The Sources of Protectionist Drift in Representative Democracies

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ABSTRACT
We analyze a two country-two good model of international trade in which citizens in each country differ by their specific factor endowments. The trade policy in each country is set by the politician who has been elected by the citizens in a previous stage. Due to a delegation effect citizens generally favor candidates who are more protectionist than they are. The one candidate per country-equilibria exhibit a "protectionist drift" owing to this delegation effect. In addition, we find an additional source of "protectionist drift" which we call the abstention effect. Not only do candidates wish to delegate to more protectionist colleagues, but these more protectionist colleagues who can win election, prefer still more protectionist candidates than themselves. Therefore, they have an incentive to abstain, that is, not run for election. We show that because of this "abstention effect" there exists a range of electable citizens all of whom are more protectionist than the median voter's most preferred candidate. We extend the analysis allowing two candidate equilibria and the possibility that there are costs and benefits of holding office.
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1 Introduction

It is well-known that a one-shot Nash equilibrium between benevolent governments independently setting their trade policies exhibits strictly positive taxes on imports (or exports) in each country[1]. This "tariff war" equilibrium result generalizes the classical "optimum tariff argument" in which governments use tariff policy in order to take advantage of the country's collective market power on international commodities markets and modify the equilibrium terms of trade with the rest of the world.

While this line of research undoubtedly gives insight into the basic incentives existing in actual economies it has been criticized because it relies on the assumption that governments maximize social utility. Trade policy decisions are made by political entities and there has been a vast literature (surveyed superbly by Rodrik (1995)) examining the link between trade policy and political decision making. Rodrik's survey presents many alternative approaches to this problem but as Rodrik points out, all of them share a single difficulty. Namely, in virtually all of these models trade policy is a second best instrument to implement the implied redistribution of income. Usually, the use of some type of domestic policy would yield a Pareto improvement. Rodrik goes on to point out that based on these models it is not obvious why politically motivated trade policy is anti-trade instead of pro-trade.

What we do is to merge the "tariff war" equilibrium concept with political economy considerations to come up with an explanation for tariffs that is not subject to the Rodrik critique. The political economy approach we follow has its roots in a paper by Wolfgang Mayer (1984). Mayer's paper marked an important step towards a positive approach to trade policy. He showed that if the indirect utility functions of the citizens in each country are single-peaked and the trade policy is determined by direct democracy, then the equilibrium tariff in country i is the tariff preferred by the median voter. The "Mayer equilibrium" is hence equivalent to a two country Nash equilibrium in trade policies where the policies are the ones preferred by the two median voters. In a classical 2X2X2 framework where the distribution of capital is more skewed than the distribution of labor in the capital rich country then the equilibrium trade policy is more protectionist in the capital-rich country and less protectionist in the capital-poor country. Hence, at a "Mayer equilibrium" there is more protection than at the equilibrium be-

[1] see Johnson (1953-4) and Kennan and Riezman (1988)

tween social utility maximizing governments. In this case, considering the influence of political decision making results in a general tendency toward more protectionist equilibria.

We build on Mayer's work by using the majority rule framework but allowing candidates to be chosen endogenously a la Besley and Coate (1997). We find that there is a "protectionist drift" in a representative democracies framework. We borrow from Besley and Coate ((1997), (1998a),(1998b)) and (Osborne and Slivinski (1996)) the idea of "citizen candidates": the future policymaker is chosen in each country among the citizens who are willing to run for election and these citizens are unable to commit to a given policy. Rather, citizens elected implement the policy associated with their given "type" as in Mayer's model. This leads to a "delegation effect". Since the election stage takes place before the trade policy selection and changes in the "type" of the policymaker does have strategic effects on the trade policy equilibrium, voters generally favor the election of somebody whose type differs from their own. We show that there exists a one candidate per country equilibrium in which the selected policymaker in country i $(i = 1, 2)$ is the ideal candidate of the median voter and is unambiguously more protectionist than her and that in every two candidate per country equilibrium the *expected* type of the elected policymaker in country i $(i = 1, 2)$ is the preferred type of the median voter. Thus, delegation effects produce "protectionist drift". This result is similar to those found by others who have investigated delegation effects in a representative democracy framework for different policy questions (Persson and Tabellini ((1992), (1994), (1996)), Chari, Jones and Marimon (1997), Besley and Coate (1998a)). In addition, Willmann (2002) studies delegation in a Grossman-Helpman framework with political decisions made by a legislature. In an earlier contribution, Gatsios and Karp (1995) study how members of a customs union benefit from delegating the power to set external tariffs to one of its members.

We go on to show, however, that besides delegation effects, there is an additional source for protectionist drift in a representative democracy when candidates are purely outcome-motivated. This is what we call the "abstention effect". Not only do candidates wish to delegate to more protectionist colleagues, but these more protectionist colleagues who can win election, prefer still more protectionist candidates than themselves. Therefore, they have an incentive to abstain, that is, not run for election. We show that because of this "abstention effect" there exists in one candidate per country equilibria a range of electable citizens all of whom are more protectionist than the

median voter's most preferred candidate. Thus, candidates who are more protectionist than the ideal candidate of the median voter may run unopposed for election because the only citizens who could defeat them choose not to run. Moreover, in two candidate per country equilibria, this abstention effect prevents policy convergence: the two candidates in country i ($i = 1, 2$) have to be far apart in order that one of them does not find worthwhile to withdraw her application.

We also introduce the possibility that there may be costs and benefits associated with holding office. In one candidate equilibria, the larger the net benefits from holding office the smaller the set of possible equilibria. With two candidate equilibria, more benefits mean less dispersion in candidate types. The interesting implication of this result is that as holding office becomes more unpleasant (larger negative net benefits) there will be more dispersion between candidates.

2 The Model

There are two countries, 1 and 2, producing two goods, A and B, with the help of specific factors. In each sector one unit of specific factor is needed to produce one unit of the good under perfect competition. Hence y_{ij} will denote both the output of good i in country j and the overall stock of the specific factor in sector i of country j. There are N_j citizens in country j. Each citizen k is endowed with $\frac{y_{Aj}}{N_j} + \theta_k$ units of factor A and $\frac{y_{Bj}}{N_j}$ units of factor B such that $\sum_{k=1}^{k=N_j} \theta_k = 0$. We suppose for the sake of simplicity that, in each country, the average and median endowments of factor A do coincide. In other words if m is the median voter $\theta_m = 0$. In the following, θ_k will be the citizen k's "type".

Citizen k has a quasi-linear utility function $U(c_{Ak}, c_{Bk}) = \alpha c_{Ak} - \frac{1}{2} c_{Ak}^2 + c_{Bk}$, $\alpha > 0$, which is the same in both countries. In equilibrium all consumers in country j will have the same demand for good A which will be denoted c_{Aj}

Under free trade it is straightforward to show that country i is a net exporter of good A if and only if its output per head in sector A is larger than in country j, i.e. $y_{Ai}N_j - y_{Aj}N_i \geq 0$. Without any loss of generality we will assume that the output of good A per head is larger in country 1, hence country 1 exports good A.

Assumption 1: $N_2 y_{A1} - N_1 y_{A2} > 0$

Let good B be the numeraire good. The price of the good A in country j is p_j. Throughout we assume that each country levies import taxes or export taxes on good A. The respective specific taxes on exports and imports of good A in countries 1 and 2 are t_1 and t_2 and the international price of good A is defined by $p = p_1 + t_1 = p_2 - t_2$. This is the price which one country must pay to the other in order to receive one unit of good A (or the price which it receives when it sells one unit of good A to the other country). In country j citizens receive a uniform lump-sum transfer f_j and the government budget constraints in countries 1 and 2 are respectively

$$\begin{aligned} t_1 (y_{A1} - N_1 c_{A1}) &= N_1 f_1 \\ t_2 (N_2 c_{A2} - y_{A2}) &= N_2 f_2 \end{aligned} \tag{1}$$

In country j each citizen k has the same demand $\alpha - p_j$ for good A. Hence the market-clearing equilibrium condition for good A is easily derived as

$$(N_1 + N_2)(\alpha - p) + N_1 t_1 - N_2 t_2 = y_{A1} + y_{A2} \tag{2}$$

and then we obtain the equilibrium international price as

$$p = \alpha + \frac{N_1 t_1 - N_2 t_2 - y_A}{N_1 + N_2} \tag{3}$$

where $y_A = y_{A1} + y_{A2}$. It follows that in country 1 we obtain

$$c_{A1} = \frac{N_2 (t_1 + t_2) + y_A}{N_1 + N_2} \tag{4}$$

for all $k = 1, 2, .., N_1$, while in country 2,

$$c_{A2} = \frac{-N_1 (t_1 + t_2) + y_A}{N_1 + N_2} \tag{5}$$

for all $k = 1, 2, .., N_2$.

The budget constraint for individual k in country i is given by

$$p_i c_{Ai} + c_{Bi} = p_i \left(\frac{y_{Ai}}{N_i} + \theta_k \right) + \frac{y_{Bi}}{N_i} + f_i \tag{6}$$

Using (1) and (6) the indirect utility function of a citizen k in country 1 is now obtained as

$$U_k^1(t_1,t_2) = \alpha c_{A1} - \frac{1}{2}c_{A1}^2 + p\left(\frac{y_{A1}}{N_1} - c_{A1}\right) + \frac{y_{B1}}{N_1} + (p - t_1)\theta_k$$

with p and c_{A1} given respectively by equations (3) and (4).

In country 2 the indirect utility function of a citizen k is obtained as

$$U_k^2(t_1,t_2) = \alpha c_{A2} - \frac{1}{2}c_{A2}^2 + p\left(\frac{y_{A2}}{N_2} - c_{A2}\right) + \frac{y_{B2}}{N_2} + (p + t_2)\theta_k$$

where p and c_{A2} given respectively by equations (3) and (5).

Let us now define the game which is played. In the first stage and in each country each citizen decides whether or not she will run for election in order to represent the community. The entry decisions are strategic: the citizens decide whether to run or not by evaluating the potential benefit from running which, for each of them, depends on the entry decisions of all the other citizens in the same country and in the other country. In the second stage and in each country the polity selects its representative in an election. All citizens have one vote which, if used, must be cast for one of the self-declared candidates. The candidate who receives the most votes is elected and, when the candidates tie, all tied candidates win with equal probability. The types of the candidates (i.e. their endowments of the specific factor A) are perfectly observable both inside and outside the country. In the third stage the representative selected in the second stage in country j selects the country's trade policy (i.e. the value of t_j). If nobody runs for office the default policy $t_j = 0$ (*laissez-faire*) is applied.

Note that we follow Besley and Coate (1997) in supposing that there is no exogenous benefit from holding office[2] (such as ego rents, resource diversion and the like): candidates are only outcome-motivated. We will indicate below how the removal of this assumption can modify some of our results.

In this paper we will first focus on the one-candidate equilibria, i.e. the equilibria where, in each country, one and only one candidate runs unopposed, and on two candidate equilibria where, in one country at least, two winning candidates run against each other. Besides convenience, there are also some good theoretical arguments for giving less attention to n-candidate equilibria when $n > 2$. In the first place, assuming that people vote *strategically*,

[2]For a different assumption see for instance Osborne and Slivinsky (1996).

contrary to Osborne and Slivinski (1996) who assume *sincere* voting, Besley and Coate (1997) have been able to show that, in a one-dimensional model, some very mild assumptions are enough to rule out elections where more than two *winning* candidates run. The basic argument is rather intuitive. If three or more candidates tie and if there is a subset of citizens nearly indifferent between two nearby candidates, it is always true (in a large country with continuous variations in endowments) that they will prefer the sure election of one of these two to the lottery between all the candidates.

We can also rule out equilibria with two winning and one or several losing candidates. The argument runs as follows: with two winning candidates the losing candidate incurs the (even infinitesimal) cost of running only if this prevents the election of her less-preferred candidate and it follows that she must be in-between the two candidates and that the median voters are voting for her. If she dropped out the medians voters would split equally their votes between the two remaining candidates and thus her presence, which is costly, can have no effect. The only remaining possibility is the existence of equilibria with one winning and three or more losing candidates. They correspond however to rather strange bootstrap equilibria which will not be considered here.

3 Trade Policy Selection

Let the citizens r and s be the representatives chosen respectively in countries 1 and 2 and θ_r and θ_s their respective "types". The first-order conditions for the trade policy game are derived as

$$-t_1 N_2 + \frac{N_2 y_{A1} - N_1 y_{A2} - N_1 N_2 (t_1 + t_2)}{N_1 + N_2} - \theta_r N_2 = 0 \tag{7}$$

for country 1 and

$$-t_2 N_1 + \frac{N_2 y_{A1} - N_1 y_{A2} - N_1 N_2 (t_1 + t_2)}{N_1 + N_2} + \theta_s N_1 = 0 \tag{8}$$

for country 2.

It is easy to check that these conditions are both necessary and sufficient (i.e. U_r^1 and U_s^2 are respectively strictly concave with respect to $t_1$and t_2) and that t_1 and t_2 are *strategic substitutes*. A Nash equilibrium of the trade policy game is now any couple $(t_1(\theta_r, \theta_s), t_2(\theta_r, \theta_s))$ solution of equations (7)

and (8). It is straightforward to show that these equations have a unique solution:

$$t_1(\theta_r, \theta_s) = \frac{1}{2}\frac{(N_2 y_{A1} - N_1 y_{2A}) - \theta_s N_2 N_1 - \theta_r (2N_2 + N_1) N_2}{N_2 (N_1 + N_2)} \tag{9}$$

$$t_2(\theta_r, \theta_s) = \frac{1}{2}\frac{(N_2 y_{A1} - N_1 y_{2A}) + \theta_r N_2 N_1 + \theta_s (N_2 + 2N_1) N_1}{(N_1 + N_2) N_1} \tag{10}$$

As can be seen from equation (9) introducing distributional considerations will tend to reduce the export tax in country 1 since the owners of factor A are hurt by the tax. Hence, the larger is the country 1 policy maker's factor A endowment the lower is the specific tax on country 1 exports of good A. The same considerations (see equation (10)) will tend to increase the tariff in country 2 since the tariff increases incomes of specific factor A owners in country 2

We next solve for the equilibrium when each country's median voter is elected. One could think of this as a result of Downsian political competition[3]. The equilibrium values of t_1 and t_2 can be obtained from (9) and (10) and simply by setting $\theta_r = \theta_s = 0$.

$$t_1(0,0) = \frac{1}{2}\frac{(N_2 y_{A1} - N_1 y_{2A})}{N_2 (N_1 + N_2)} \tag{11}$$

$$t_2(0,0) = \frac{1}{2}\frac{(N_2 y_{A1} - N_1 y_{2A})}{N_1 (N_1 + N_2)} \tag{12}$$

In each country the trade policy is the optimal trade policy of *the median voter* as in Mayer (1984). In this case, country 1 sets a positive export tax and country 2 has a positive tariff. They differ only depending on country size, *the larger country setting the larger tax*. Thus, the larger the country 2 policy maker's factor A endowment the larger is the specific tax on imports of good A in country 2. It is, moreover, easy to compare the median voter utility at a "Mayer equilibrium" to her utility under free trade. Subtracting the latter from the former one obtains for country 1[4]:

$$\frac{(2N_1 - 3N_2)(N_2 y_{A1} - N_1 y_{A2})^2}{8N_1^2 N_2 (N_1 + N_2)^2}$$

[3]In each country two office-motivated candidates who care only about winning the elections both commit in equilibrium to the policy preferred by the median voter.

[4]Symmetric results for country 2 are readily obtained.

Obviously the median voter's utility in country 1 is larger at the Mayer equilibrium iff $N_1 > \frac{3}{5}(N_1 + N_2)$, i.e. country one is large enough. This result is consistent with Kennan and Riezman (1988). The utility function of any given citizen in either country is indeed strictly concave (and hence single-peaked) and the median voter theorem can be applied. In the next section we determine whether this is an equilibrium in a "citizen candidate" model of political equilibrium.

It is also possible to determine the conditions under which country 1 is a net exporter of good A. Net exports of good A by country 1 are easily obtained as

$$\frac{1}{2}\frac{(\theta_r - \theta_s)N_2N_1 + (N_2y_{A1} - N_1y_{A2})}{(N_1 + N_2)}$$

It is thus *a priori* possible than the natural (i.e. free-trade) specialization of countries (determined by the sign of $(N_2y_{A1} - N_1y_{A2})$) be reversed by a biased choice of policy-makers in one or both countries[5]: this could occur for instance if the country 2 policy-maker 's endowment in factor A was much larger than country 1 policy maker's. Of course this can't occur under direct democracy. We will show below that this never occurs in equilibrium under representative democracy.

4 Voting

In this section we examine a model of "citizen candidates." We assume that, in each country, the citizens can anticipate the utility imputations which arise from the policies selected by each possible couple (θ_r, θ_s) of policy-makers. In country 1 for instance, a citizen k will receive a utility level $U_k^1(t_1(\theta_r, \theta_s), t_2(\theta_r, \theta_s), \theta_k) = V^1(\ \theta_r, \theta_s, \theta_k)$ which depends on its own endowment and on the types of the domestic and the foreign policy-makers. We show in the Appendix that V^1 and V^2 are strictly concave respectively with respect to θ_r and θ_s. We first analyze the delegation effect.

[5] "Natural" specialization occurs not only under free trade but also when the policies are set in each country by the median voters ($\theta_r = \theta_s = 0$).

4.1 The Delegation Effect

In this section we show that each policy maker wants to delegate the authority to make trade policy to a more protectionist candidate. It is now straightforward to derive explicitly who is the "ideal" policy-maker for a θ_k-type citizen of country j given the policy-maker's type in the other country. In country 1

$$\theta_r\left(\theta_k,\theta_s\right)=\frac{2N_1\theta_k(N_1+N_2)-(N_2y_{A1}-N_1y_{A2})+\theta_sN_2N_1}{(3N_2+2N_1)N_1} \tag{13}$$

We can now see clearly that the policymaker type which is preferred by a type θ_k-citizen generally differs from θ_k. This source of this difference lies in the strategic effect of the choice of a policymaker: selecting a candidate with a lower factor A endowment leads to a higher equilibrium value of the export tax t_1 in country 1 and hence to a larger international price for good A. This is beneficial for all citizens whose types are larger than some critical value; they would like to delegate the trade policy choice to some citizen more protectionist than themselves. $\widehat{\theta}_k(\theta_s)=\theta_s-\left(\frac{y_{A1}}{N_1}-\frac{y_{A2}}{N_2}\right)$ is the critical endowment value in country 1: any citizen with an endowment θ_k larger (resp. lower) than this value favors a candidate with a lower (resp. larger) factor A endowment than her own one (see figure 1 below). The intuition for this result is that a higher export tax results in better terms of trade for owners of factor A, but also lowers the domestic price of good A for any given international price, p. This, reduces incomes for voters who own large amounts of factor A. So, voters who own less factor A will be more aggressive and charge higher export taxes. In figure 1 all factor owners who own more than $\widehat{\theta}_k$ of factor A want to delegate the power to make trade policy to a candidate who owns less factor A than they do. These types will clearly be

in the majority. θ_r^* is the type preferred by the median voter in country 1.

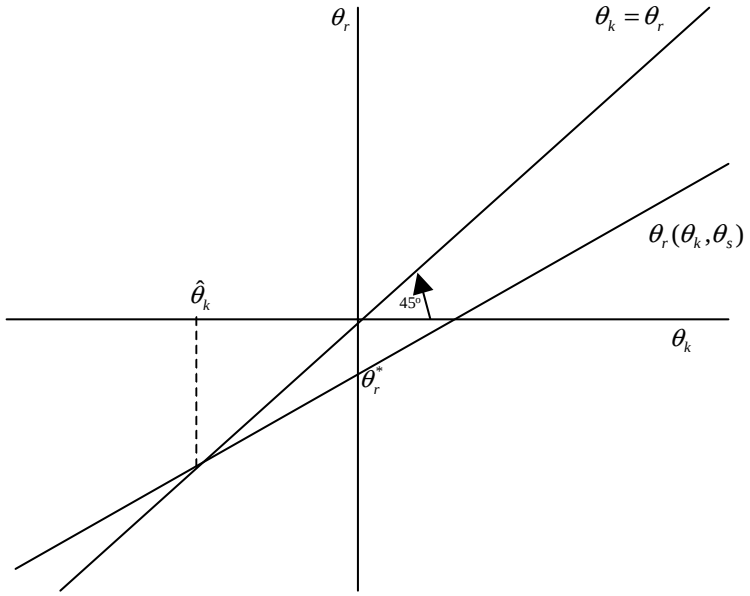

Figure 1

In country 2

$$\theta_s(\theta_k, \theta_r) = \frac{2N_2\theta_k(N_1 + N_2) + (N_2 y_{A1} - N_1 y_{A2}) + \theta_r N_2 N_1}{(2N_2 + 3N_1)\, N_2} \tag{14}$$

and the corresponding critical endowment value $\widehat{\theta}_k(\theta_r) = \theta_r + \left(\frac{y_{A1}}{N_1} - \frac{y_{A2}}{N_2}\right)$. This case works differently than the export case. In country 2, owners of factor A benefit from higher tariffs in two ways. First, they improve the terms of trade as before, but now increases in the tariff increase the domestic price of good A leading to an increase in income for voters who own large amounts of factor A. So, in the case of the importing country, most factor owners prefer a policymaker who owns more A than they do. Figure 2 illustrates this. Here all factor owners to the left of $\widehat{\theta}_k$, clearly a majority, wish to delegate the power to make trade policy to someone who owns more factor

A than they do. θ_s^* is the type preferred by the median voter in country 2.

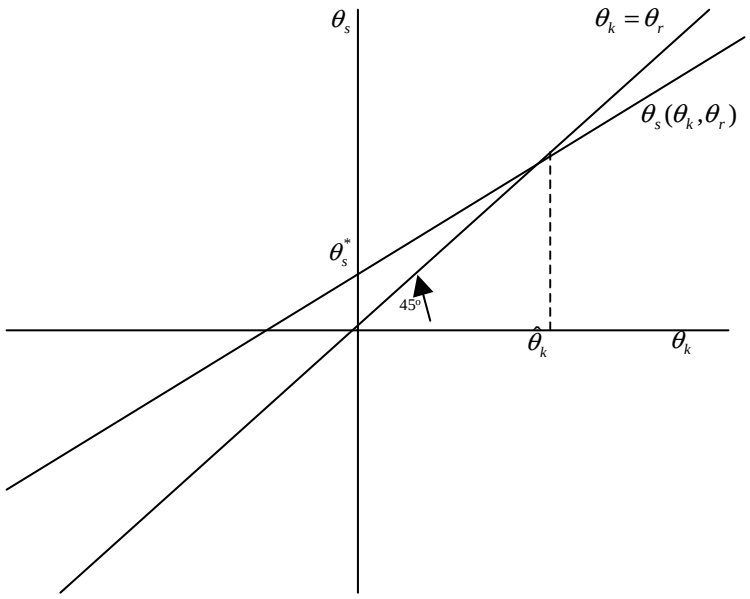

Figure 2

We now define single candidate equilibria.

Definition: (θ_r^*, θ_s^*) is a **single candidate equilibrium** if:

(i) Given that candidates θ_r^* and θ_s^* are willing to serve no other candidate who could beat (θ_r^*, θ_s^*) in their respective country wants to serve

(ii)candidates θ_r^* and θ_s^* prefer serving rather than have nobody serve.

It is now straightforward to see that there exists an equilibrium where, in each country, there is one and only one candidate who is the "ideal policy-maker" of the median voter. To solve for this equilibrium set $\theta_k = 0$ in (13) and (14) and solve the resulting equations to get

$$\theta_r^* = \frac{1}{3}\frac{N_1 y_{A2} - N_2 y_{A1}}{N_1 (N_1 + N_2)} \tag{15}$$

$$\theta_s^* = \frac{1}{3}\frac{N_2 y_{A1} - N_1 y_{A2}}{N_2 (N_1 + N_2)} \tag{16}$$

This equilibrium is illustrated in figure 3. $\theta_r(0, \theta_s)$ is a reaction curve that indicates the desired type of the median voter in country 1 given that

country 2 has selected a type θ_s as its political decision maker. This function is obtained from equation (13) by setting $\theta_k = 0$. $\theta_s(0, \theta_r)$ is country 2's reaction function obtained by setting $\theta_k = 0$ in equation (14).

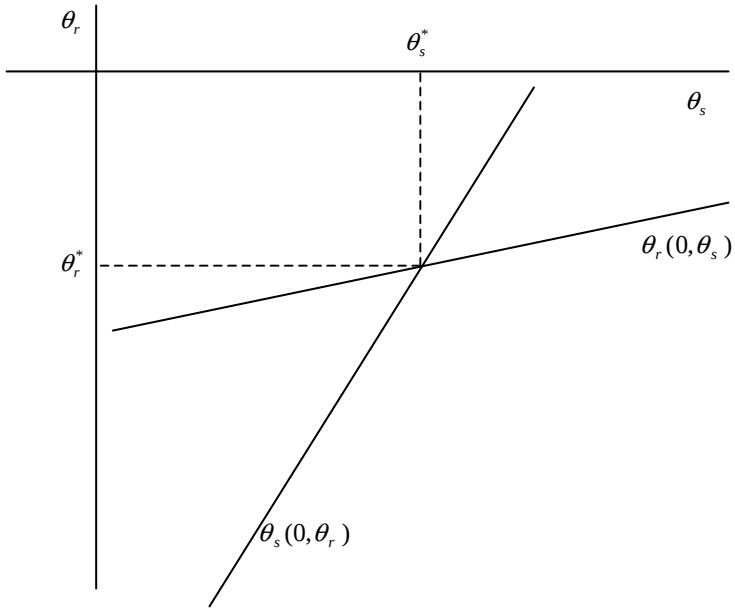

Figure 3

Moreover, *these candidates are more protectionist than the respective median voters of their countries*: *in the exporting country they own less factor A than average and in the importing country they hold a larger than average amount of factor A.* This follows from a pure delegation effect in each country: delegating the trade policy choice to somebody more protectionist than themselves is a convenient way for the median voters to credibly commit their respective countries to more aggressive trade policies.

Proposition 1 *There exists a one candidate per country-equilibrium* (θ_r^*, θ_s^*) *where*

$$\theta_r^* = \frac{1}{3} \frac{N_1 y_{A2} - N_2 y_{A1}}{N_1 (N_1 + N_2)} \tag{17}$$

$$\theta_s^* = \frac{1}{3} \frac{N_2 y_{A1} - N_1 y_{A2}}{N_2 (N_1 + N_2)} \tag{18}$$

$$t_1^* = t_2^* = \frac{1}{3}\left(\frac{y_{A1}}{N_1} - \frac{y_{A2}}{N_2}\right) \tag{19}$$

Proof: (i) clearly $\theta_r^* = \theta_r(0, \theta_s^*)$ and $\theta_s^* = \theta_s(0, \theta_r^*)$, i.e. (θ_r^*, θ_s^*) is a Nash equilibrium where the policymaker selected in each country is the best reply of the median voter of this country to the policymaker chosen in the other country; straightforwardly it is a best reply for the other citizens in both countries to stay outside the electoral competition since they would win with zero probability;

(ii) it remains to show that it is better for the candidates in both countries to run for office rather than to stay outside; remember that we assumed that if there is no candidate the default policy in the country i is *laissez faire* (i.e. $t_i = 0$);

Let us consider country 1: *laissez faire* (and hence not running for office) is formally equivalent to having a policy-maker of type $\widetilde{\theta}_r$ who would select $t_1\left(\widetilde{\theta}_r, \theta_s^*\right) = 0$, i.e. such that

$$\widetilde{\theta}_r = \frac{1}{3}\frac{(N_2 y_{A1} - N_1 y_{A2})(2N_1 + 3N_2)}{(N_1 + N_2)\, N_2\, (2N_2 + N_1)} > 0 \tag{20}$$

It is then straightforward to show that $\widehat{\theta}_k(\theta_s^*) - \theta_r^* = \frac{2}{3}\frac{-N_2 y_{A1} + N_1 y_{A2}}{N_1 N_2} < 0$ and hence $\theta_r\,(\theta_r^*, \theta_s^*) < \theta_r^* < 0 < \widetilde{\theta}_r$: the strict concavity of $V^1(\,\theta_r, \theta_s, \theta_k)$ with respect to θ_r now implies that $V^1(\theta_r^*, \theta_s^*, \theta_r^*) > V^1(\widetilde{\theta}_r, \theta_s^*, \theta_r^*)$;

in country 2 now *laissez faire* is equivalent to having a default policy-maker of type

$$\widetilde{\theta}_s = \frac{1}{3}\frac{-(3N_1 + 2N_2)(N_2 y_{A1} - N_1 y_{A2})}{(N_1 + N_2)\, N_1\, (N_2 + 2N_1)} < 0 \tag{21}$$

whereas $\widehat{\theta}_k(\theta_r^*) - \theta_s^* = \frac{2}{3}\frac{N_2 y_{A1} - N_1 y_{A2}}{N_1 N_2} > 0$ and hence $\theta_s(\theta_r^*, \theta_s^*) > \theta_s^* > 0 > \widetilde{\theta}_s$: one again the strict concavity of $V^2(\theta_s, \theta_r, \theta_k)$ with respect to θ_s implies that $V^2(\theta_s^*, \theta_r^*, \theta_s^*) > V^2(\widetilde{\theta}_s, \theta_r^*, \theta_s^*)$.□

It is interesting to compare the values of t_1 and t_2 at the above equilibrium with their equilibrium values under direct democracy. This can be thought of as measuring the delegation effect. It is straightforward to show that *the import and export taxes are both larger under representative democracy if and only if* $\frac{N_i}{N_1 + N_2} < \frac{2}{3}$, $i = 1, 2$. That is, if countries are roughly the same size the

delegation effect results in a higher export tax and a higher tariff. However, if countries are different sizes the delegation effect will reflect country size. Suppose, for example, that country one is relatively large. In particular, suppose, $\frac{N_1}{N_1+N_2} > \frac{2}{3}$. It is easy to show that the equilibrium value of t_1 is *smaller* than $t_1(0,0)$ but the equilibrium value of t_2 is now *larger* than $t_2(0,0)$. Thus, when countries are different sizes delegation leads to higher tariffs (or export taxes) for "smaller" countries and lower tariffs (or export taxes) for "bigger" countries.

Strategic commitment through the election of a policymaker who is more protectionist than the median voter allows a "small" country to in fact, obtain a less protectionist trade policy from the bigger country. The intuition can be seen by comparing (11) and (12) with (19). In the direct democracy equilibrium ((11) and (12)) the large country charges a higher tariff/export tax than the smaller country. This accords with standard theoretical results. Once countries can delegate the power to set tariffs we see from (19) that the tariff/export tax is the same regardless of country size. Thus, it follows that moving from the direct democracy case to the delegation case results in the large country tariff/export tax falling while the small country's rises.

The possibility of delegating means that the "small" country can effectively negate the advantage that the "big" country has at the direct democracy equilibrium. Why does this occur? The delegation equilibrium allows voters to form their preferences for protection taking into account how the tariff game will be played between the two elected politicians. In the direct democracy case, the small country loses this game. Understanding this makes the voters in the "small" country more aggressive and voters in the "large" country become less aggressive. In equilibrium, the initial advantage of the large country is eliminated.

The effect on welfare of moving from direct democracy to a delegation equilibrium follow from the results on tariffs. "Small" countries benefit from the delegation effect as follows from a comparison of the utility of the median voter at the Mayer equilibrium with her utility at the "delegation equilibrium" of Proposition 1. Subtracting the former from the latter one obtains for country 1

$$\frac{(3N_2 - 10N_1)\,(N_2 y_{A1} - N_1 y_{A2})^2}{72N_1^2(N_1+N_2)^2}$$

Thus, the median voter in country 1 is better off at the "delegation equilibrium" than at the "Mayer equilibrium" iff $N_1 < \frac{3}{13}(N_1+N_2)$ i.e., country

one is small enough.

4.2 The Abstention Effect

In contrast with the model of representative democracy developed by Besley and Coate (1997), (1998) (see also Osborne and Slivinski (1996)) in which the preferred candidate of any given citizen is a citizen of the same type, there exist here other one-candidate equilibria than the equilibrium where the policy makers who are chosen are the preferred candidates of the median voters. Implicit in Proposition 1 is the notion that voters θ_r^* and θ_s^* are willing to run for office and serve if elected. There is one difficulty with this assumption. Both type θ_r^* and θ_s^* voters prefer a citizen of different type than themselves to run (see figure 1). Let us consider for instance the electoral competition process in country 2 (the same analysis can be applied to the electoral competition in country 1). Let us show that there can be in country 2, for a given type θ_r-policymaker selected in country 1, a type θ_s candidate such that $\theta_s \neq \theta_s(0, \theta_r)$ running unopposed. For this to happen it is necessary and sufficient that (a) this candidate prefers the political outcome following her election to the default (laissez-faire) outcome, (b) there exists no citizen who would prefer her own election to the election of the single candidate and who would be preferred to her opponent by a majority of citizens.

Note that the first condition is satisfied if and only if the single candidate strictly prefers her own election to the election of some other citizen who would favor *laissez-faire* (i.e. $t_2 = 0$). It is straightforward from (10) to derive the type $\widetilde{\theta}_s(\theta_r)$ of such a citizen:

$$\widetilde{\theta}_s(\theta_r) = \frac{-N_2 y_{A1} + N_1 y_{A2} - \theta_r N_2 N_1}{N_1(N_2 + 2N_1)} = -\frac{N_2}{N_2 + 2N_1}\widehat{\theta}_k(\theta_r) \qquad (22)$$

We will come back to this condition below. Let us now determine exactly who are the citizens who would prefer their own election to the election of a θ_s-type citizen. First one has to determine the type θ_k^* of citizen who is indifferent between herself and the type θ_s. Given the linear-quadratic nature of the indirect utility functions V, the value of θ_k^* is determined by solving the equation $\theta_s - \theta_s(\theta_k^*, \theta_r) = \theta_s(\theta_k^*, \theta_r) - \theta_k^*$. Using equation (14) we obtain

$$\theta_k^* = \frac{\theta_s N_2(2N_2 + 3N_1) - 2(y_{A1}N_2 - N_1 y_{A2}) - 2\theta_r N_2 N_1}{(2N_2 + N_1)\, N_2} \qquad (23)$$

There are now only two cases to be considered:

(i) $0 < \theta_s(0,\theta_r) < \widehat{\theta}_k(\theta_r)$[6]

A sufficient condition for a θ_s-type candidate to run unopposed is simply that $\theta_s \geq \theta_s(0,\theta_r)$ and $\theta_k^* \leq 0$[7], i.e. $\theta_s(0,\theta_r) \leq \theta_s \leq 2\theta_s(0,\theta_r)$ $(< \widehat{\theta}_k(\theta_r))$. In figure 4 let $A = \theta_s(0,\theta_r)$ and $B = 2\theta_s(0,\theta_r)$ and for simplicity call a candidate with an endowment of $\theta_s(0,\theta_r)$ $(2\theta_s(0,\theta_r))$ candidate $A(B)$.

Any candidate to the left of A $(\theta_s < \theta_s(0,\theta_r))$ would be defeated by candidate A since the median voter (type $\theta_s(0,\theta_r)$) and all voters to the right of the median voter would prefer A. In addition, A would serve herself rather than have someone to her left be elected. For a candidate to the right of B $(\theta_s > 2\theta_s(0,\theta_r))$, one can show using equation (23) that the median voter would prefer to run herself (and would clearly win) rather than have a candidate to the right of B in office.

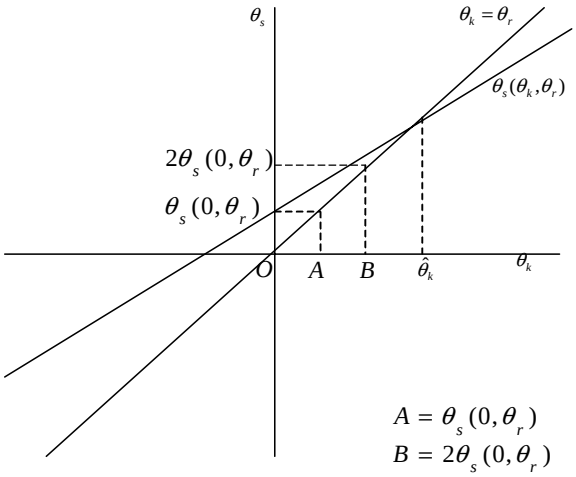

Figure 4

That leaves candidates between A and B as possible winners of single candidate elections. If any candidate between A and B chooses to run they will win.

To see this consider candidate B. If candidate B runs she gets all votes to the right of the median voter. Candidates to the left of B do even better.

[6]Note that a sufficient condition for this set of inequalities is $\widehat{\theta}_k(\theta_r) > 0$ since $\theta_s(0,\theta_r)) = \widehat{\theta}_k(\theta_r)\frac{N_1}{2N_2+3N_1}$.

[7]Note that all the citizens located at the *right* of θ_k^* strictly prefer a type θ_s-candidate to a candidate located at θ_k^* or at her left. Hence if $\theta_k^* < 0$ the type θ_s-candidate is chosen by a majority of voters.

Using equation (23) one can easily show that A prefers any candidate in the AB range to running herself. Extending that logic, all voters in the AB range would prefer a candidate to their *right* to themselves. But, they would prefer to run themselves rather than have someone to their *left* win. Therefore, any candidate between A and B is a one candidate equilibrium. Candidates closer to A get larger winning vote shares but would always prefer that someone to their right actually be elected.

The distance OA in figure 4 measures the delegation effect. The median voter wants to delegate authority to a voter with OA more of the specific factor than she has. The distance from A to B measures the abstention effect. The voter at A although in some sense the most "popular" candidate actually prefers someone to her right to run. In fact, she prefers any voter between A and B to herself. So, any of those voters represent potential one candidate equilibria. As you move from A to B the candidates are decreasing in "popularity" and increasing in their "eagerness" to run for election.

(ii) When $\widehat{\theta}_k(\theta_r) < \theta_s(0,\theta_r) < 0$ a sufficient condition for a θ_s-type candidate to run unopposed is simply that $\theta_s \leq \theta_s(0,\theta_r)$ and $\theta_k^* \leq 0$, i.e. $2\theta_s(0,\theta_r) \leq \theta_s \leq \theta_s(0,\theta_r)$. The logic is the same as case (i) above so we will not repeat the argument.

The same analysis can be applied to the electoral competition in country 1. Using equations (13), (14), and (23) we can obtain a complete characterization of the set of one-candidate equilibria.

Proposition 2 *Given Assumption 1 any pair* (θ_r, θ_s) *such that*

$$\begin{aligned} \frac{-2(N_2 y_{A1} - N_1 y_{A2}) + 2\theta_s N_2 N_1}{(3N_2 + 2N_1) N_1} &\leq \theta_r \leq \frac{-(N_2 y_{A1} - N_1 y_{A2}) + \theta_s N_2 N_1}{(3N_2 + 2N_1) N_1} \\ \frac{(N_2 y_{A1} - N_1 y_{A2}) + \theta_r N_2 N_1}{(2N_2 + 3N_1) N_2} &\leq \theta_s \leq \frac{2(N_2 y_1 - N_1 y_2) + 2\theta_r N_2 N_1}{(2N_2 + 3N_1) N_2} \end{aligned}$$

is a one candidate per country-equilibrium.

Obviously the equilibrium of Proposition 1 (where the single candidate in each country is the preferred candidate of the median voter) is one of these equilibria. There are in addition infinitely many other equilibria as shown in Figure 5 below: any point belonging to the area ACBD corresponds to a possible equilibrium. At the more "extremist" of the symmetric equilibria (point B in Figure 5) one obtains

$$\theta_r^{**} = -\frac{2}{3}\frac{(N_2 y_{A1} - N_1 y_{A2})(N_1 + 2N_2)}{(3N_1N_2 + 2N_2^2 + 2N_1^2)N_1} \quad (24)$$

$$\theta_s^{**} = \frac{2}{3}\frac{(N_2 y_{A1} - N_1 y_{A2})(N_2 + 2N_1)}{N_2(3N_1N_2 + 2N_2^2 + 2N_1^2)} \quad (25)$$

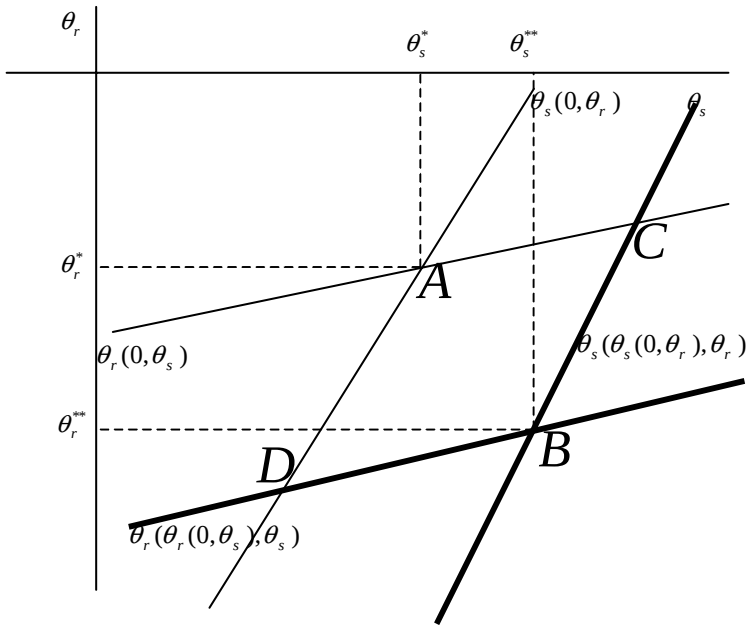

Figure 5

If these most "extremist" candidates are chosen the resulting tariff and export tax is (substituting equations (24) and (25) into equations (9) and (10))

$$t_1 = \frac{(2N_2 + N_1)(2N_1^2 + 5N_1N_2 + 4N_2^2)(N_2 y_{A1} - N_1 y_{A2})}{6N_1(2N_2^2 + 3N_1N_2 + 2N_1^2)N_2(N_1 + N_2)} \quad (26)$$

$$t_2 = \frac{(N_2 + 2N_1)(4N_1^2 + 5N_1N_2 + 2N_2^2)(N_2 y_{A1} - N_1 y_{A2})}{6N_1(2N_2^2 + 3N_1N_2 + 2N_1^2)N_2(N_1 + N_2)} \quad (27)$$

Note that the extent of the "protectionist drift" depends not only on the extent of the delegation and abstention effects in both countries but

also on the strategic interaction between the two countries. In fact, the strategic complementarity between the policy makers limits the impact of the delegation and abstention effects as can be seen by noting that the value of θ_s^* above is less than twice the value of θ_s^{**}. However, it is still the case that if the country sizes are not too dissimilar then both the export tax and the tariff are higher than when only the delegation effect is considered (Proposition 1.) Thus, both the delegation and abstention effects tend to result in higher protection levels.

We do obtain clearer results regarding the welfare of the median voter. The utility levels of the median voters in *both* countries are unambiguously lower at the "extremist" equilibrium B than at any of the other equilibria, the "delegation equilibrium," point A, at the Mayer equilibrium, point O and at the free trade equilibrium point.

5 Two Candidate Equilibria

We now consider the case when, at the first stage of the game, there are, at least in one country, two candidates who decide to run for election. This may correspond either to equilibria in which in both countries there are two candidates or to equilibria in which two candidates run for election in one country and one candidate in the other country. Our analysis has to be modified in order to account for the possibility of two candidates running in one country, each of them having a probability 0.5 of winning.

Suppose that there are two candidates in each country. In country 1 the two candidate types are given by $\left(\theta_r^1, \theta_r^2\right)$ and $\left(\theta_s^1, \theta_s^2\right)$ are the two candidates that run in country 2. The *expected* utility $E(V^1(\left(\theta_r^1, \theta_r^2\right), \left(\theta_s^1, \theta_s^2\right), \theta_k)$, of a citizen k in country 1 is then

$$E(V^1(\left(\theta_r^1, \theta_r^2\right), \left(\theta_s^1, \theta_s^2\right), \theta_k) = \frac{1}{4}(V^1(\theta_r^1, \theta_s^1, \theta_k) + V^1(\theta_r^1, \theta_s^2, \theta_k) + V^1(\theta_r^2, \theta_s^1, \theta_k) + V^1(\theta_r^2, \theta_s^2, \theta_k)) \quad (28)$$

The expected utility of citizen k when there are two candidates in one country and one candidate in the other country is easily derived in the same way. A very useful feature of our model is the linearity of the function V^1 with respect to θ_s (and, at the same time, of the function V^2 with respect to θ_r). This linearity allows us to write (28) more simply as

$$E(V^1(\left(\theta_r^1, \theta_r^2\right), \left(\theta_s^1, \theta_s^2\right), \theta_k) = \frac{1}{2}\left(V^1(\theta_r^1, \theta_s, \theta_k) + V^1(\theta_r^2, \theta_s, \theta_k)\right)$$

where $\theta_s = \frac{\theta_s^1 + \theta_s^2}{2}$.

The decisions in one country in the first stage of the game need then to be only functions of the *expected* type of the policymaker in the other country. This simplifies greatly the analysis. We can now proceed to the (partial equilibrium) analysis of two candidate equilibria in one country (country 1 without loss of generality), given the expected type of the foreign policymaker.

If two candidates of different types θ_r^1 and θ_r^2 run against each other then two conditions must be met. First, each of them should have a positive probability (equal to $\frac{1}{2}$) of being elected and second, no candidate prefers to let the other run unopposed. The first condition amounts to stipulating that the election of the two candidates must give the median voter the same utility level. Given the linear-quadratic nature of the function V^1 this simply means that they must be equidistant from the median voter's preferred candidate, i.e., given equation (13),

$$\frac{\theta_r^1 + \theta_r^2}{2} = \frac{\theta_s N_2 N_1 - (N_2 y_{A1} - N_1 y_{A2})}{(3N_2 + 2N_1)N_1} \tag{29}$$

The second condition is equivalent to the condition that the candidates' types should not belong to the interval $[2\frac{\theta_s N_2 N_1 - (N_2 y_{A1} - N_1 y_{A2})}{(3N_2+2N_1)N_1}, \frac{\theta_s N_2 N_1 - (N_2 y_{A1} - N_1 y_{A2})}{(3N_2+2N_1)N_1}]$. Given equation (29) above, if the first condition is satisfied, this condition means that the leftist candidate's type $\theta_r^1 < 2\frac{\theta_s N_2 N_1 - (N_2 y_{A1} - N_1 y_{A2})}{(3N_2+2N_1)N_1}$, since, otherwise, she would run unopposed (see Subsection 4.2). Hence the existence of a delegation effect implies that the two candidates be far apart to guarantee that the rightist candidate does not find it worthwhile to withdraw. A similar argument holds for country 2. As a result, we obtain the following Proposition.

Proposition 3 *Given Assumption 1 the pairs* $\left(\left(\theta_r^1, \theta_r^2\right), \left(\theta_s^1, \theta_s^2\right)\right)$ *that satisfy*

$$\frac{\theta_r^1 + \theta_r^2}{2} = \frac{1}{3}\frac{(N_1 y_{A2} - N_2 y_{A1})}{(N_2 + N_1)N_1}$$

$$\frac{\theta_s^1 + \theta_s^2}{2} = \frac{1}{3}\frac{(N_2 y_{A1} - N_1 y_{A2})}{(N_2 + N_1)N_2}$$

$$\begin{aligned}\theta_r^1 &< \frac{2}{3}\frac{(N_1 y_{A2} - N_2 y_{A1})}{(N_2+N_1)N_1}\\ \theta_r^2 &> \frac{1}{3}\frac{(N_1 y_{A2} - N_2 y_{A1})}{(N_2+N_1)N_1}\end{aligned}$$

$$\begin{aligned}\theta_s^2 &> \frac{2}{3}\frac{(N_2 y_{A1} - N_1 y_{A2})}{(N_2+N_1)N_2}\\ \theta_s^1 &< \frac{1}{3}\frac{(N_2 y_{A1} - N_1 y_{A2})}{(N_2+N_1)N_2}\end{aligned}$$

is a two candidate per country equilibrium.

Note that a two candidate per country equilibrium is, when one considers the *expected values* of the policymakers' equilibrium types, equivalent to the one candidate per country equilibrium of Proposition 1 (it corresponds to point A in Figure 5). When there are two candidates in one country the delegation effect only determines the expected type of the policymaker. This is not to say that the abstention effect disappears completely since it is the reason why, contrary to what happens in the citizen's candidate model without delegation effects (Besley and Coate (1997)), the two candidates must be far apart, *preventing policy convergence* even if there are no costs/benefits of running for office.

The following Proposition characterizes the equilibria in which two candidates run for office in one country and one candidate runs unopposed in the other.

Proposition 4 *Given Assumption 1,*
(i) any triple $\left(\theta_r^1, \theta_r^2, \theta_s\right)$ *such that*

$$\begin{aligned}\frac{\theta_r^1 + \theta_r^2}{2} &= \frac{\theta_s N_2 N_1 - (N_2 y_{A1} - N_1 y_{A2})}{(3N_2+2N_1)N_1} = \theta_r\\ \theta_r^1 &< 2\theta_r,\ \theta_r^2 > \theta_r\\ \frac{\theta_r N_2 N_1 + (N_2 y_{A1} - N_1 y_{A2})}{(3N_1+2N_2)N_2} &\leq \theta_s \leq 2\frac{\theta_r N_2 N_1 + (N_2 y_{A1} - N_1 y_{A2})}{(3N_1+2N_2)N_2}\end{aligned}$$

is an equilibrium with two candidates in country 1 and one candidate in country 2;

(ii) any triple $(\theta_r, \theta_s^1, \theta_s^2)$ *such that*

$$\begin{aligned} \frac{\theta_s^1 + \theta_s^2}{2} &= \frac{\theta_r N_2 N_1 + (N_2 y_{A1} - N_1 y_{A2})}{(3N_1 + 2N_2)N_2} = \theta_s \\ \theta_s^1 &< \theta_s, \quad \theta_s^2 > 2\theta_s \\ 2\frac{\theta_s N_2 N_1 - (N_2 y_{A1} - N_1 y_{A2})}{(3N_2 + 2N_1)N_1} &\leq \theta_r \leq \frac{\theta_s N_2 N_1 - (N_2 y_{A1} - N_1 y_{A2})}{(3N_2 + 2N_1)N_1} \end{aligned}$$

is an equilibrium with one candidate in the country 1 and two candidates in country 2.

In the country with two candidates, the *expected type* of the policymaker is the preferred type of the median voter. In the other country, the single candidate could take any value between the preferred type of the median voter and twice this value. Looking at Figure 5 the policymakers' expected equilibrium types lie here somewhere on AC (two candidates in country 1, one in country 2) or AD (one candidate in country 1, two in country 2).

Thus, considering two candidate per country equilibria modify the results somewhat. With two candidates the *expected type* of the policymaker is the preferred type of the median voter. The abstention effect is still present, but manifests itself in a different way. The abstention effect determines how far apart the two candidates are from each other.

6 Rents from Office and Entry Costs

In this section we show how our previous analysis and results are modified when there are rents from office R and entry costs C. The rents from office, otherwise called "spoils of office", are the direct *net* benefits from being in charge. These benefits do not include the gains from being able to implement one's most preferred policy. Instead, they include the wage and all the specific advantages, both material and psychological (the "ego rents") from being in office *minus* the income and advantages foregone. Note that there is nothing to guarantee *a priori* that rents from office are always positive[8]. The entry

[8]The wage of the former US President Bill Clinton was about $200,000 per year, much less than he could have earned in the private sector.

costs, C would include personal wealth spent on the campaign and income foregone while campaigning. For one candidate per country equilibria three cases should be considered.

When $R = C$ the results of the previous sections go through without any change. The set of one candidate per country-equilibria remains as it is characterized by Proposition 2: nobody who wanted to run is discouraged from running and nobody who wanted to stay out is encouraged to run.

When $R < C$ the set of one candidate per country-equilibria is enlarged and *includes* the set defined by Proposition 2 provided that $C - R$ is not so large that some previous candidates now prefer the implementation of the *default policy* to running for office. To see why the set of one candidate equilibria is enlarged consider Figure 4. Given that a candidate of type θ_r is elected in country r it remains true that any $\theta_s \in [\theta_s(0, \theta_r), 2\theta_s(0, \theta_r)]$ may run unopposed in country s. However, given that $C - R > 0$, it is even less profitable (compared to the case of $C = 0$ and $R = 0$) than before to run against her. Moreover, candidates immediately to the right of B (i.e. of types larger than $2\theta_s(0, \theta_r)$) or to the left of A (i.e. of types lower than $\theta_s(0, \theta_r)$) can now run unopposed since it is no more profitable for candidate A or for the median voter to oppose (and defeat) them. The equilibrium correspondences are thus enlarged and so is the equilibrium set.

When $R > C$ *there is no other possible one candidate per country-equilibrium that the one described by Proposition 1*, namely in each country the type most preferred by the median voter is elected. To see why this is the case, suppose that in country s a candidate of type $\theta_s > \theta_s(0, \theta_r)$ runs for office. Clearly from the continuity of the distribution of types and of the indirect utility functions there is an $\epsilon > 0$ such that a candidate of type $\theta_s - \epsilon$, immediately on the left of θ_s but on the right of $\theta_s(0, \theta_r)$, is willing to run (since the benefits from office minus the cost of running exceed the loss from a less favorable policy outcome.) This type $\theta_s - \epsilon$ is clearly preferred by a majority to θ_s. This result means that when the benefits from office exceed the cost of running, the abstention effect disappears, leaving only the delegation effect.

Therefore, in the one candidate case, if there are net costs of holding office the set of equilibria expands. When there are net benefits from office the set of equilibria contract. In particular, the abstention affect disappears.

What about two candidate equilibria? The introduction of rents from office and/or costs of running does not change the basic result that the *expected* policymaker's type is the preferred type of the median voter. Hence,

the expected policymakers' types in two candidate per country equilibrium remain unchanged. The only thing which changes is the equilibrium distance between the two candidates. Intuitively, this distance is inversely related to $R - C$. When $R - C$ is not only positive but also very large, the distance between the two candidates goes to zero. If $R - C$ is negative then the distance between candidates increases as the net benefits to holding office become increasingly negative.

7 Concluding Remarks

In this paper we used a two-country framework to show that a majority of citizens in both countries favor the election of representatives who are more protectionist than themselves. The key for this result is that the election of a representative is a way for the citizens to commit their country to a more aggressive trade policy.

We demonstrated the existence of an infinite number of one candidate per country equilibria. Provided that the countries sizes are not too dissimilar, all countries are unambiguously more protectionist than in the "Mayer equilibrium" (the median voter in each country selects trade policy.) This "protectionist drift" may be ascribed to a *delegation effect* and an *abstention effect*. The delegation effect occurs because all citizens want to choose a policy maker who is more aggressive (protectionist) than they are. The abstention effect is more subtle. This more protectionist citizen who is chosen policy maker herself wishes to delegate to one more protectionist still. What we show is that since there are other viable candidates, the candidate most preferred by the median voter may choose to "abstain" from running for office in order to allow someone more protectionist than herself to run. This results in even greater protectionist drift than would be present with only the delegation effect.

Two candidate equilibria work a bit differently. The *expected* types of the elected policymakers are always those preferred by the median voters, i.e. more protectionist than them, so that the delegation effect is clearly at work. The abstention effect is still present though it operates in a different way by preventing a convergence of the political positions of the two candidates in a given country.

The introduction of costs and/or benefits from holding office modifies the results in a very simple way. If the spoils of office are larger than the

cost of running[9] the abstention effect vanishes in one candidate per country equilibria: the only possible equilibrium of this type is the one where in each country the running candidate is the ideal candidate of the median voters. In two candidate equilibria, net benefits from office reduces the distance between the two candidates. If, however, the cost of running for office is larger than the rents from office the set of one candidate per country equilibria is enlarged and the distance between candidates in two candidate equilibria is increased. These results suggest that as office holding becomes unpleasant more extremism will be observed.

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[9] It is not sufficient that they are positive.

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APPENDIX

Lemma 5 *V^1 (resp. V^2) is strictly concave with respect to θ_r (resp. θ_s).*

Proof: It will be enough to prove the strict concavity of V^1 (the concavity of V^2 is proved using a similar argument). From the definition of $V^1($ $\theta_r, \theta_s, \theta_k)$ and equations (3), (4), (7) and (8) we obtain

$$\frac{\partial V^1}{\partial \theta_r} = \frac{N_1 N_2(\theta_k + 2t_1(\theta_r, \theta_s) + t_2(\theta_r, \theta_s)) - (y_{A1}N_2 - N_1 y_{A2})}{N_1\,(N_1 + N_2)}$$

and then, using again equations (7) and (8),

$$\frac{\partial^2 V^1}{\partial \theta_r^2} = \frac{-N_2(3N_2 + 2N_1)}{(N_1 + N_2)^2} < 0$$

□