POLICY RESEARCH WORKING PAPER 2317

Trade Negotiations in the Presence of Network Externalities

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With technology-related goods and services, the presence of network externalities affects a country's willingness to trade. To achieve efficiency gains through worldwide standardization and mutually beneficial trade arrangements, it is important to arrive at multilateral trade agreements before regional blocs form.

The World Bank
Development Research Group
Trade
April 2000

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Summary findings

Network externalities exist when the benefit a consumer derives from a good or service depends on the number of other consumers using the same good or service (as happens, for example, with telecommunications, television broadcasting standards, and many other technology-related goods and services).

National monopolies, regulated and endorsed by sovereign governments, tended to produce network externalities in the past: most countries had telephone monopolies, often state-owned, before deregulation. Whether to allow foreign competition in such industries becomes a pressing issue when national boundaries begin to blur as technology advances and as previously untraded goods and services become tradable.

Despite obvious gains from trade in such newly tradable sectors, governments often keep trade-prohibiting measures. With analog high definition television (HDTV) transmission standards, for example, regulations and politics kept Europe and Japan from cooperating, so each invested heavily to develop its system in an attempt to have its own standard adopted by the rest of the world.

Kubota analyzes how the presence of network externalities affects a country's willingness to trade. In her model, governments decide whether or not to allow international trade. When trading is permitted, the superior standard drives out all others in the trading area.

She shows that even when there are efficiency gains from worldwide standardization, global free trade may not prevail. The technology leader is generally eager to trade, but countries with less advanced technology often choose to form inefficient regional blocs or not to trade at all. Once such regional networks are established, global efficiency-enhancing free trade becomes even harder to achieve than it would have been in their absence.

Transfer payments between countries reduce or eliminate such inefficiency and facilitate the achievement of efficient trade in products.

To achieve mutually beneficial trade arrangements, it is important to arrive at multilateral agreements before regional blocs form.

This paper is a product of Trade, Development Research Group. Copies of the paper are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact Lili Tabada, room MC3-333, telephone 202-473-6896, fax 202-522-1159, email address ltabada@worldbank.org. Policy Research Working Papers are also posted on the Web at www.worldbank.org/research/workingpapers. The author may be contacted at kkubota@worldbank.org. April 2000. (27 pages)

Trade negotiations in the presence of network externalities

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1 Introduction

Network externalities are demand-side economies of scale, which make the benefit a consumer derives from a good or service dependent on the number of other consumers purchasing the

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same item. Telecommunications systems and television broadcasting standards are good examples. In autarchy each country is likely to develop a single national standard, which is often not compatible with those used in foreign countries. The television standard that is used in the United States and Japan is NTSC, while much of Western Europe uses PAL, and Eastern Europe and France use SECAM. This means that a movie video purchased in a French store cannot be played on an American video cassette recorder without a converter. A single global standard best takes advantage of network externalities but the world is already fragmented with locked-in consumers and producers of multiple standards, endorsed and regulated by national governments. Adopting a single standard to make all but one existing systems completely obsolete will entail large adjustment costs. The drastic nature of transition may cause politicians to be more concerned than usual about producers of goods and services who suddenly lose business with the adoption of a new technology. Conversely, if the national standard is adopted by the rest of the world, suppliers of associated goods and services stand to gain a windfall. Therefore, governments deciding whether to liberalize their network-related markets face a difficult trade-off of overall efficiency gains and a prospect for acquiring new markets on the one hand, and a possibility of incurring sizable adjustment costs on the other.

Whether to allow foreign systems to be introduced to the domestic market was not an issue while national boundaries were clear and sovereign governments had the sole responsibility for setting standards[1]. Foreign electronics producers simply manufactured television sets that were compatible with the system used in the destination market, and did not question whether NTSC should be adopted in France. The situation began to change in the last decade or so with the advancement of technology as well as government policies of deregulation and liberalization, which made many previously untraded goods and services tradable. Trade in goods and services that are subject to network externalities differs from that in conventional goods in a number of ways. For example, barriers to trade generally take the form of prohibitions, quantitative restrictions, and government regulations instead of import tariffs. In many such sectors, liberalization tends not to be a gradual process since the equivalent of slowly phasing out tariffs is not available: opening the domestic market to international trade is equivalent to allowing foreign systems into the country, and is an all-or-nothing decision. This feature makes trade liberalization in such sectors even more contentious than that for conventional goods.

In this paper, I analyze how the presence of network externalities affects a country's willingness to trade when international trade involves a potential switching of the national standard. For the purpose of this paper, trading is synonymous with having a common standard. I show that even when there are efficiency gains from adopting a worldwide standard, global free trade may not prevail. The technology leader is usually eager to engage in free trade but countries with less advanced technology have more complicated welfare analyses to make. In particular, laggard countries may prefer forming a regional bloc among themselves to global free trade in order to protect its own national champion from competition, prevent a foreign firm from exercising monopoly power over its economy, or avoid paying adjustment costs. Once a regional standardization occurs, the sheer size of the consumer base can give the regional bloc a market power that leads to an inefficient outcome. When countries are not free to pick and choose trading partners, which is the case under the Most Favored Nation principle of WTO,

[1] Although there were a few notable exceptions such as Motorola's attempt to introduce the American system for the analogue mobile phone to Japanese market, where an incompatible standard was used.

however, they may be persuaded to agree to free trade even when a regional bloc is their most preferred option. This paper finds regionalism insidious, and underscores the importance of multilateral trade arrangements.

This paper is related to two distinct strands in the economics literature. First, it fits in the long tradition of regional versus multilateral trade literature. This literature is divided into two camps, one that considers regionalism to be harmful (McLaren 1999; Bhagwati and Panagariya 1996, Levy 1997; to list a few), and the other that thinks it is a step in the right direction (Kemp and Wan 1976; Summers 1991; Baldwin 1995; Ethier 1998; among many others). This paper is in the first group, and argues that formation of regional blocs alters the incentive structure of participating countries in a way that makes free trade more difficult to achieve. I discuss whether forming a particular trading coalition is in the interest of member states, which is similar in spirit to works by Riezman (1985) and Burbidge et al. (1997). Second, the basic idea of the paper is related to the industrial organization literature on network externalities (Katz and Shapiro 1985, 1986, 1994; Farrell and Saloner 1986; Bensen and Farrell 1994). This literature examines how technology standards are adopted within a domestic market when the good or service in question is subject to network externalities. The difference between a purely domestic and international set up is that the number and the type of competitors that exist are controlled by governments which have different objectives from firms. This paper focuses on the government's decision problem in trade negotiations, and does not address the subtle issues related to arrivals of new technologies or the mechanism with which standards are adopted in the domestic market. Network externalities have not been studied extensively in the context of international trade. One of the few exceptions is a paper by Bhattari and Whalley (1998), which estimates gains from trade liberalization in a computer simulated model and finds that gains accrue approximately equally to large and small countries. In an insightful overview book, Sykes (1995) discusses issues related to product standards for internationally integrated goods. He makes a distinction between a product standard and a regulation: compliance with the first is voluntary, and with the second is mandatory. He then suggests when government fiat may be appropriate and when market solution is sufficient. In this paper, I use the terms technology, network, and standard interchangeably, and all of them are essentially regulations in Sykes' terminology. This paper is much narrower in scope than his book and aims to demonstrate theoretical reasons why governments may "regulate" foreign producers out of their markets. Gandal and Shy (2000 forthcoming) make another important and related contribution. In their model based on Salop's circular country, all domestic and foreign brands (standards) are tradable regardless of governments' decision. What the governments determine is whether to "recognize" foreign brands or not, which influences the price and hence the attractiveness of foreign brands. In contrast, this paper makes the consequences of governments' decisions more drastic: when governments agree to trade, only one standard survives in the entire trading area due to network externalities. I examine governments' willingness to trade when trading is a all-or-nothing proposition whereas they study whether governments have strategic incentives to erect barriers that are merely trade-reducing.

In the next section, I outline a model of trade negotiations in the presence of network externalities. I explore two alternative specifications of government's objective function using the same basic set up: in the first specification, the government is benign and maximizes consumer welfare; the second specification makes the government more concerned about the national monopoly than consumers. I use the concept of the core adapted from Riezman (1985)

to analyze which trade arrangement emerges as a result of trade negotiations. Concluding remarks follow.

2 The Model

This model of trade negotiations in the presence of network externalities is adapted from Katz and Shapiro (1986). I use the core solution concept applied to coalitional choice proposed by Riezman (1985). There are three countries, S, E, and W. They have distinct technologies but are otherwise symmetric. There are two time periods, $t = 1, 2$. There is homogeneous population, N, in each country and both periods. Consumers have completely inelastic demand for one unit of service, priced p_t^i, where $i \in \{S, E, W\}$ denotes the country or its technology. Let S be the technology leader and most efficient. The utility consumers derive from the service is determined by how many others are in the same network (consume the same service) in the same period. The net utility of a typical consumer who belongs to network i, in period t is:

$$v(n) - p_t^i$$

where n is the number of people consuming i in the same period *anywhere in the world*, and $v(.)$ is a concave and increasing function. It is simple to show that even when there are more than one choice of networks available, all consumers will pick the same one. Suppose there are two networks, A and B, priced p_A and p_B, used by n_A and n_B consumers respectively. Then it must be the case that no consumer purchasing that technology wants to switch to the other technology. For technology A, this condition is

$$v(n_A) - p_A \geq v(n_B + 1) - p_B \tag{1}$$

For technology B, this condition is

$$v(n_B) - p_B \geq v(n_A + 1) - p_A \tag{2}$$

Given that $v(.)$ is an increasing function and that individuals have a unit mass, these two conditions cannot be satisfied simultaneously. Therefore, whenever more than one networks are available, all consumers choose the same one. Katz and Shapiro (1986) call this a *bandwagon result*. In the first period, all countries are in autarchy and consumers use their own country's technology:

$$v(N) - p_1^i$$

Before entering the second period, the countries have an option of opening their markets to trade. Trading arrangements are "unanticipated events" in the sense that consumers made the network choice in the first period without regard to the prospects of trade negotiations. The government chooses the trade regime (autarchy, regional bloc, or free trade) to maximize its objective function. Inter-country transfers are ruled out unless otherwise noted. By the *bandwagon result* discussed above, a single standard will prevail within a trading area. I assume that consumers choose the network from all available options instantaneously. In reality, there will obviously be a transitional period, during which some loss of consumer welfare is likely to occur. Taking this possibility into account will decrease the gains from trade but will not alter

the fundamental results. In each of the cases discussed below, I assume that N is sufficiently large so that the price difference offered by the leader and a laggard in equilibrium is such that

$$p^{laggard} - p^{leader} > v(N+1) - v(N)$$

That is, the price difference between networks is relatively large compared to the marginal benefit of an additional person in the network around N so that when the leader and a laggard begin trading, consumers choose the lower priced (i.e., better quality for the purpose of this paper) technology[2]. There is uncertainty about which network prevails only when the two (or more) available technologies are identical (priced the same).

Let trading countries be denoted by a curly bracket. There are five possible trading arrangements:

1. $A : \{S\}\ \{E\}\ \{W\}$
2. $RB(EW) : \{E, W\}\ \{S\}$
3. $RB(WS) : \{W, S\}\ \{E\}$
4. $RB(SE) : \{S, E\}\ \{W\}$
5. $FT : \{S, E, W\}$

All countries remain in autarchy in trading arrangement A, regional blocs form in 2 to 4 (written RB with trading countries in the parenthesis), and free trade emerges in number 5 (marked FT for free trade). Denote the welfare of country i under trading arrangement j as $V^i(j)$. Countries use the utility level associated with each trading arrangement to evaluate coalitions. The welfare associated with one country coalition, for example $\{S\}$, is the same regardless of what the other countries do: that is, $V^S(A) = V^S(RB(EW))$. Trade negotiations are modeled as a coalition forming game, and its outcome as elements in the core. The definition of the core is the following.

Definition: A trading arrangement j is in the core if it is unblocked by any possible coalition. A coalition L blocks arrangement j if, for all $i \in L$,

$$V^i(L) \geq V^i(j)$$

with strict inequality for at least one member of L.

I discuss two alternative objective functions that negotiating governments use to evaluate their options. First, the governments maximize their own citizens' utility. There are adjustment costs involved in switching networks. Next, I analyze a case where each government optimizes

[2]The consumers' technology choice problem has multiple equilibria. For example, many consumers who were in the "leader" network can choose to switch to the "laggard" network for some reason. If the expanded consumer base of the "laggard" network constitutes a critical mass, then, by the bandwagon result, all consumers will flock to the "laggard" network. This possibility of convergence to an inferior equilibrium has been studied extensively in the IO literature, and is not the main focus of this paper. Therefore, I assume that consumers choose the superior technology: that is, the focal equilibrium prevails.

a weighted average of the national monopolist's profits and consumers' utility. I assume there are no adjustment costs under the second scenario, but that the monopolists sank set up costs in period 1. In the benchmark case under both sets of specifications, the government chooses trading partners, consumers decide which technology to use, and inter-country transfers are ruled out. Then, I discuss how the outcome would change if inter-country transfers are allowed.

2.1 Costly switching

In this section I assume there is a fixed adjustment cost K for a country to switch to a new technology. This could be thought of as one-time unemployment benefits or retraining costs for workers whose expertise becomes obsolete with scrapping of the current network. I also assume the prices are fixed exogenously, for example, regulated to equal the marginal costs, at p_2^S, p_2^W, and p_2^E respectively. I discuss the pricing strategies of monopolists in the following section. Technological merits are summarized by the marginal costs: the technological leader S has the lowest costs, and the laggards have higher and identical costs ($p_2^S < p_2^W = p_2^E$). Since the focus of the analysis is entirely on the second period, I drop the time subscript hereafter for brevity unless it is confusing to do so. The government decides whether to allow foreign technologies into the market, and by implication, to accept the possibility of having to pay the adjustment cost, which is raised through a lump-sum tax of $k \equiv \frac{K}{N}$ from all citizens in the country if switching takes place. All consumers will voluntarily choose the same (least expensive) technology from available choices by the *bandwagon result* discussed above. When networks have the same technological merit (i.e., the same price), either is chosen with equal probability. When there is uncertainty about which network will be adopted in the trading bloc, the ex-ante and ex-post welfare are different. I assume that countries are risk-neutral.

I discuss global efficiency and the choices of national governments in turn. Each subsection is followed by a summarizing proposition. Figures that illustrate the propositions with curves marked by the corresponding equation numbers in the text are in the appendix.

2.1.1 Global efficiency

Global efficiency depends on the concavity of $v(.)$ and magnitudes of parameter values. Denote global welfare associated with the trading arrangement j as $V^G(j)$:

$$V^G(FT) = 3N[v(3N) - p^S] - 2K$$

In a free trade equilibrium, every individual in the world derives utility $v(3N)$ since all $3N$ people are in network S. Each pays p^S, and the net utility is multiplied by the world population $3N$. Since W and E switch to network S, both pay the adjustment cost K.

Welfare under outcomes $RB(WS)$ and $RB(SE)$ yield:

$$V^G(RB(WS)) = V^G(RB(SE)) = 2N[v(2N) - p^S] - K + N[v(N) - p^E]$$

Here, two countries, W and S or S and E, have formed a regional bloc, and thus, their citizens enjoy a network with $2N$ people. Net utility of each individual in the regional bloc is $v(2N) - p^S$ since S is adopted, and there are $2N$ people who enjoy this level of net utility. The laggard country (either W or E) pays K. Since these are regional bloc outcomes, one

country is left in autarchy. Its citizens have a small network with each individual deriving net utility of $v(N) - p^E$ (or $v(N) - p^W$) but this country does not pay the adjustment cost K.

Global welfare under a regional bloc between the laggards is analogous:

$$V^G(RB(EW)) = 2N[v(2N) - p^E] - K + N[v(N) - p^S]$$

This regional bloc is always less efficient than those involving the leader because more people pay the higher laggard price in $RB(EW)$ than in either $RB(WS)$ or $RB(SE)$.

Global net welfare under autarchy is:

$$V^G(A) = 3Nv(N) - N \sum_{i \in \{S,E,W\}} p^i$$

where each individual in country i attains net utility of $v(N) - p^i$.

Now I am ready to compare the global welfare under different trading arrangements. Intuitively, global efficiency depends on how large network benefits are (the curvature of $v(.)$), what the leader and laggard price difference is ($p^E - p^S = \Delta p$), and how large the adjustment cost is (K). Free trade is more efficient than regional blocs WS and SE when the following inequality holds:

$$V^G(FT) - V^G(RB(WS)) = V^G(FT) - V^G(RB(SE))$$

$$= N\{3[v(3N) - v(2N)] + [v(2N) - v(N)] + \Delta p\} - K > 0 \tag{3}$$

Regional blocs involving S are more efficient than autarchy when:

$$V^G(RB(WS)) - V^G(A) = V^G(RB(SE)) - V^G(A)$$

$$= N\{2[v(2N) - v(N)] + \Delta p\} - K > 0 \tag{4}$$

And finally, free trade is more efficient than autarchy when:

$$V^G(FT) - V^G(A) = N\{\frac{3}{2}[v(3N) - v(N)] + \Delta p\} - K > 0 \tag{5}$$

Thus, the parameter space can be divided into three regions according to global efficiency. This result is depicted in **figure 1**, and is summarized in the following proposition. In all figures, additional network benefits an individual receives when his country moves from autarchy to a regional bloc is normalized to unity ($v(2N) - v(N) = 1$), incremental benefits of moving from a regional bloc to free trade, $v(3N) - v(2N)$, is on the vertical axis, and the adjustment cost in per capita terms, $\frac{K}{N}$, is on the horizontal axis. The area marked FT is where free trade is most efficient. The small triangle region marked RB is where the outcome $RB(WS)$ or $RB(SE)$ is efficient. When a third country in the network adds significant benefits to a regional bloc ($v(3N) - v(2N) > \frac{1}{3}[v(2N) - v(N)]$), regional blocs are never efficient. Autarchy is efficient in the remaining parameter space, marked A.

Proposition 1 *For given $v(.)$, N, and Δp, there exists a pair of cutoff levels (K_{ft}, K_{rb}) such that free trade is efficient for all $K \in [0, K_{ft}]$, regional bloc is efficient in $K \in [K_{ft}, K_{rb}]$, and autarchy the most efficient for $K \geq K_{rb}$. For some parameter values, $K_{ft} = K_{rb}$ (regional bloc is never efficient).*

2.1.2 National Governments

National governments do not take welfare of other countries into account. For this reason, global efficiency and the actual outcome do not always coincide. The two technology laggards have an identical optimization problem, while the leader has a different set of incentives. I now discuss national government's optimization problem.

Technology leader Government S compares the welfare under three different trade regimes. Free trade yields:

$$V^S(FT) = N[\, v(3N) - \, p^S]$$

The leader leaps the benefits of an expanded network while not paying any of the adjustment cost by the virtue of having a superior technology. Forming a regional bloc with either partner gives S:

$$V^S(RB(WS)) = V^S(RB(SE)) = N[v(2N) - p^S]$$

Again, its trading partner always pays the adjustment cost, while citizens of S enjoy the expanded network. If S stays in autarchy, the welfare is:

$$V^S(A) = V^S(RB(EW)) = N[v(N) - p^S]$$

Thus, the technology leader is always eager to trade because it receives the benefits of expanded network without ever having to pay the adjustment cost whenever it engages in trade:

$$V^S(FT) > V^S(RB(WS)) = V^S(RB(SE)) > V^S(A) = V^S(RB(EW))$$

Technology laggards Government E (W) chooses the trade regime by analyzing its options. In a free trade equilibrium, welfare of E is:

$$V^E(FT) = N[v(3N) - p^S] - K$$

Citizens of E always switch to network S, and thus, must pay the adjustment cost. The consumers enjoy a lower price as well as expanded network.

A regional bloc with the leader yields:

$$V^E(RB(SE)) = N[v(2N) - p^S] - K$$

whereas a bloc with the fellow laggard gives them an *expected* utility of:

$$Expected\ V^E(RB(EW)) = N[v(2N) - p^i] - \frac{K}{2}$$

where $i \in \{E, W\}$ As discussed above, the ex-ante welfare is different from the ex-post welfare in the case of a regional bloc between E and W because there is uncertainty about which network will be adopted in the trading bloc: country E is expected to pay the adjustment cost only half of the time. In autarchy, its welfare is:

$$V^E(A) = V^E(RB(WS)) = N[v(N) - p^E]$$

In this case, E foregoes the benefits of expanded network but does not have to pay the adjustment cost.

Government E's trade policy can be determined by comparing welfare under different trade regimes. A quick inspection shows that free trade is always welfare-superior to a regional bloc with S since the adjustment cost must be paid in both cases, while the network benefits are higher in free trade than in a regional bloc. Free trade is also weakly better than a regional bloc with W if:

$$V^E(FT) - V^E(RB(EW)) = 2N\{v(3N) - v(2N) + \Delta p\} - K \geq 0 \tag{6}$$

and weakly preferred to autarchy if:

$$V^E(FT) - V^E(A) = N\{v(3N) - v(N) + \Delta p\} - K \geq 0 \tag{7}$$

Outcome $RB(EW)$ is weakly preferred to A when:

$$V^E(RB(EW)) - V^E(A) = N\{v(2N) - v(N)\} - \frac{K}{2} \geq 0 \tag{8}$$

These results indicate that technology laggards tend to trade less than global efficiency calls for either by choosing autarchy excessively or by forming an inefficient regional bloc between themselves. This is because the adjustment costs fall exclusively on laggards when they trade with the leader whereas when they trade with one other, the costs are shouldered evenly ex-ante. **Figures 2a** and **2b** illustrate these results. **Figure 2a** depicts the case where the network benefits are relatively large compared to the price difference between the leader and laggards ($\Delta p < v(2N) - v(N)$). The area marked $RB(EW)$ is the parameter space for which the inefficient regional bloc EW forms. In **figure 2b**, the price difference outweighs the additional network benefits of moving from autarchy to a regional bloc. In this case, inefficient regional bloc never forms. In either case, the *efficient* regional bloc $RB(WS)$ or $RB(SE)$ never forms, and all countries tend to end up excessively in autarchy[3]. The following proposition summarizes the results.

Proposition 2 *Even when it is globally most efficient to have free trade ($K \in [0, K_{ft}]$), there exists a range of K such that an inefficient regional bloc (outcome $RB(EW)$) or autarchy is the unique element of the core. Outcome $RB(EW)$ can be an element of the core only if $v(2N) - v(N) > \Delta p$. Regional blocs $RB(WS)$ and $RB(SE)$ never form even when they are efficient.*

If the two technological laggards have already formed a regional bloc prior to considering trading with S, free trade is even less attractive to them than in a case where they are weighing the options in autarchy. This is because welfare in status quo:

$$v(2N) - p^i$$

[3]On the boundary that divides the parameter space between FT and RB, and the one that separates FT and A ((6) for $K/N \leq 2$ and (7) for $K/N \geq 2$), free trade is the unique element of the core because laggards are indifferent, and the leader strictly prefers free trade. On the boundary (8) for $v(3N) - v(2N) < 1 - \Delta p$, both A and $RB(EW)$ are elements of the core since E and W are indifferent between the two outcomes.

$i \in \{E, W\}$ is higher than it is under autarchy, and one of them has already sunk the switching cost. In order for free trade to be in the core[4], K must satisfy:

$$K/N \leq [v(3N) - v(2N)] - \Delta p \tag{9}$$

This result is depicted in **figure 3**. The area in which the governments of E and W prefer regional bloc to free trade, marked $RB(EW)$, is much larger than *before* the regional bloc EW was formed (the cutoff is now (9) instead of (6)). This regional bloc is insidious in the sense that it makes the efficient free trade outcome more difficult to achieve.

2.1.3 Allowing inter-country transfer payments

In the analysis above, there are parameter values for which outcome A or $RB(EW)$ is the unique element of the core even when it is inefficient. In particular, the leader tends to be left in autarchy excessively. In this section, I show that inter-country transfer payments can reduce these inefficiencies. If the price difference between the laggards and the leader is large relative to the marginal network benefits of moving from autarchy to a regional bloc ($v(2N) - v(N) < \Delta p$), that is, if the parameter space where $RB(EW)$ is the unique element of the core does not exist, then, inefficiencies are eliminated completely. Inefficiencies arise in the laissez-faire equilibrium because the leader does not share the costs of standardization, and therefore is a less attractive trading partner than its technological merit warrants. The outcome is more likely to be efficient when S bears a part of switching costs in the form of transfer payments. Transfers will always be from the leader to the laggard(s) because payments by laggards will only exacerbate the existing distortion.

Let b^{FT} and b^{RB} be the amount of transfer the leader is willing to pay to bring about free trade and a regional bloc respectively, and t^{FT}(each) and t^{RB} be the amount that will convince the laggards to participate in free trade and regional bloc. The results are summarized in proposition 3, and are illustrated in **figure 4**.

Case 1. Parameter space where laggards choose autarchy in no transfer case: In order to convince both countries to trade, the leader is willing to pay up to:

$$b^{FT} \leq V^S(FT) - V^S(A) = N[v(3N) - v(N)] \tag{10}$$

where $V^S(.)$ continues to denote country S's welfare *before* transfer payments. This inequality says the transfer payments must not be larger than the difference in welfare between participating in free trade and being in autarchy. Government of E (W) agrees to free trade if it receives:

$$t^{FT} \geq V^E(A) - V^E(FT) = K - N\{v(3N) - v(N) + \Delta p\} \tag{11}$$

That is, if the transfer compensates for the adjustment cost net of the increased network benefits and the reduced price. Transfer payments can bring about free trade only if the amount that the leader is willing to pay is larger than or equal to the sum of amounts the two laggards require:

$$2t^{FT} \leq b^{FT} \Leftrightarrow K/N \leq \frac{3}{2}[v(3N) - v(N)] + \Delta p \tag{12}$$

[4]Free trade is the *unique* element of the core when (9) holds with equality because the laggards are just indifferent and the leader strictly prefers free trade.

The equilibrium payment b^{FT*} is the smallest b^{FT} that satisfies (12).

To convince E (W) to form a regional bloc, S is willing to pay up to:

$$b^{RB} \leq V^S(RB(SE)) - V^S(A) = N[v(2N) - v(N)] \tag{13}$$

Country E (W) agrees if it receives:

$$t^{RB} \geq V^E(A) - V^E(RB(SE)) = K - N\{v(2N) - v(N) + \Delta p\} \tag{14}$$

For the regional bloc SE of WS to be in the core, the transfer payments the leader is willing to make must be larger than what are required for one of the laggards to agree to trade:

$$t^{RB} \leq b^{RB} \Leftrightarrow K/N \leq 2[v(2N) - v(N)] + \Delta p \tag{15}$$

The equilibrium payment b^{RB*} is the smallest b^{RB} that satisfies (15). The leader prefers transfer inclusive free trade to a transfer inclusive regional bloc when:

$$V^S(FT) - b^{FT*} \geq V^S(RB) - b^{RB*}$$

$$\Leftrightarrow K/N \leq 3[v(3N) - v(2N)] + [v(2N) - v(N)] + \Delta p \tag{16}$$

Case 2. Region in which laggards choose RB(EW) if no transfer is permitted: This situation, which only happens if additional network benefits of moving from autarchy to a regional bloc is large relative to the price difference between the laggards and the leader ($v(2N) - v(N) > \Delta p$), is more complicated than the first case. The maximum transfer the leader is willing to make to trade with both countries and with one of them are the same as (10) and (13) respectively. In order for laggards to prefer free trade to the regional bloc between them, each needs a transfer of:

$$V^E(FT) + t^{FT} \geq V^E(RB(EW)) \Leftrightarrow t^{FT} \geq \frac{K}{2} - N\{v(3N) - v(2N) + \Delta p\} \tag{17}$$

Free trade is in the core only if the transfers the leader is willing to make are larger than what are required for the laggards to agree to trade:

$$b^{FT} \geq 2t^{FT} \Leftrightarrow K \leq N\{3[v(3N) - v(2N)] + [v(2N) - v(N)] + 2\Delta p\} \tag{18}$$

The leader weakly prefers free trade to regional blocs if transfer inclusive welfare of free trade is higher than that of a regional bloc:

$$V^S(FT) - b^{FT} \geq V^S(RB(SE)) - b^{RB} \Leftrightarrow b^{FT} - b^{RB} \leq N[v(3N) - v(2N)] \tag{19}$$

One of the laggards agrees to form a regional bloc with S if the transfer satisfies:

$$t^{RB} \geq V^E(RB(EW)) - V^E(RB(SE)) = \frac{K}{2} - N\Delta p \tag{20}$$

Substituting the smallest values that satisfy the inequalities (20) and (17) in (19), the condition for the leader to weakly prefer free trade to regional bloc, both with transfers, is:

$$V^S(FT) - b^{FT*} \geq V^S(RB(SE)) - b^{RB*} \Leftrightarrow K/N \leq 6[v(3N) - v(2N)] + 2\Delta p \tag{21}$$

The leader prefers a regional bloc with transfer to autarchy when:

$$V^S(RB(SE)) - b^{RB*} \geq V^S(A) \Leftrightarrow b^{RB*} \leq N[v(2N) - v(N)] \tag{22}$$

A regional bloc between E (or W) and S is in the core only if:

$$b^{RB*} \geq t^{RB*} \Leftrightarrow \frac{K}{2N} \leq v(2N) - v(N) + \Delta p \tag{23}$$

In the parameter space where the inequality (23) holds but (21) does not, which is the blank triangle area below line (21) and to the left of $K/N = 2$ in **figure 4**[5], $RB(SE)$ and $RB(WS)$ appear to be the elements of the core. However, this is not the case. Country W is left in autarchy when regional bloc SE forms, which makes it willing to accept a smaller transfer than E to become S's trading partner, as long as it is better off than in autarchy. The leader is better off trading with a partner that requires a smaller transfer. The two laggards will bid down the transfers in order to avoid being left in autarchy. A transfer that makes W (or E) marginally better off than in autarchy, however, will leave both E and W worse off than in outcome $RB(EW)$. Therefore, the core is empty in the parameter space below (21) and to the left of $K/N = 2$. It is interesting to note that countries engage in free trade excessively in the area above (21), below (16), and to the left of $K/N = 2$. This is because S prefers to pay inefficiently large transfers to E and W in order to avoid being left in autarchy. In the parameter space where an inefficient regional bloc between the laggards ($RB(EW)$) would have formed, the change in the dynamics of trade negotiations caused by inter-country transfers creates instability that makes the outcome unpredictable in some cases. The surplus from transfer-induced trade accrues exclusively to the leader since the laggards are paid just enough to be indifferent between trading with S and not. The results are summarized in the following proposition.

Proposition 3 *Inefficiency is reduced when inter-country transfers are allowed. Transfers are always made from the leader to laggard(s). In the parameter space where $RB(EW)$ is an element of core when such transfers are not allowed, inefficiency remains because efforts by all three countries to avoid getting left out of the regional bloc introduce competitive instability. If the parameter values are such that $RB(EW)$ is never an element of the core, inter-country transfers eliminate all inefficiencies. Gains from transfer-induced trade accrue exclusively to the leader (transfer giver).*

2.2 Defending the national monopoly

Now suppose the government cares about both the national monopoly profits and its consumers' welfare. In this section, I assume there are no adjustment costs involved in switching technologies but instead, there is a fixed (sunk) cost F (common for all technologies) to start up a new network. At first, I examine the case where no inter-country transfer payments are allowed. The constant marginal cost MC^i, $i = \{S, E, W\}$, differs depending on the location of the firm. Let S, the technology leader, have the lowest marginal cost and the two laggards have the same production costs. Assume further that the magnitude of the fixed cost is such

[5] Only $k \in (2(p^E - p^S), 2]$ is relevant for case 2.

that the average cost of producing $3N$ units in S is larger than the marginal costs in E and W:

$$MC^S < MC^W = MC^E < AC^S(3N) = MC^S + \frac{F}{3N}$$

Another important difference from the previous section is that firms in this section price their services strategically. Each network is assumed to be proprietary but entrepreneurs are free to launch a new network, and therefore, national monopolies make expected zero profits under autarchy. In other words, monopolies engage in limit-pricing because the markets are contestable. Under these specifications, it is globally efficient to allow the least cost producer to service the entire world.

At the beginning of the second period, the government is (unexpectedly, as before) given a chance to trade with other countries, and makes a decision by maximizing the weighted average of producer and consumer surpluses:

$$\max_{trade\ regime} (1-\beta)(producer\ surplus) + \beta N[v(n) - p^i]$$

where $\beta \in (0, \frac{1}{2})$ is the welfare weight on consumers[6] and $i \in \{S, E, W\}$. When foreign technologies become available, all consumers in the trading area choose the least expensive network by the bandwagon result as before[7]. As before, I assume there is no transitional welfare loss for simplicity.

Technology leader Welfare of country S under autarchy is:

$$V^S(A) = V^S(RB(EW)) = (1-\beta)N[AC^S(N) - MC^S] + \beta N[v(N) - AC^S(N)]$$

The first expression on the right-hand-side is the monopolist's surplus, multiplied by the welfare weight, $1 - \beta$. Since the market is contestable, the monopolist prices at its average cost, makes per unit surplus equal to the difference between its average and marginal costs, sells to N citizens of S, and receives the total surplus equivalent to the initial set up cost F ($F = N[AC^S(N) - MC^S]$). The second expression is the aggregate net consumer utility with the welfare weight β.

Forming a regional bloc brings an incumbent competitor. The monopolists in S and its trading partner are now a duopoly in the regional bloc, and they engage in a Bertrand competition. Since ex-monopolist S is a lower cost producer, it wins the market by pricing at (a shade below) its competitor's marginal cost:

$$V^S(RB(SE)) = V^S(RB(WS)) = (1-\beta)2N(MC^i - MC^S) + \beta N[v(2N) - MC^i]$$

$i \in \{E, W\}$. Ex-monopolist S's surplus per unit of sale shrinks from $AC^S(N) - MC^S$ to $MC^i - MC^S$, but the sales are twice as many now. Denote the difference in marginal costs

[6] It is not customary to assume a lower weight on consumers than on the monopoly in the industrial organization literature but is more common in the political economy literature. Eminent predecessors, such as Grossman and Helpman (1992) have made use of it, and I believe it is a realistic assumption for governments that are participating in WTO negotiations.

[7] As discussed in the previous section, I assume that consumers will choose the "focal" equilibrium.

between laggards and the leader as ΔC $(= MC^i - MC^S)$. This ΔC is the per unit surplus for producer S when the country trades. The consumers enjoy an expanded network as well as a lower price.

In the case of free trade, three incumbents play a Bertrand game, and S's welfare is:

$$V^S(FT) = N\{(1-\beta)3\Delta C + \beta[v(3N) - MC^i]\}$$

Country S's preference is depicted in **figure 5**. The technology leader always prefers free trade to regional blocs. This is because the producer surplus per unit, ΔC, is the same in both free trade and regional blocs but the increase in sales and the benefits from network externalities are larger in free trade than in regional blocs. The leader weakly prefers free trade to autarchy if and only if:

$$V^S(FT) - V^S(A) = N[v(3N) - v(N) + \frac{3-4\beta}{\beta}\Delta C] - \frac{1-2\beta}{\beta} \cdot F \geq 0 \qquad (24)$$

That is, if the benefits of network externalities and increased sales volume outweigh the price reduction the monopoly must take.

Technology laggards Welfare of country E (W) under autarchy is:

$$V^E(A) = V^E(RB(WS)) = (1-\beta)N(AC^E(N) - MC^E) + \beta N[v(N) - AC^E(N)]$$

This is analogous to technology leader S's.

The welfare of laggards is different from that of the leader when they trade because the monopolist in E (W) cannot generate positive producer surplus under trade unlike its counterpart in S, which just suffers a reduction of surplus per unit. Even when monopolist E (W) wins the market, as it may do when trading with the fellow laggard, it still makes zero surplus since the competitor is a same cost producer. A regional bloc with either partner gives E (W) the welfare of:

$$V^E(RB(EW)) = V^E(RB(SE)) = \beta N[v(2N) - MC^E]$$

The welfare under free trade is:

$$V^E(FT) = \beta N[v(3N) - MC^E]$$

Country E weakly prefers free trade to autarchy if and only if:

$$V^E(FT) - V^E(A) = N[v(3N) - v(N)] - \frac{1-2\beta}{\beta} \cdot F \geq 0 \qquad (25)$$

which is the area marked FT on and to the left of line (25) in **figure 6.** Note that this participation constraint is harder to satisfy than S's constraint (24). Country E will participate in free trade if network externalities are relatively large compared to the fixed costs. It always prefers free trade to regional blocs since its own monopolist will not make any surplus in either case, and benefits from network externalities are larger in free trade than in regional blocs. Free trade is the unique element of the core on the boundary (25) since the laggards are indifferent and the leader strictly prefers free trade.

Proposition 4 *When the markets are contestable and the government is maximizing the weighted average of producer and consumer surpluses, regional blocs are never elements of the core. There exists a parameter space where the leader wants free trade but laggards choose autarchy, and hence, autarchy is the outcome.*

2.2.1 A variation: duopoly collusion

So far, the results indicate that governments choose free trade over regional blocs if they decide to trade at all. Now suppose that in the case of a regional bloc between the two laggards, their national monopolies form a cartel (or merge), set the price p^c above their marginal costs, and split the market. The maximum the cartel can charge is $p^c = AC^E(2N) > MC^E = MC^W$ since a higher price will attract new entrants. The welfare of each country under such a cartel is:

$$V^E(Cartel) = (1-\beta)N(p^c - MC^E) + \beta N[v(2N) - p^c]$$

Each member of the cartel makes producer surplus of $N(p^c - MC^E) = F/2$. This seems to be a realistic depiction of the world: faced with a tough competitor, two technological laggards join forces in defending their national monopolies. Such a regional bloc is weakly preferred to free trade when:

$$V^E(Cartel) - V^E(FT) = \frac{1-2\beta}{2\beta}F - N[v(3N) - v(2N)] \geq 0 \tag{26}$$

That is, when the fixed costs are relatively large compared to network benefits, the preference of E and W between regional bloc and free trade reverses from the benchmark case discussed above. The triangle to the left of the line numbered (25) and to the right of (26) in **figure 7** depicts the parameter space in which the inefficient cartel deters free trade. Both E and W always prefer a cartel between them to a regional bloc with S regardless of the magnitude of the fixed cost:

$$V^E(Cartel) - V^E(RB(ES)) = (1-2\beta)(p^c - MC^e)N > 0 \Leftrightarrow \beta < \frac{1}{2}$$

This is because choosing the cartel over a bloc with S forces a transfer from consumers to the producer whose welfare the government values more. Finally, this cartel is weakly preferred to autarchy when:

$$V^E(Cartel) - V^E(A) = N[v(2N) - v(N)] - \frac{1-2\beta}{2\beta}F \geq 0 \tag{27}$$

The cartel improves efficiency in the parameter space to the right of (25) and to the left of (27) in **figure 7** since consumers enjoy a lower price as well as higher network benefits. The results are summarized in the following proposition.

Proposition 5 *There exists a range of parameter values $v(.)$, F, N, β such that E and W form a cartel. In a part of this parameter space, the cartel is trade-diverting and insidious in the sense that it makes free trade more difficult to achieve than in its absence. However, there also exists a parameter space where the cartel is trade-creating and thus, is efficiency-improving.*

2.2.2 Inter-country transfer payments

Now allow inter-country transfers to see if they will improve global efficiency. In the benchmark case without the possibility of cartel, there is a parameter space where S would like free trade but the equilibrium outcome is A (see **figure 6**). In the case that allows a cartel, there is an area in which the inefficient cartel deters free trade. Do inter-country transfer payments reduce these inefficiencies? The leader is left excessively in autarchy because the governments of E and W are reluctant to allow S to compete their monopolies out of business. It follows that any transfers must be from S to the laggards in order to compensate for the loss of producer surplus.

Let b^{FT} and b^{RB} be the maximum transfer payments that the leader is willing to make to achieve free trade and a regional bloc respectively, and t^{FT} (each) and t^{RB} be the transfers that make E and W willing to enter free trade and a regional bloc with S. I continue to denote the welfare of country i in trade regime j *before* transfers as $V^i(j)$

If the laggards prefer autarchy In order to achieve free trade, the leader is willing to pay up to the welfare difference between being in the free trade regime and in autarchy:

$$b^{FT} \leq V^S(FT) - V^S(A) = (3-4\beta)N\Delta C - (1-2\beta)F + \beta N[v(3N) - v(N)] \quad (28)$$

where the first two terms on the right-hand-side are the producer surplus gain from consumer base expansion net of profit margin reduction and the last term is the consumer surplus gain. Government E (W) agrees to free trade if it receives a transfer of:

$$t^{FT} \geq V^E(A) - V^E(FT) = (1-2\beta)F - \beta N[v(3N) - v(N)]$$

That is, if the transfer payment is large enough to compensate for the loss of producer surplus net of gains in consumer surplus. The outcome FT is in the core only if transfer the leader is willing to pay is larger than what the two laggards require:

$$2t^{FT} \leq b^{FT} \Leftrightarrow \frac{1-2\beta}{\beta} \cdot \frac{F}{N} - \frac{3-4\beta}{3\beta}\Delta C \leq [v(3N) - v(N)] \quad (29)$$

For E (W) to agree to a regional bloc with S, the transfer necessary is:

$$t^{RB} \geq V^E(A) - V^E(RB(SE)) = (1-2\beta)F - \beta N[v(2N) - v(N)] \quad (30)$$

The leader is willing to pay up to:

$$b^{RB} \leq V^S(RB(SE)) - V^S(A) = (2-3\beta)N\Delta C - (1-2\beta)F + \beta N[v(2N) - v(N)] \quad (31)$$

Therefore, regional bloc ES or SW will form only if:

$$b^{RB} \geq t^{RB} \Leftrightarrow v(2N) - v(N) \geq \frac{1-2\beta}{\beta}\frac{F}{N} - \frac{2-3\beta}{2\beta}\Delta C \quad (32)$$

The leader prefers free trade to a regional bloc with either partner if and only if:

$$V^S(FT) - b^{FT} \geq V^S(RB) - b^{RB} \Leftrightarrow b^{FT} - b^{RB} \leq (1-\beta)N\Delta C + \beta N[v(3N) - v(2N)]$$

Substituting in the equilibrium transfer payments which are the smallest values that satisfy (29) and (32), this inequality can be rewritten as:

$$v(3N) - v(2N) \geq \frac{1-2\beta}{3\beta}\frac{F}{N} - \frac{1}{3}[v(2N) - v(N)] - (\frac{1-\beta}{3\beta})\Delta C \quad (33)$$

If laggards prefer cartel In the parameter space where the laggards choose to be in a cartel in the absence of transfers, the situation is complicated as it was in section 2.1.3. The amounts the leader is willing to pay to achieve free trade and to form a regional bloc are the same as (28) and (31) respectively. Country E (W) weakly prefers transfer- inclusive free trade to cartel if it receives a transfer of at least:

$$t^{FT} \geq V^E(Cartel) - V^E(FT) = (1-2\beta)F/2 - \beta N[v(3N) - v(2N)] \tag{34}$$

Free trade will happen only if transfers the leader is willing to make are larger than the amount that will convince the two laggards to trade with S:

$$2t^{FT} \leq b^{FT} \Leftrightarrow v(3N) - v(2N) \geq \frac{2-4\beta}{3\beta}\frac{F}{N} - \frac{1}{3}[v(2N) - v(N)] - \frac{3-4\beta}{3\beta}\Delta C \tag{35}$$

For E to agree to a regional bloc with S instead of a cartel, the transfer necessary is:

$$V^E(RB) + t^{RB} \geq V^E(Cartel) \Leftrightarrow t^{RB} \geq (1-2\beta)\frac{F}{2} \tag{36}$$

The leader weakly prefers free trade to a regional bloc if and only if:

$$V^S(FT) - b^{FT} \geq V^S(RB) - b^{RB} \Leftrightarrow b^{FT} - b^{RB} \leq (1-\beta)N\Delta C + \beta N[v(3N) - v(2N)]$$

Substituting in the equilibrium values of b^{FT} and b^{RB}, which are the smallest values that satisfy (35) and (36) (if any) respectively,

$$\frac{1-2\beta}{6\beta}\frac{F}{N} - \frac{1-\beta}{3\beta}\Delta C \leq [v(3N) - v(2N)] \tag{37}$$

In the parameter space where inequality (37) does not hold but the leader is willing to pay a transfer large enough to induce one of the laggards to prefer a bloc with the leader to the cartel:

$$b^{RB} \geq t^{RB} \Leftrightarrow v(2N) - v(N) \geq \frac{1-2\beta}{\beta}\frac{F}{N} - \frac{2-3\beta}{2\beta}\Delta C$$

the situation is analogous to section 2.1.3, and the core is empty.

These results are summarized in the following proposition and illustrated in **figures 8a** and **8b**.

Proposition 6 *When inter-country transfers are allowed, the parameter space that results in an inefficient outcome is reduced. There is a parameter space where the core is empty. (i) If* $v(2N) - v(N) < \frac{2-3\beta}{2\beta}\Delta C$ *(**figure 8a**), cartel between the two laggards is no longer in the core, and outcomes* $RB(SE)$ *and* $RB(WS)$ *are elements of the core in a subset of the parameter space. Both of these regional blocs are more efficient than autarchy. (ii) If* $v(2N) - v(N) > \frac{2-3\beta}{2\beta}\Delta C$ *(**figure 8b**), there is a parameter space where the cartel persists, and regional blocs involving* S *are never elements of the core. (iii) If* $v(2N) - v(N) = \frac{2-3\beta}{2\beta}\Delta C$, *neither regional blocs nor the cartel are elements of the core.*

2.2.3 Governments choose network

In all trading equilibria discussed above, consumers choose S whenever available. This made governments of E and W choose inefficient outcomes in an effort to protect their monopolies at the expense of their consumers. How would the outcome change if governments have the power to choose which technology is adopted as well as which countries to trade with instead of having inter-country transfers possibilities? This describes a situation where one (or more) of the trading partners keeps its own domestic market closed to foreign competition while taking advantage of the partner's open market.

Benchmark: no transfers and no cartel: In the benchmark case, the leader weakly prefers free trade using the less advanced technology E (W) to autarchy when

$$\beta[v(3N) - v(N)] \geq (1 - 2\beta)\frac{F}{N} + \beta\Delta C \tag{38}$$

As long as S is reduced to using technology E (W), it always prefers free trade to a regional bloc with E (W). Every country always welcomes others to join its network, but free trade using an inferior technology is even less attractive to the other laggard, W, than that using the leader's technology. Therefore, free trade using E or W is not an element of the core if free trade was not the in the core in the benchmark case. In the parameter space where free trade using S is in the core, the governments of S and W (E) would not agree to use network E (W). So free trade using an inferior technology is never an element of the core in the benchmark case (without cartel possibility) even when governments can choose which network to use.

Is there a parameter space that $RB(ES)$ or $RB(SW)$ using an inferior technology is in the core? In the region where all countries stay in autarchy in the benchmark case, for S to want to form a regional bloc with E converting to E's technology, the following must be the case:

$$v(2N) - v(N) \geq \frac{2 - 3\beta}{2\beta}\frac{F}{N} + \Delta C \tag{39}$$

That is, the benefits of an expanded network net of the price increase must offset the loss of producer surplus. This must hold at the same time as E wanting to be in autarchy:

$$v(3N) - v(N) \leq \frac{1 - 2\beta}{\beta} \cdot \frac{F}{N} \tag{40}$$

Inequalities (39) and (40) cannot be satisfied at the same time. Therefore, the government's ability to choose the network to be adopted in the trading area (or close their own markets while taking advantage of the other open market(s)) does not make trade more likely to occur.

Cartel allowed (no transfers): In the case that E and W choose to form a cartel (i.e., (26) and (27) holds), S wants to join the EW trading area by *switching to the bloc's standard* if:

$$v(3N) - v(N) \geq \Delta C + \frac{3 - 5\beta}{3\beta}\frac{F}{N} \tag{41}$$

This can be satisfied at the same time as (26) and (27) when benefits of network externalities are large compared to fixed costs and the difference in production efficiency:

$$v(2N) - v(N) \geq \Delta C + \frac{3 - 4\beta}{12\beta} \cdot \frac{F}{N} \tag{42}$$

This parameter space is the triangle area above inequality (41) and below (26) in **figure 9**. In such a case, the size of the consumer base in the cartel gives it an advantage of scale that outweighs S's technological superiority, and the world standardizes to an inefficient system. Aggregate consumer surplus in free trade using an inefficient technology is higher than when S stays in autarchy while E and W form a cartel.

Proposition 7 *There exists a range of parameter values $v(.)$, F, N, β such that the leader S will accede to the cartel EW, switching to the (inefficient) network prevailing in the cartel.*

When governments are more concerned about their monopolies' profits than consumers' welfare, they may choose not to trade with other countries, and thus forego the benefits of network externalities. A profit-sharing cartel improves welfare when it is trade-creating but worsens it when it is trade-diverting. Inter-country transfer payments reduce inefficiencies. Consumers are always better off when more countries are trading. That is, when other countries refuse to open their markets, consumers in a technologically advanced country are better off when their government opens the market unilaterally and adopts an inferior technology than staying in autarchy and using a superior network, as long as the technological difference is not huge ($MC^e < AC^s(3N)$ assumption).

3 Conclusion

The difficulty with which accords were reached during the Uruguay Round of the GATT negotiations illustrates that trade liberalization is not an easily achieved goal. This paper proposes the installed base problem associated with network externalities as an example of why free trade may not prevail in multilateral negotiations even when there are clear gains from trade. It further suggests that regionalism, at least in this context, is not a step in the right direction but is an impediment to achieving free trade. Network externalities are a salient feature of technology related goods and services. They are likely to influence the bargaining positions of governments in future rounds of trade negotiations although government interventions do not always make economic sense. International transfer payments, which can take a form of technical assistance as well as a pure monetary transfer, can reduce inefficiencies and should be considered as an option particularly when there is a clear technology leader.

For the ease of exposition, this paper focuses on relatively narrow cases where there is a national monopoly in each country and the government makes the decision of whether to allow foreign technology into the domestic market, but the underlying issues are much broader. Empirical evidence is rather scant so far, and it is an interesting and important area to be explored in the future research.

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*v(2N)-v(N) is normalized to 1 in all figures.
** numbers in parenthesis correspond to the equations in the text.

Figure 1. Efficiency

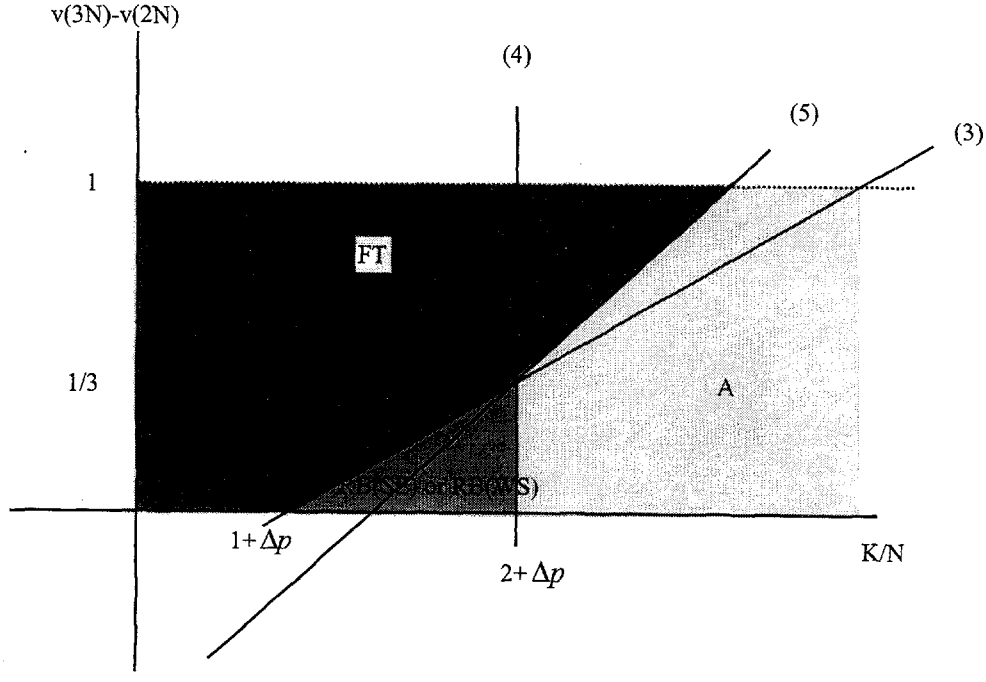


Figure 2a. v(2N)-v(N)> Δp

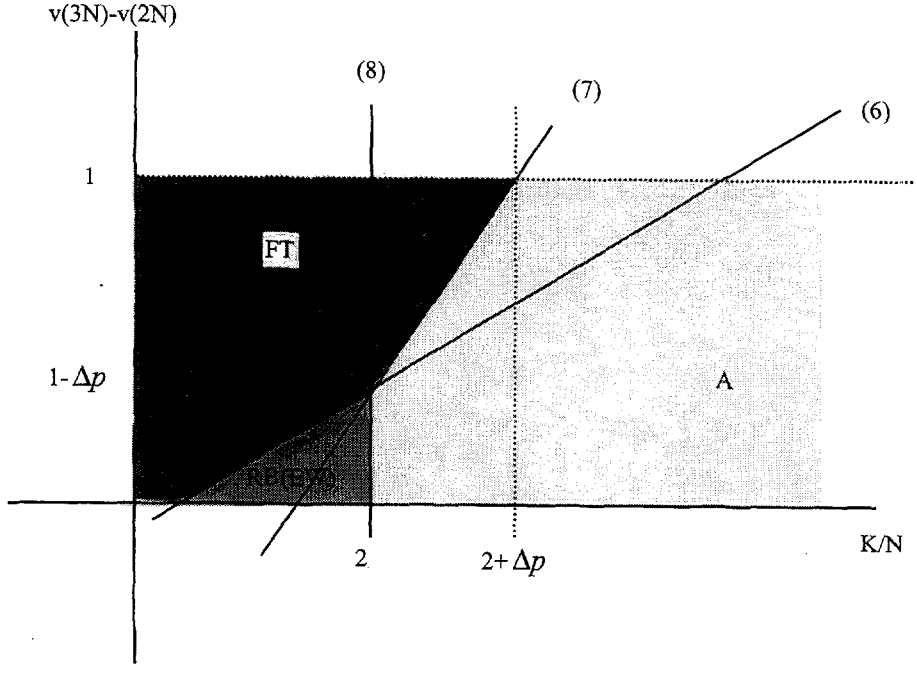


Figure 2b. v(2N)-v(N)< Δp

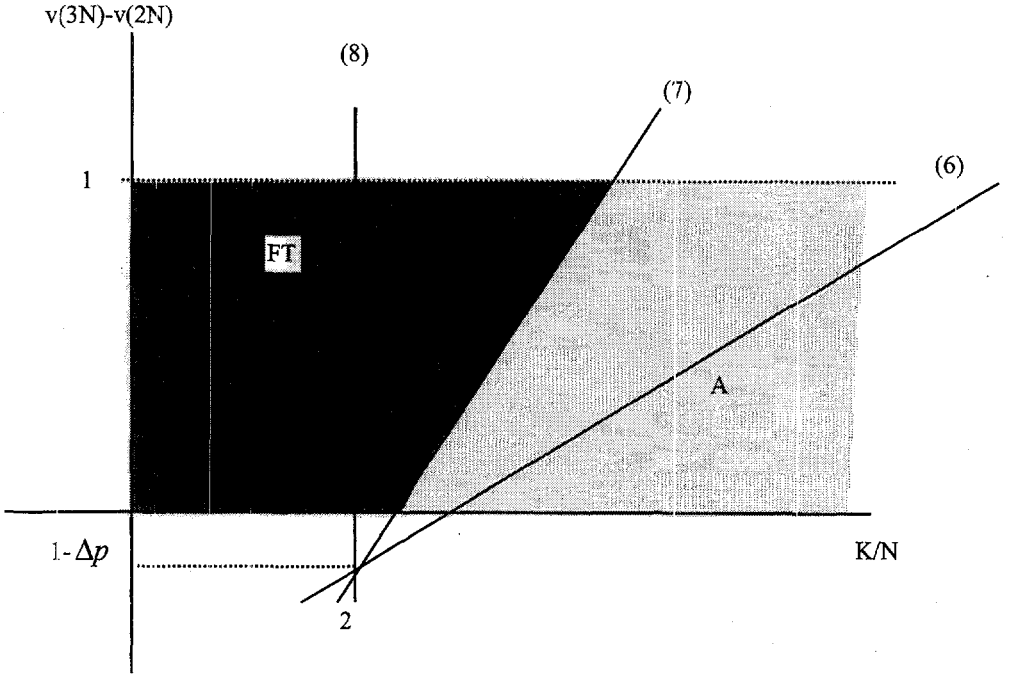


Figure 3. Case where RB(EW) has already formed

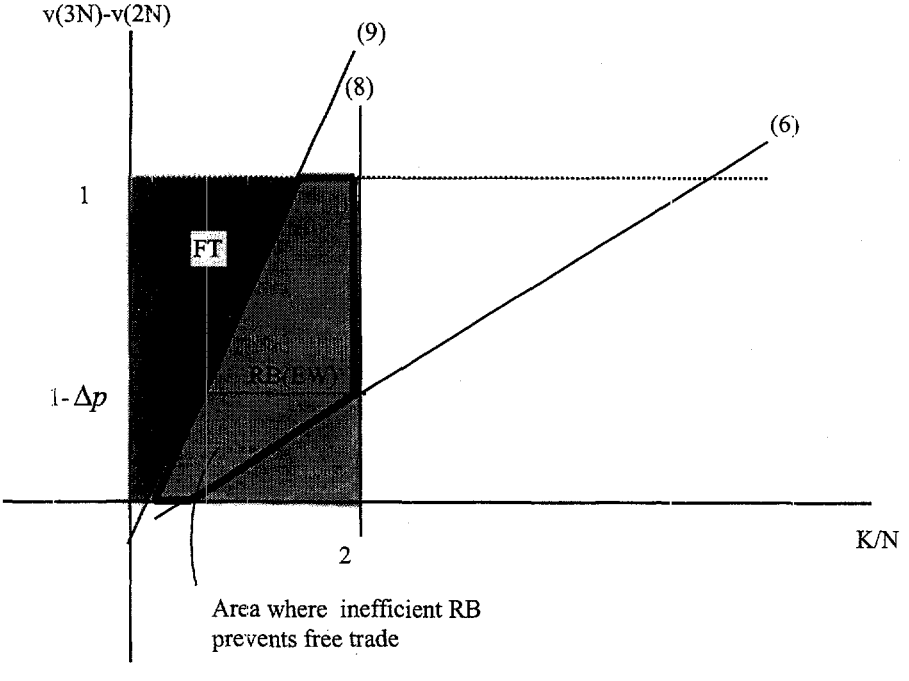


Figure 4. Outcome with transfers

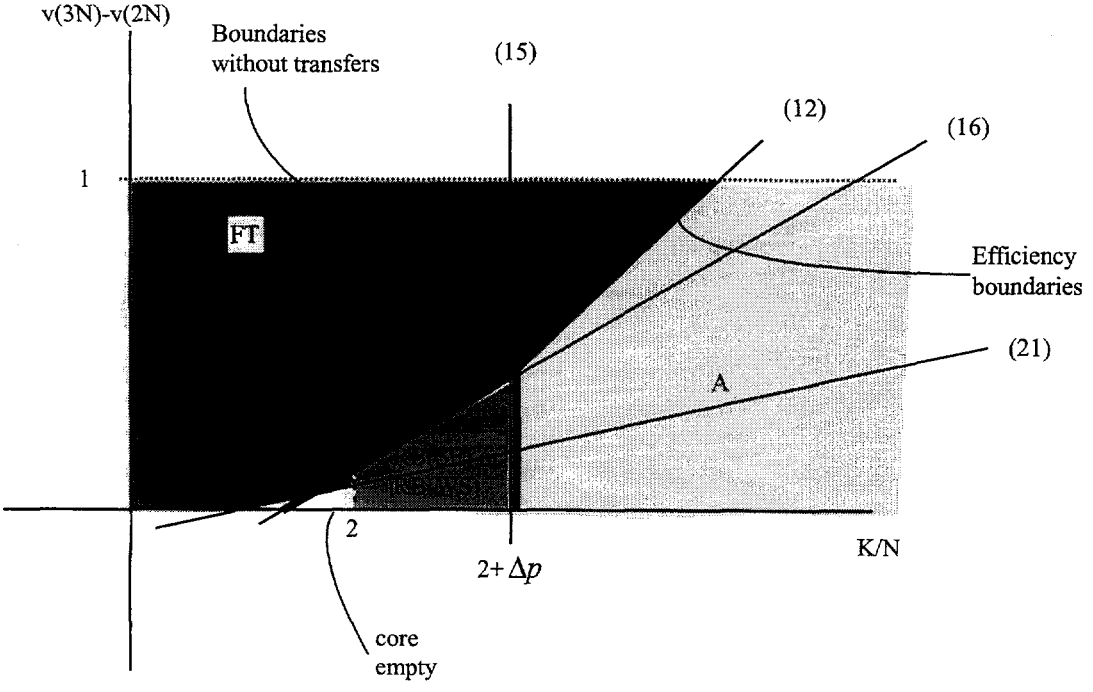


Figure 5. Leader's preference

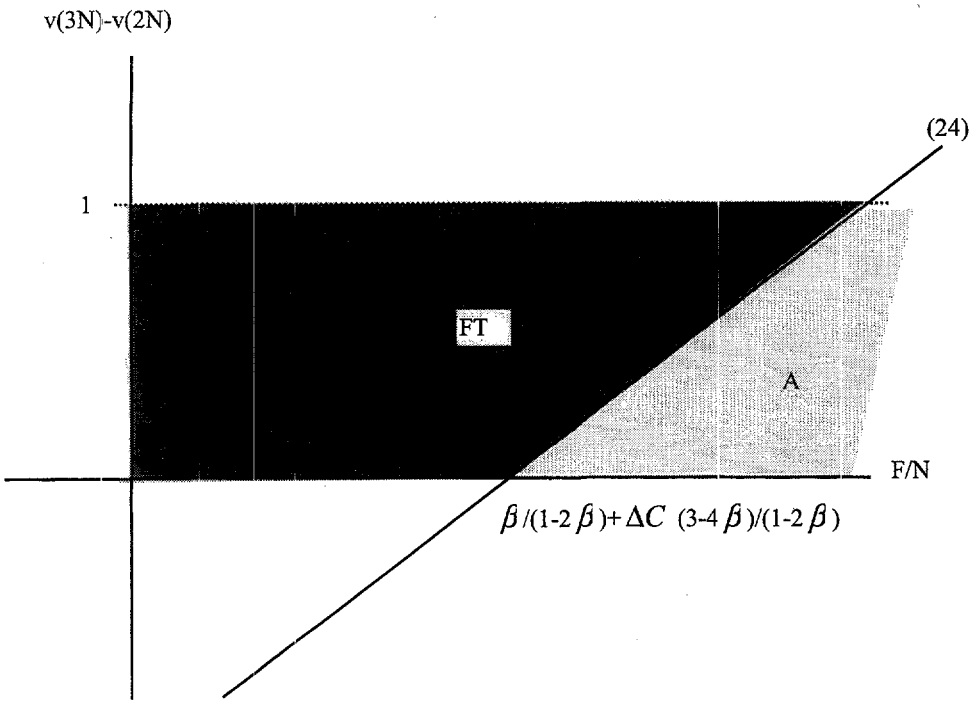


Figure 6. Outcome

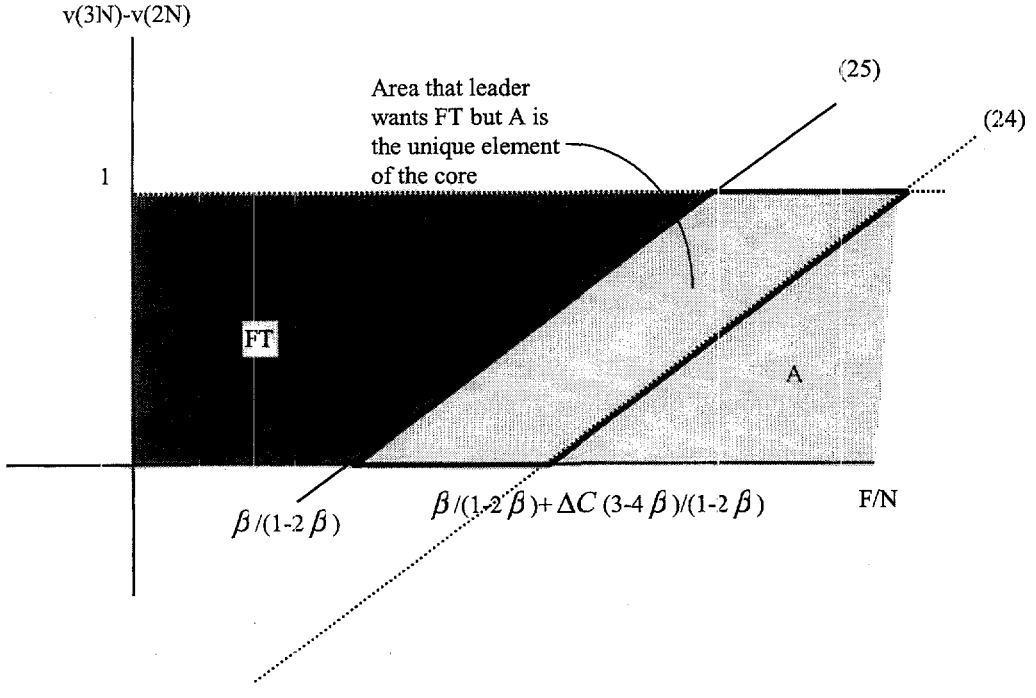


Figure 7. Outcome with Cartel possibility

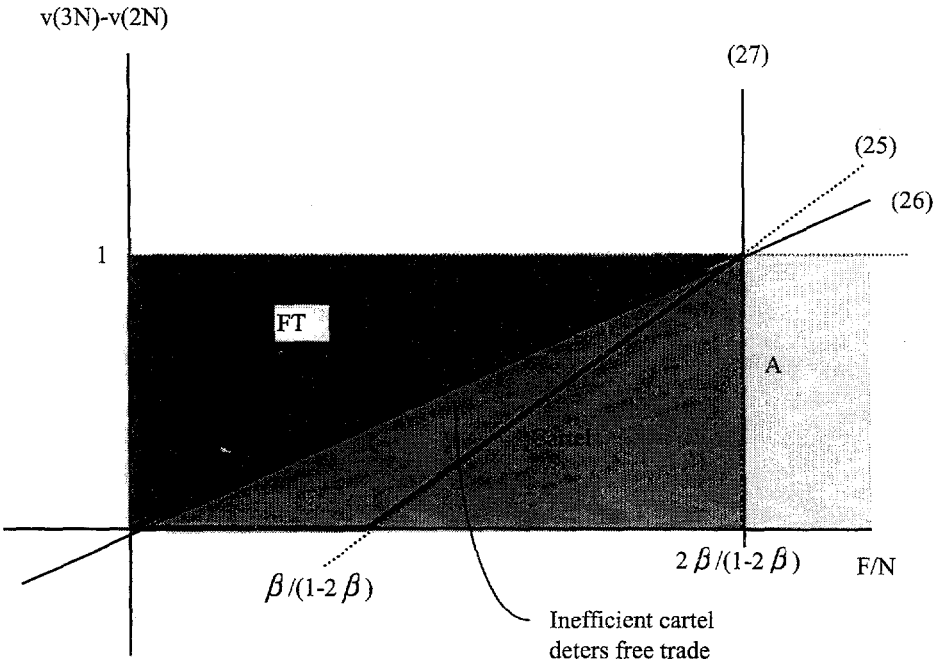


Figure 8a. $\Delta C > 2\beta/(2-3\beta)$

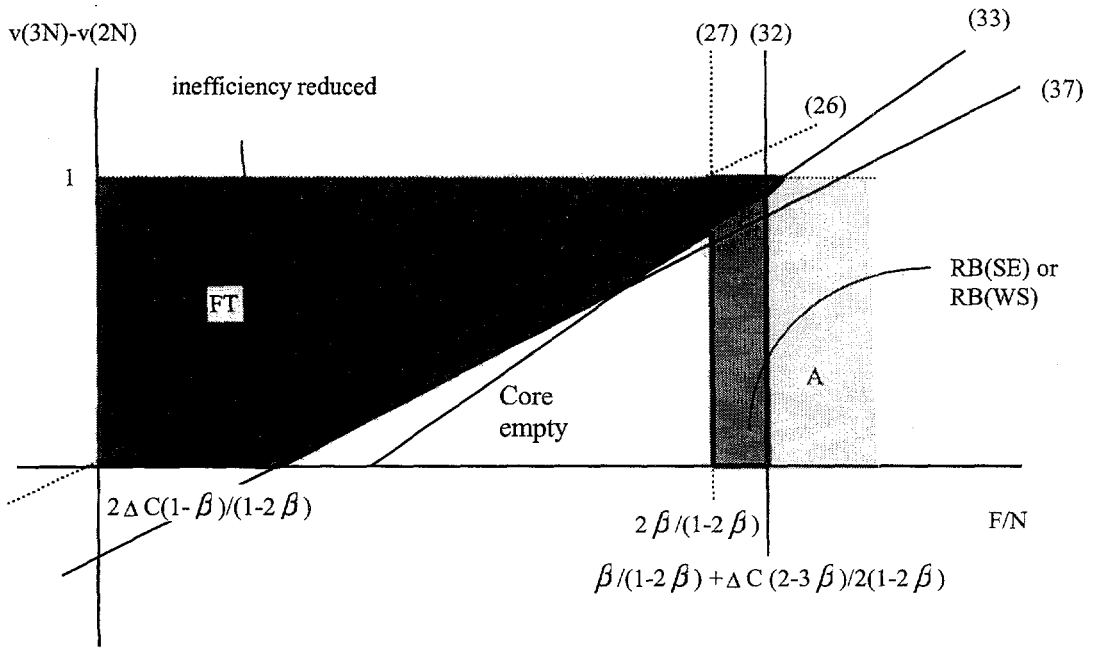


Figure 8b. $\Delta C < 2\beta/(2-3\beta)$

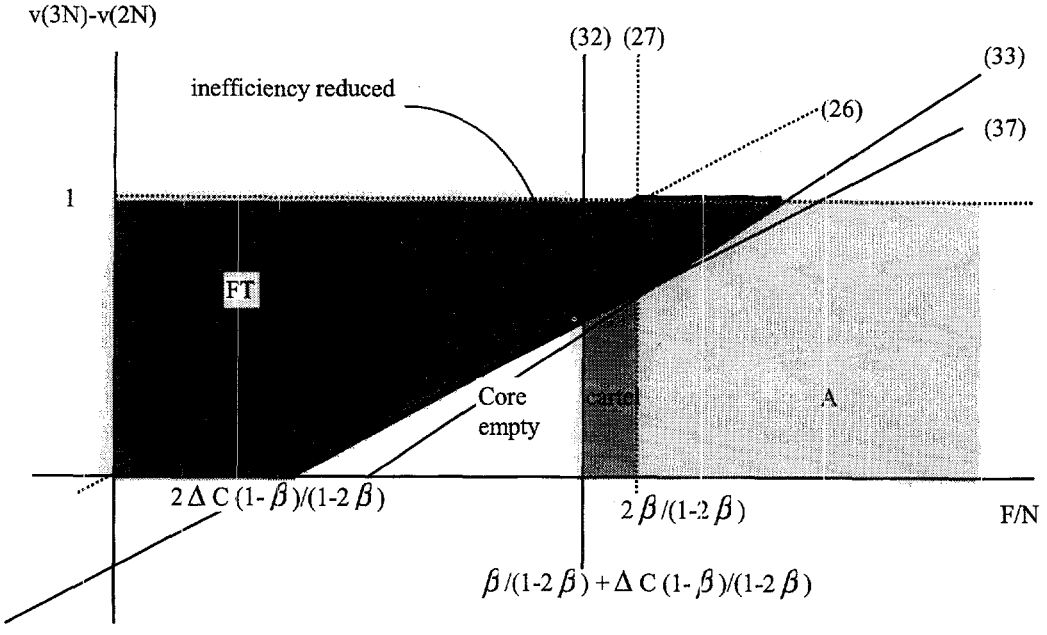
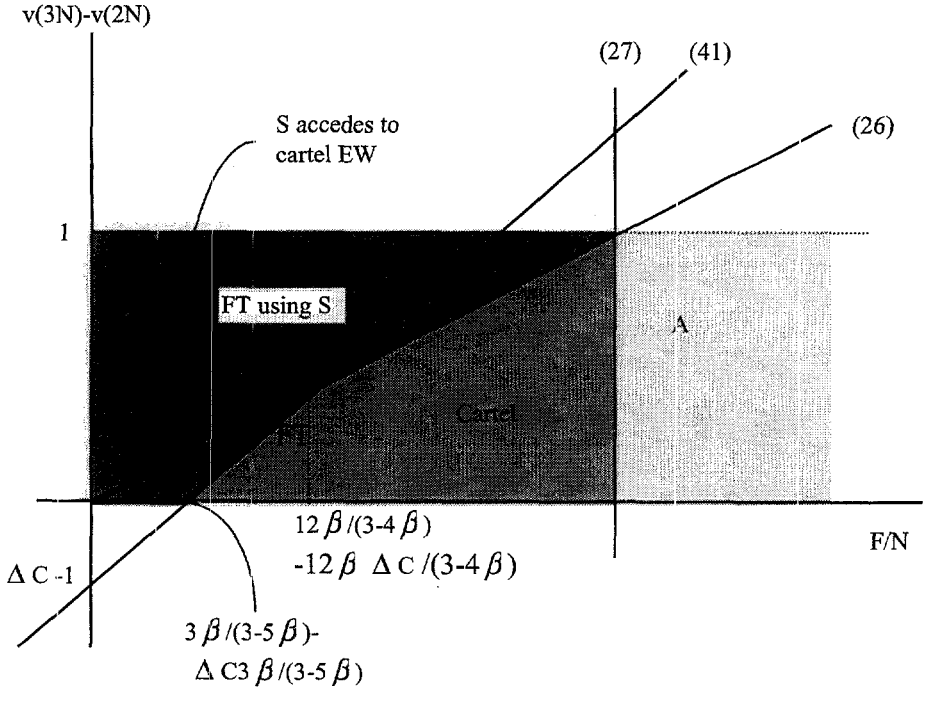


Figure 9



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