k)-r''(k)\dfrac{\mathrm{d}k_C}{\mathrm{d}k^*}[2r'(k^*)+r''(k^*)(k^*-1)]}{[r'(k)]^2} \tag{A.16}$$

and

$$\frac{d^2k_R}{dk^{*2}}=\left\{\{[3w''(k^*)+w'''(k^*)(k^*-1)]k^*+w'(k^*)2+w''(k^*)(k^*-1)\}w'(k)\right.$$

$$\left.-\frac{dk_R}{dk^*}w''(k)[2w'(k^*)+w''(k^*)(k^*-1)]k^*\right\}\div[w'(k)]^2. \tag{A.17}$$

At the status quo point, recalling (A.5) and (A.6),

$$\frac{d^2k_C}{dk^{*2}}=-\frac{r''(1)}{r'(1)} \tag{A.18}$$

and,

$$\frac{d^2k_R}{dk^*}=-\frac{w''(1)}{w'(1)}+2=1-\frac{r''(1)}{r'(1)}. \tag{A.19}$$

By (A.1) and (A.2), and the capital constraint for the two countries, we have for CAPEX

$$\bar{k}=k+k^*-1. \tag{A.20}$$

Thus, given k and k^* that satisfy the first-order condition for CAPEX, (A.11), there is an initial endowment of capital of Mancunia, $\bar{k}$, given by (A.20) for which the said (k,k^*) is optimal. Evaluating at the status quo point, we get, by (A.15) and (A.18) (where $\bar{k}_C$ is used instead of simply $\bar{k}$ to indicate that the calculations correspond to CAPEX):

$$\frac{d\bar{k}_C}{dk^*}=\frac{dk_C}{dk^*}+1=3 \tag{A.21}$$

and

$$\frac{d^2\bar{k}_C}{dk^{*2}}=\frac{d^2k_C}{dk^{*2}}=-\frac{r''(1)}{r'(1)}. \tag{A.22}$$

Similarly, by (A.1) and (A.8), we have for RAMA:

$$k=\frac{\bar{k}}{2-1/k^*}. \tag{A.23}$$

Hence, using $\bar{k}_R$ instead of $\bar{k}$ to identify this case,

$$\bar{k}_R=k(1-1/k^*). \tag{A.24}$$

Differentiating (A.24) at the status quo point we get, by (A.15) and (A.18), and recalling (A.21) and (A.22):

$$\frac{\mathrm{d}\bar{k}_R}{\mathrm{d}k^*}=\left(2-\frac{1}{k^*}\right)\frac{\mathrm{d}k_R}{\mathrm{d}k^*}+\frac{k}{k^{*2}}=3=\frac{\mathrm{d}\bar{k}_C}{\mathrm{d}k^*} \tag{A.25}$$

and

$$\frac{\mathrm{d}^2\bar{k}_R}{\mathrm{d}k^{*2}}=3-\frac{r''(1)}{r'(1)}>\frac{\mathrm{d}^2\bar{k}_C}{\mathrm{d}k^{*2}}. \tag{A.26}$$

The implication of (A.25) and (A.26) is seen in fig. A.1, where functions $\bar{k}_R$ and $\bar{k}_C$ start at the status quo point (where, it should be recalled, the two countries have identical capital/labor ratios). By (A.25) these functions have the same positive slope at $k^*=1$, but, by (A.26), $\bar{k}_R$ rises at a faster rate; therefore, as shown in the figure, for a neighborhood to the right of $k^*=1$, the graph of $\bar{k}_R$ lies above that of $\bar{k}_C$.[9] An important implication of the latter is that, denoting k_C^* and k_R^* the values of k^* associated with CAPEX and RAMA, respectively, there exists some open interval $(1, I)$, $I>1$, such that of $\bar{k}\in(1, I)$, then $k_R^*<k_C^*$; see fig. A.1 for a proof.

We will now prove the proposition advanced in the text:

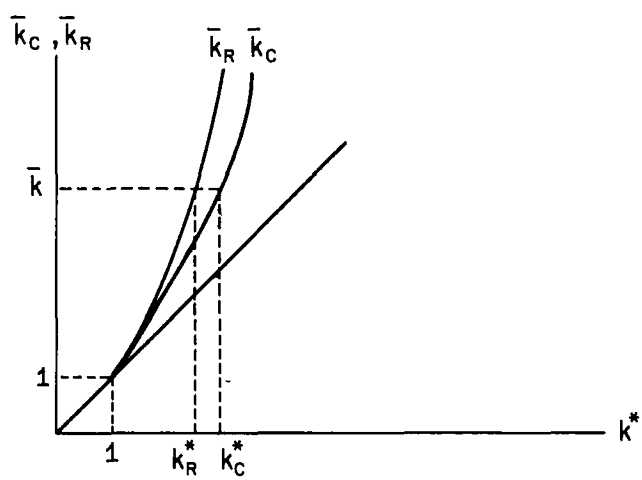

Fig. A1. Determination of optimal k^*.

[9]It should be noted, however, that as argued in the text, footnote 8, it does not seem to be possible to show in general that these two curves will not cross each other for some $k^*>1$.

Theorem. If Mancunia's capital/labor endowment ratio, $\bar{k}$, is such that $\bar{k}\in(1,l)$ then the income of Agrarians is larger under CAPEX than under RAMA.

Proof. In both policy regimes the income of Agrarians is given by [recall (A.1)]:

$$w^*+r^*=f(k^*)-f'(k^*)(k^*-1). \tag{A.27}$$

Hence,

$$\frac{\mathrm{d}(w^*+r^*)}{\mathrm{d}k^*}=-f''(k^*)(k^*-1)>0, \quad \text{if} \quad k^*>1. \tag{A.28}$$

By fig. A.1, when $k\in(1,l)$,

$$k_C^*>k_R^*>1. \tag{A.29}$$

The theorem now trivially follows from (A.28) and (A.29). Q.E.D.

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