THE NOODLE BOWL EFFECT: STUMBLING OR BUILDING BLOCK?

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CONTENTS

FIGURES

ABSTRACT

Although it is well-known that a global trade regime best ensures economic welfare, there has nevertheless been a proliferation of free trade agreements (FTAs) between individual countries. This poses the challenge known as the “noodle bowl effect”—stemming from different rules of origins and technical standards. In this paper, we explore an economy’s incentive for entering an FTA rather than anticipating a global trade regime. Using basic game theories, we show that in order for an equilibrium number of FTA participants to be obtained, the negative impact of FTAs should be significant. Globally, the side effects of FTAs centered on noodle bowl effects could contribute to inducing a global free trade regime—and also increase the viability of such regime once established. Ironically, then we need to encourage more FTAs across countries to facilitate the spread of greater noodle bowl effects instead of trying to curb the rush to FTAs to promote a global trade regime.

Keywords: FTA game, global trade regime, noodle bowl effect

JEL Classification: C70, F10, F13

I. INTRODUCTION

The number of free trade agreements (FTAs) or regional trade agreements (RTAs) is multiplying at an ever-increasing pace. According to World Trade Organization (WTO) data, by January 2015 there were 274 bilateral or multilateral RTAs in force—those notified to the WTO (Appendix 1). In Asia alone there were 126 in force; 215 including those under negotiation (Appendix 2). The proliferation of FTAs reflects the importance many open economies place on freer trade. This phenomenon is also associated with expanding global value chains and production networks—whereby manufacturing and reprocessing imported parts and components is an integral part of production processes and trading patterns. In Asia and the Pacific, much attention has also been directed toward mega or regionwide FTAs—such as the Trans-Pacific Partnership (TPP) and Regional Comprehensive Economic Partnership (RCEP).[1]

While FTAs can help lower trade costs—tariff and nontariff barriers alike—the plethora of FTAs do not come without some costs. Apart from the financial costs from required industrial adjustments or some form of compensation for those adversely affected by FTAs, multiple FTAs in many cases entail direct compliance costs for businesses that otherwise would benefit directly. In addition, overlapping and sometimes conflicting rules and regulations under different FTAs can add significant compliance costs. One Asian Development Bank (ADB) survey of exporters from Japan, the Republic of Korea, Singapore, and Thailand found just 22% took advantage of preferential rules of origin treatment (The Economist 2009).

The "noodle bowl" syndrome of multiple bilateral or regional FTAs and their overlapping and different types of rules of origins only highlights the need for attaining the overarching goal of a multilateral trade regime that could be achieved through successful Doha Development Agenda negotiations. Unfortunately, this has been largely stalled since 2008. From the perspective of economic efficiency and people's welfare, a global trade regime should be the first and best option for freer global trade—averting negative distortionary effects such as trade diversion and costs from noodle bowl effects. However, a huge divide between developed and developing countries on issues such as non-tariff barriers, agricultural subsidies and trade remedial measures, among others, has created the present gridlock, leading to much pessimism over the prospect of securing a truly global free trade regime. Indeed, the task of divining a common denominator is increasingly difficult as more equations—many political—must be considered.

Thus, the proliferation of bilateral and plurilateral FTAs to a large extent emanates from the pessimism over reaching a global trade agreement. The question then becomes what could be the underlying conditions to better ensure a successful global regime as the ultimate outcome. This paper intends to shed light on these issues from a strategic trade policy perspective.

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[1] The TPP is a proposed free trade and investment agreement with "21st century" standards being negotiated among Australia, Brunei Darussalam, Chile, Canada, Japan, Malaysia, Mexico, New Zealand, Peru, Singapore, the United States (US), and Viet Nam. The genesis of the TPP dates back to the 1990s. But current TPP negotiations started in March 2010, with 19 formal negotiating rounds as of August 2013, and more than a dozen ministerial or chief negotiator meetings held afterward through April 2015. The US Congress' late June 2015 conferment of Trade Promotion Authority—also known as "fast track authority"—to the US President is perceived as a key factor in ensuring the success of TPP negotiations. The RCEP is an FTA under negotiation by the 10 Association of Southeast Asian Nations (ASEAN) members and ASEAN's FTA partners (Australia, the People's Republic of China, India, Japan, the Republic of Korea, and New Zealand). The RCEP negotiation process was formally launched during the 2012 ASEAN Summit in Cambodia, and aims to deepen integration through greater trade liberalization. It seeks to establish a single template for future FTAs involving Asia and harmonizes various rules and regulations among existing FTAs.

Grossman and Helpman (1995) used a political economy framework to illustrate the interaction between interest groups and incumbent governments in examining the conditions that guarantee an FTA as an equilibrium solution. Their analysis was focused on the welfare maximization problem of each government as it is lobbied by domestic interest groups. Qiu (2004) explored the sustainability of FTAs using a political economy approach and showed that protectionist lobbying may not reduce FTA sustainability—through modeling the interaction between special interest groups and governments. Cadot, Melo and Olarreaga (1999) examined the impact of RTAs on tariff policy in a three-good, three-country political model that showed deepening regional integration is likely to strengthen a protectionist stance against nonmembers. Meanwhile, Rose (2004) estimated the effect of multilateral trade agreements, including the WTO, the General Agreement on Tariffs and Trade (GATT), and the European Union's Generalized System of Preferences using a gravity model. His research showed little evidence of significant changes in trade patterns resulting from a country's joining the GATT or WTO. As he has pointed out, however, this does not necessarily imply the same small effects on income or welfare levels of a country garnered from the global trade regime. Goyal and Joshi (2006) find that, if countries are symmetric, a complete network—one in which every pair of countries has an FTA (and thus global free trade obtains)—is consistent with the incentives of individual countries. This suggests that bilateralism can be a useful step toward building a liberal world trading system. However, this result hinges on the assumption of country symmetry. No research has clearly shown whether the proliferation of FTAs is a stumbling or building block for a global free trade regime under a general framework—and what could be the underlying conditions to strengthen the creation of an overall framework. This paper tries to tackle these issues by using simple game theories—given the strategic trade policy nature of countries' decision making over FTA participation or nonparticipation. In this game theory approach, countries choose actions, either participation into FTA or nonparticipation and they receive payoffs which depend on the combination of choices they've made. Naturally, countries behave in the way to maximize their payoffs given other countries' choices, which are reflected into their best responses.

The rest of the paper is organized as follows. Section II discusses a general *n*-country FTA game to see if there could be a stable Nash equilibrium. Section III analyzes two-stage finite FTA-global trade regime game and related comparative statistics. Section IV expands the scope of the previous game into the framework of an infinitely repeated game. Section V concludes.

II. GENERAL FREE TRADE AGREEMENT GAME

A. Existence of Nash Equilibrium with Stable *k*

We consider the usual *n*-country type game—where *n* number of countries play FTA games. We follow the framework developed by d'Aspremont et al. (1983) and used by Thoron (1998) on the stability criteria of a cartel and apply it to this FTA game. We do not differentiate the size and type of FTA. As a result, bilateral or regional FTAs are all feasible in this model. The number of countries entering into any type of FTA is simply represented by *k*, where $\forall k \in N$ and $\forall 1 \leq k < N$. The strategy and payoff set of this game can be represented by $G = \{a_1 ...., a_n; U_1,....., U_n\}$ where $a_i \in S_i$, $\forall_i \in n$.

We also assume that S_i = 0 or 1, where 0 means no FTA strategy and 1 means an FTA entrance strategy. U_i denotes country *i*'s payoff function and $U_i(a_1,..........,a_n)$ indicates the payoff to country *i* if the players choose strategies $(a_1,\ldots\ldots\ldots,a_n)$. For each U_i , $U_i^N(k)$ represents country *i*'s payoff from not entering any FTA when *k* number of countries choose an FTA entrance strategy. Likewise, $U_i^F(k)$ represents country *i*'s payoff from entering FTA(s) with any partners when *k* number of countries including the *i* country itself choose the FTA entrance strategy.

In this game G, we first consider whether there exists a Nash equilibrium. Each country *i*'s strategy a_i^* where *i* = 1, 2, ..., *n* are a Nash equilibrium if, for each country, a_i^* is country *i*'s best response to the strategies played by *n*-1 other countries. That is

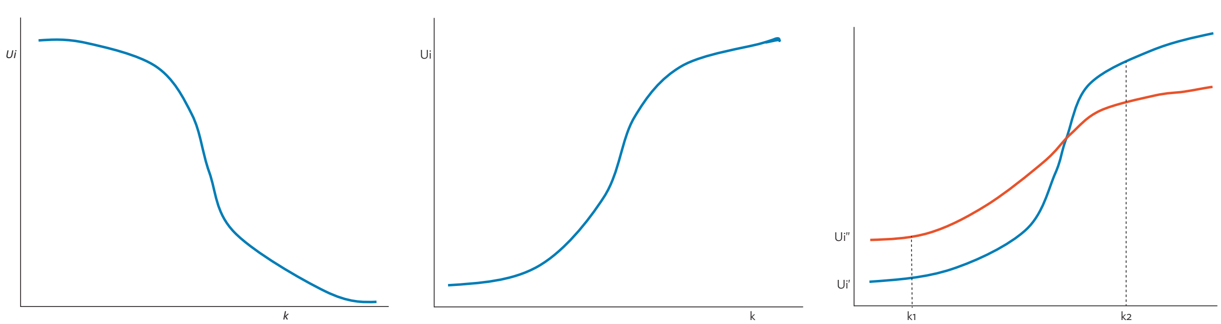
$$U_i(a_i^*, a_{-i}^*) \geq U_i(a_i, a_{-i}^*) \;\; \forall_i \in n, \; a_i \in S_i \text{ and } a_{-i}^* = (a_1^*, a_2^*, \ldots\ldots. a_{i-1}^*, a_{i+1}^*, \ldots\ldots, a_n^*) \qquad (1)$$

As the number *k* is calculated by $\sum_{i=1}^{n} a_i$, we can also present

$$U_i\,(a) = U_i^F(k) \;\; \forall_i \text{ such that } a_i = 1 \text{ and } U_i\,(a) = U_i^N(k) \;\; \forall_i \text{ such that } a_i = 0. \qquad (2)$$

We assume $U_i\,(a)$ follows a monotonic function in terms of *k*, hence, if $U_i^F(k) > U_i^F(k-1)$, then $U_i^F(k+1) > U_i^F(k)$. And if $U_i^N(k) > U_i^N(k-1)$, then $U_i^N(k+1) > U_i^N(k)$. This does not necessarily mean that if $U_i^F(k) > U_i^N(k-1)$, then $U_i^F(k+1) > U_i^N(k)$ and vice versa. An exemplary representation of the functional form of these payoff functions could be as follows (Figure 1):

Figure 1: Increasing or Decreasing Monotonic Payoff Function and Noncross Monotonicity



Source: Author's calculations.

We explore country *i*'s best response a_i^* under a given *k*, which is materialized through *n* countries' FTA or non-FTA strategy. Following the framework devised by d'Aspremont et al. (1983) and elaborated by Thoron (1998) on the stability criteria of a cartel, we define the internal and external stability criteria of the FTA game as follows:

$$\text{Internal stability criteria: } U_i^F(k) > U_i^N(k-1) \qquad (3)$$

$$\text{External stability criteria: } U_i^N(k) > U_i^F(k+1).$$

B. Four Models

We construct four models depending on the different assumptions on country *i*'s payoff function by expanding Thoron (1998) to explore conditions that could guarantee a Nash equilibrium and stable number *k*.

1. Model 1

A1) $U_i^N(1) \le U_i^N(0)$ and $U_i^N(k) < U_i^N(k-1)$

A2) $U_i^F(1) \ge U_i^F(0)$ and $U_i^F(k) > U_i^F(k-1)$

Under these assumptions, country *i* receives a higher payoff when it joins FTAs as more other countries join FTAs, be those FTAs where county *i* itself is a member or not. On the contrary, a country that decides not to join any FTAs acquires less payoff as more other countries are riding the FTA wagon. This does not necessarily mean that the payoff from an FTA entering strategy is always greater than that of not joining. It simply indicates that with an increasing number of FTA-joining countries, an FTA strategy offers increasing benefits. This can be construed that the positive impact from a growing number of FTA-joining countries—such as trade creation—outweighs negative externalities such as trade diversion and noodle bowl effects. Even if additional countries are not joining the same FTA group with country *i*'s, there still exists the possibility that indirect or second-hand effects of lower tariff and nontariff barriers between countries *l* and *m* could garner higher benefits to country *i*—by lowering barriers hindering multiple country production networks. For example, assume countries *i* and *l* belong to one existing FTA which favors a production network between these two countries. When countries *l* and *m* form a new FTA, country *i* can also benefit from this FTA as now a three-country *i*, *l* and *m* production network can benefit from lower import costs of intermediate goods from each other. In addition, if an FTA between *i* and *l* contains most-favored-nation clauses, additional preferential treatment in a new FTA between *l* and *m* may automatically apply to country *i*.

Proposition 1: There does not exist a Nash equilibrium that guarantees an equilibrium number *k* of FTA member countries in this game.

Proof: We first check whether stability criteria $U_i^F(k) > U_i^N(k-1)$ and $U_i^N(k) > U_i^F(k+1)$ can be met at the same time to guarantee an equilibrium number of *k* in this model. We start from $U_i^F(k) > U_i^N(k-1)$ and $U_i^N(k) > U_i^F(k+1)$. Since $U_i^N(k) < U_i^N(k-1)$ from A1, at optimal number of *k*, this yields $U_i^F(k^*) > U_i^N(k^*-1) > U_i^N(k^*) > U_i^F(k^*+1)$. This violates A2 $U_i^F(k) > U_i^F(k-1)$. Hence, there does not exist a stable number of *k* nor Nash equilibria.

2. Model 2

A1-1) $U_i^N(1) \le U_i^N(0)$ and $U_i^N(k) < U_i^N(k-1)$

A2-1) $U_i^F(1) \le U_i^F(0)$ and $U_i^F(k) < U_i^F(k-1)$

A1-1 implies that the payoff to a nonparticipant in an FTA decreases as more and more countries enter into FTAs, possibly due to growing exclusion spillovers from preferential trade treatments among FTA members. At the same time, A2-2 indicates that the negative impact from a growing number of FTA participants—such as trade diversion and noodle bowl effects—outweigh the positive impact. While

FTAs offer opportunities for freer trade with lower transaction costs for members, the trade distorting effect intrinsic to their second best nature can sometimes exceed their positive effects. While trade diversion might adversely affect country *i*'s payoff when more number of other countries get into FTAs, noodle bowl effects will have direct negative impact to its payoff when the country *i* itself enters into FTAs with other partners. Negative noodle bowl effects are aggravated not only by a country's joining multiple FTAs with overlapping and mutually conflicting rules, but by other countries joining various types of FTAs with diverse memberships—due to trade diversion and other trade distorting effects of FTAs. In this model, as the number of FTA entering countries increases, both members and nonmembers are negatively affected.

Proposition 2: There exists a Nash equilibrium that guarantees equilibrium number *k* of FTA members in this game.

Proof: We first examine whether stability criteria $U_i^F(k) > U_i^N(k-1)$ and $U_i^N(k) > U_i^F(k+1)$ can be met at the same time to guarantee an equilibrium number of *k* in this model. We start from $U_i^F(k) > U_i^N(k-1)$ and $U_i^N(k) > U_i^F(k+1)$. As $U_i^N(k) < U_i^N(k-1)$ from A1-1, at optimal number of *k*, this yields $U_i^F(k^*) > U_i^N(k^*-1) > U_i^N(k^*) > U_i^F(k^*+1)$. This is consistent with A2-1 $U_i^F(k^*) < U_i^F(k^*-1)$. Hence, there exists a stable number *k*. Under this situation, *k* number of countries choose $a_i^* = 1$ by entering FTAs while *n-k* countries choose $a_i^* = 0$ where a_i^* is country *i*'s best response to the strategies played by *n*-1 other countries—that is $U_i(a_i^*, a_{-i}^*) \geq U_i(a_i, a_{-i}^*)$ $\forall_i \in n,\ a_i \in S_i$ and $a_{-i}^* = (a_1^*, a_2^*, ...a_{i-1}^*, a_{i+1}^*, ..., a_n^*)$, which ensures Nash equilibria. It is worth noting that at equilibrium *k*, $U_i^F(k^*) > U_i^N(k^*)$.

From model 1 and 2, it becomes evident that $U_i^F(k) < U_i^F(k-1)$ is a necessary and sufficient condition for the existence of a Nash equilibrium and stable *k* when there is growing negative externality impact to non-FTA members. This means that in order to ensure the existence of a Nash equilibrium of the FTA game, an increasing number of FTA participants should lead to a decreasing payoff to existing FTA participants—due to negative side effects, such as the noodle bowl syndrome arising from overlapping FTAs. Otherwise, an ever-increasing number of countries will wish to enter into FTAs due to the negative impact on nonmembers and the positive benefits of joining.

3. Model 3

A1-2) $U_i^N(1) \geq U_i^N(0)$ and $U_i^N(k) > U_i^N(k-1)$

A2-2) $U_i^F(1) \leq U_i^F(0)$ and $U_i^F(k) < U_i^F(k-1)$

A1-2 implies positive spillovers from an increasing number of FTA participants to nonmembers. One possibility is that the trade liberalization spurred by FTAs could offer benefits even to nonmembers when FTA members expand preferential treatment to nonmember countries through unilateral multilateralization of treatment. Another is the free-rider effect of freer trade. Augmented markets derived from expanded FTAs and regional single markets based on trade union may pose greater opportunities for trade and other economic activities for non FTA members. A2-2 indicates the same negative impact from a growing number of FTA participants—such as trade diversion and noodle bowl effects—which outweighs the positive impact as shown in model 2.

Proposition 3: There exists a Nash equilibrium that guarantees equilibrium number of FTA member countries *k* in this model if and only if strong necessary and sufficient conditions are met.

Proof: We first check whether stability criteria $U_i^F(k) > U_i^N(k-1)$ and $U_i^N(k) > U_i^F(k+1)$ can be met at the same time to guarantee an equilibrium number of *k* in this model. We start from $U_i^F(k) > U_i^N(k-1)$ and $U_i^N(k) > U_i^F(k+1)$. Since $U_i^N(k) > U_i^N(k-1)$ from A1-2, at an optimal number of *k*, this yields $U_i^F(k^*) > U_i^N(k^*-1) < U_i^N(k^*) > U_i^F(k^*+1)$. This does not guarantee A2-2 $U_i^F(k) < U_i^F(k-1)$. A low $U_i^N(k^*)$ implying a small free-rider effect for nonmembers can be a necessary condition for a stable *k*, but sufficient is small enough $U_i^F(k^*+1)$ due to negative spillovers, such as noodle bowl effects. At equilibrium, $U_i^F(k^*) > U_i^N(k^*)$ or $U_i^N(k^*) > U_i^F(k^*)$. However, with a low $U_i^N(k^*)$ as a necessary condition for a stable *k*, it is more likely to be $U_i^F(k^*) > U_i^N(k^*)$.

4. Model 4

A1-4) $U_i^N(1) \geq U_i^N(0)$ and $U_i^N(k) > U_i^N(k-1)$
A2-4) $U_i^F(1) \geq U_i^F(0)$ and $U_i^F(k) > U_i^F(k-1)$

A1-4 implies positive spillovers and free-rider effects from an increasing number of FTA participants to nonmembers, as discussed under model 3. A2-4 indicates that FTA participants enjoy a positive impact from the growing number of FTA-joining countries—that trade creation outweighs negative externalities such as trade diversion and noodle bowl effects as explained under model 1.

Proposition 4: There exists a Nash equilibrium that guarantees equilibrium number *k* of FTA member countries in this game.

Proof: We first examine whether stability criteria $U_i^F(k) > U_i^N(k-1)$ and $U_i^N(k) > U_i^F(k+1)$ can be met at the same time to guarantee an equilibrium number of *k* in this model. We start from $U_i^F(k) > U_i^N(k-1)$ and $U_i^N(k) > U_i^F(k+1)$. Since $U_i^F(k) > U_i^F(k-1)$ from A2-4 at an optimal number of *k*, this yields $U_i^N(k^*) > U_i^F(k^*+1) > U_i^F(k^*) > U_i^N(k^*-1)$. This is consistent with A1-4 $U_i^N(k) > U_i^N(k-1)$. Hence, there exists a stable number of *k*. Under this situation, *k* number of countries choose $a_i^* = 1$ by entering FTAs, while *n-k* countries choose $a_i^* = 0$, where a_i^* is country *i*'s best response to the strategies played by *n*-1 other countries—that is $U_i(a_i^*, a_{-i}^*) \geq U_i(a_i, a_{-i}^*)$ $\forall_i \in n,\ a_i \in S_i$ and $a_{-i}^* = (a_1^*, a_2^*, ...a_{i-1}^*, a_{i+1}^*, ..., a_n^*)$, which ensures Nash equilibria. It is worth noting that at equilibrium *k*, $U_i^N(k^*) > U_i^F(k^*)$—which implies payoff to a non-FTA member—is greater than that of FTA participant ex post.

From model 3 and 4, it turns out that $U_i^F(k) < U_i^F(k-1)$ is still a necessary and sufficient condition for the existence of Nash equilibrium and a stable *k* when there is growing free-rider impact on non-FTA members. This means that in order to ensure the existence of Nash equilibrium of the FTA game, an increasing number of FTA participants should lead to a negative net payoff to existing

FTA participants. When there is greater benefit from increasing FTA participants, there can still be a stable number of participants so long as nonparticipants can enjoy greater positive spillover effects from increasing *k*. Otherwise, there will be a race to the ceiling, where each country tries to join FTAs. However, benefits from joining FTAs do not exceed free-rider benefits. This could have a significant ramification if we make the model dynamic—whereby the best response in period 1 has to take into account the expected payoffs from the next periods based on a set of future a_i s.

The analyses of models 1 to 4 suggest that the benefit from non-FTAs does not have to be greater than that of FTA accession. Instead, the negative impact of an increasing number of FTA participants—such as noodle bowl effects—should be a key factor in ensuring Nash equilibria and a stable number of FTA participants.

III. TWO-STAGE FINITE GAME AND COMPARATIVE STATICS

Now we consider a simple, two-period finite game where a credible expectation exists that a global free trade regime will emerge in the second period as long as not all countries enter bilateral or regional FTAs with trading partners in the first period. Intuitively, as more countries enter into some types of FTAs, it would be very difficult to forge a global trade regime by addressing diverse vested interests embedded across different FTAs. For simplicity, however, we assume in this section that a global trade regime in the next period is viable as long as not all countries enter into FTAs in the first. Here we search for the condition which guarantees country *i*'s non-FTA strategy in the first period as a Nash equilibrium under a given number of countries entering into bilateral or regional FTAs. Here, we do not differentiate FTA types and modalities—bilateral or regional FTAs all are viable in this model. The number of countries which enter into FTAs is represented by *k*, where $\forall k \in M$ and $\forall 1 \leq k < M$.

As in Section II, we denote $U_i^N(k)$ country *i*'s payoff from not entering into FTAs with any other partners when *k* number of countries out of *M* choose an FTA entrance strategy. $U_i^F(k)$ denotes country *i*'s payoff from entering into FTAs with other partners when *k* number of countries including the country *i* itself chooses an FTA entrance strategy. Also, $U_i^W(M)$ denotes country *i*'s payoff from a single global trade regime with the participation of all *M* countries. All other models and basic assumptions are the same as those in Section II. In this two-stage game, if country *i* sticks to a non-FTA strategy, it can expect $U_i^N(k)$ in period 1 and $U_i^W(M)$ in period 2. On the other hand, country *i*'s FTA participation strategy in period 1 guarantees $U_i^F(k)$ payoff across both periods if *k* is equal to *M* and $U_i^F(k)$ in period 1 and $U_i^W(M)$ if *k*<*M*. Hence, the expected payoff of an FTA strategy depends on how much probability (*p*) of a global free trade regime in period 2 is anticipated by country *i* as a result of not all countries in period 1 participating in FTAs where $0 \leq p < 1$. Below δ denotes the discount rate which captures country *i*'s time preference. Our interest lies in whether we can draw cooperation from each country in not entering into any FTAs in period 1, and instead waiting for the emergence of a global trade regime in period 2. We search for the condition that guarantees a non-FTA strategy in period 1 with the expected global trade regime in period 2 as best responses for every country, which ensures the Nash equilibrium of this FTA-global trade regime game.

For this $U_i^N(k)+\delta U_i^W(M)\geq p\{U_i^F(k)+\delta U_i^W(M)\}+(1-p)\{U_i^F(k)+\delta U_i^F(k)\}$ (4)

should be met. By rearranging (4), we get $\delta\geq\dfrac{U_i^F(k)-U_i^N(k)}{(1-p)\{U_i^W(M)-U_i^F(k)\}}$. (5)

Hence, as long as the level of δ is greater than or equal to this critical value, we can predict that our proposed strategy will be the best response for all countries, rendering no FTAs viable in period 1 and a subsequent global trade regime attainable in period 2 as the Nash equilibrium. Otherwise, each country will have an incentive to deviate from the cooperation strategy by entering FTAs in period 1. From the lower boundary condition of δ, we assume $U_i^W(M)>U_i^F(k)$ as otherwise (5) degenerates into an upper boundary condition for δ. The critical value of δ makes interesting comparative analyses possible. First, as the gap between $U_i^F(k)$ and $U_i^N(k)$ becomes smaller and that between $U_i^W(M)$ and $U_i^F(k)$ becomes larger, the critical value of δ becomes smaller in (5), which makes the non-FTA strategy equilibria for all *M* countries more viable. This is quite intuitive in the sense that, as the expected benefit from global trade regime in period 2 is greater and that from deviation strategy in period 1 by participating in FTAs is smaller, it becomes more likely that the non-FTA strategy for all countries in period 1 to be followed by a global free trade regime in period 2 will be the (subgame perfect) Nash equilibrium. Second, if $U_i^F(k)\leq U_i^N(k)$ while $U_i^W(M)>U_i^F(k)$, then a non-FTA strategy for all in period 1 becomes Nash equilibria with 100% certainty. If the payoff from a deviation strategy in period 1 is not high enough, no country will choose the deviation strategy. Third, the assessment of *p* value offers an interesting implication. If p is large, the right-hand side of (5) becomes higher, rendering the critical value δ higher. This means that, as country *i* attaches higher probability to the successful global trade regime in period 2, it is less likely that a non-FTA strategy for all becomes Nash equilibria. This interpretation may seem counterintuitive. Ironically, if country *i* anticipates a global trade regime with high certainty as a result of not all countries joining FTAs in period 1, it opts for a deviation strategy to secure a larger benefit in period 1 with less concern about a global trade regime breaking down in period 2.

Now, we investigate how the changes in the number of countries participating in FTAs can affect the critical value of δ. For this, we conduct comparative statistics in terms of level of *k*. We assume *p* = 0 for simplicity of analyses to focus on dynamics of FTA and non-FTA payoff functions. When we differentiate the right-hand side of (5) in terms of *k*, we get the following result:

$$\frac{\left(\dfrac{\partial U_i^F(k)}{\partial k}-\dfrac{\partial U_i^N(k)}{\partial k}\right)\bullet\left(U_i^W(M)-U_i^F(k)\right)-\left(U_i^F(k)-U_i^N(k)\right)\bullet\left(\dfrac{\partial U_i^W(M)}{\partial k}-\dfrac{\partial U_i^F(k)}{\partial k}\right)}{\{U_i^W(M)-U_i^F(k)\}^2}. \quad (6)$$

As the sign and size of (6) also depends on the relative size of each component, we cannot make a definitive assessment on the direction and sensitivity of the critical value of δ in terms of *k*. Our interest lies in the various conditions that make the global trade regime in period 2 and the non-FTA rush in period 1 the most viable. This hinges on the sign and size of (6). Note that $\dfrac{\partial U_i^W(M)}{\partial k}$ = 0, since $U_i^W(M)$ does not depend on the level of *k*. According to the lower boundary condition

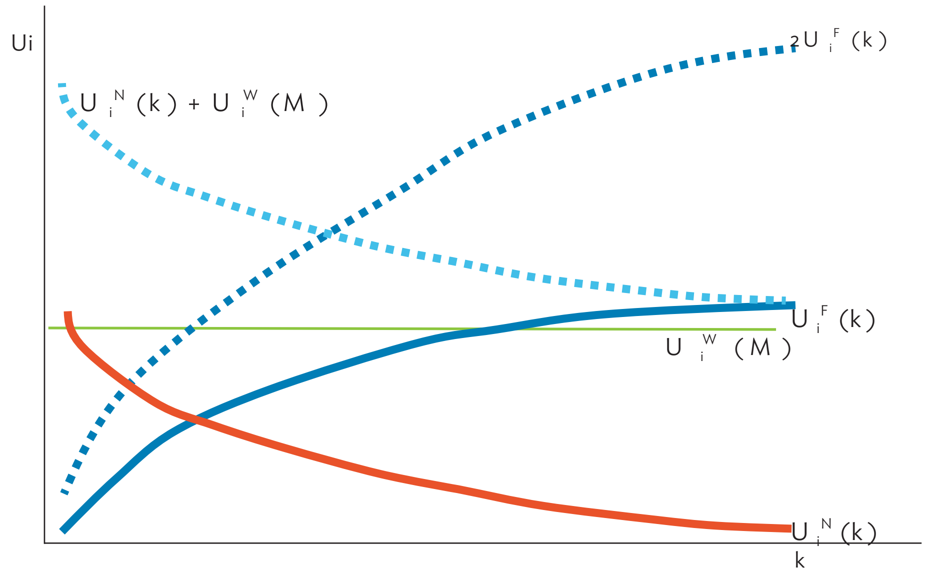
$U_i^W(M) > U_i^F(k)$, hence the denominator of (6) should always be positive. Therefore, if the numerator is positive, the larger the gap $U_i^W(M) - U_i^F(k)$—and if the numerator is negative, the smaller the gap $U_i^W(M) - U_i^F(k)$—the critical value of δ changes in the direction to heighten the possibility of non-FTA equilibria in period 1, when there is an incremental change in the number of *k*. A few cases can be examined:

First, when the numerator of (6) is negative, the probability of the above Nash equilibrium will increase as the critical value of δ decreases in terms of *k*. For this, $\left(\frac{\partial U_i^F(k)}{\partial k} - \frac{\partial U_i^N(k)}{\partial k}\right) \bullet \left(U_i^W(M) - U_i^F(k)\right)$ should be less than $\left(U_i^F(k) - U_i^N(k)\right) \bullet \left(\frac{\partial U_i^W(M)}{\partial k} - \frac{\partial U_i^F(k)}{\partial k}\right)$. A sufficient condition to meet this requirement is for the term $\left(\frac{\partial U_i^F(k)}{\partial k} - \frac{\partial U_i^N(k)}{\partial k}\right)$ to be negative and for $\left(U_i^F(k) - U_i^N(k)\right) \bullet \left(\frac{\partial U_i^W(M)}{\partial k} - \frac{\partial U_i^F(k)}{\partial k}\right)$ to be positive. Negativity of the former term implies $U_i^N(k)$ should be more sensitive in the changes of *k* than $U_i^F(k)$. For the latter term, as $\frac{\partial U_i^W(M)}{\partial k}$ = 0, $U_i^N(k)$ should be greater than $U_i^F(k)$ if both $\frac{\partial U_i^F(k)}{\partial k}$ >0 and $\frac{\partial U_i^N(k)}{\partial k}$ >0. If $\frac{\partial U_i^F(k)}{\partial k}$ <0, however, the greater the $\left|\frac{\partial U_i^F(k)}{\partial k}\right|$, the more likely the critical value of δ becomes negative. This could be the case where there are greater noodle bowl effects. In a nutshell, the probability of a non-FTA strategy equilibrium in period 1 increases when *k* increases if (i) the payoff of a non-FTA strategy is greater than that of an FTA strategy, and (ii) the payoff of a non-FTA strategy is more sensitive to the changes in number of participating countries than that of an FTA strategy. The effect of $U_i^W(M) - U_i^F(k)$ poses conflicting interpretations. While a smaller gap will raise the absolute value of the negative critical value, at the same time it will lessen the impact of the first term of the numerator. Hence, there is no definite effect of this gap.

Second, if the numerator is positive, as the gap $U_i^W(M) - U_i^F(k)$ becomes larger, both the gap of $\left(\frac{\partial U_i^F(k)}{\partial k} - \frac{\partial U_i^N(k)}{\partial k}\right)$ and $\frac{\partial U_i^F(k)}{\partial k}$ should be smaller, while $U_i^F(k) - U_i^N(k)$ should be larger—to ensure a higher probability of a non-FTA strategy as Nash equilibrium in period 1. When the payoff of the global trade regime is greater than that of a deviation strategy, the more slowly the critical value of δ will increase in terms of *k* if the payoff of the deviation strategy exceeds a non-FTA strategy by a large margin; but it is not too sensitive to the changes in *k* compared with a non-FTA strategy.

Below we demonstrate how important the noodle bowl effect is in ensuring a global free trade regime. In the Nash equilibrium condition of this FTA-global trade regime game (4), we assume *p* = 0 and δ = 1 for simplicity. Now, the Nash equilibrium condition becomes $U_i^N(k) + U_i^W(M) \geq 2U_i^F(k)$.

Figure 2: No Existence of Global Trade Regime Nash Equilibrium under Increasing $U_i^F(k)$

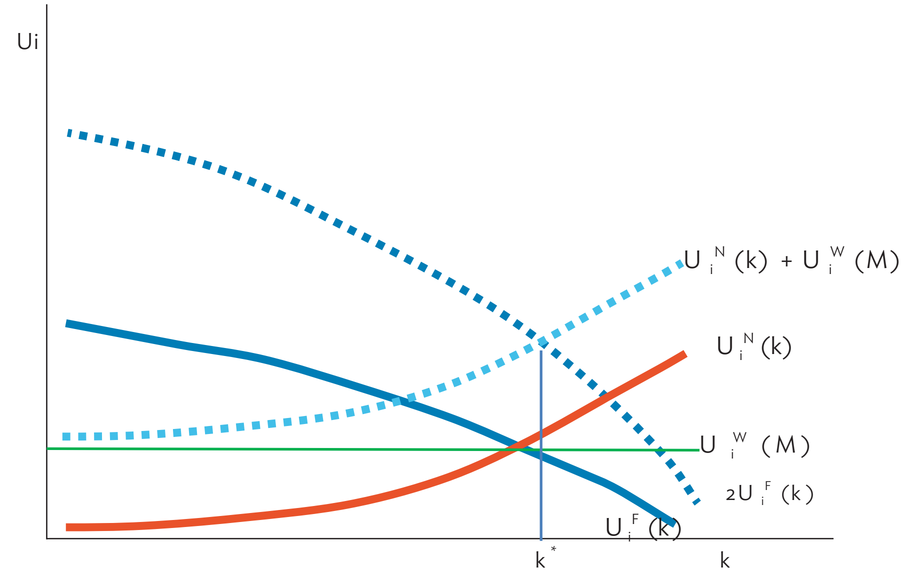


Source: Author's calculations.

As shown in Figure 2 above, if an individual country's payoff from an FTA increases and that from a non-FTA strategy decreases in terms of the number of FTA participating countries, there is no stable number of *k*, and no FTA participation coupled with a global free trade regime can be secured for good—even if the welfare effect from the global trade regime is high. On the other hand, if a country's payoff from an FTA decreases as more countries enter into FTAs—due to negative effects such as the noodle bowl syndrome—a stable *k* is attained and after the equilibrium number of *k*, a global trade regime can be secured—even if the welfare from the global trade regime is not very high (Figure 3). Again, this highlights the significant role the noodle bowl effect plays in ensuring a stable number of FTA participants and the ultimate realization of the global trade regime as the first best optimum.

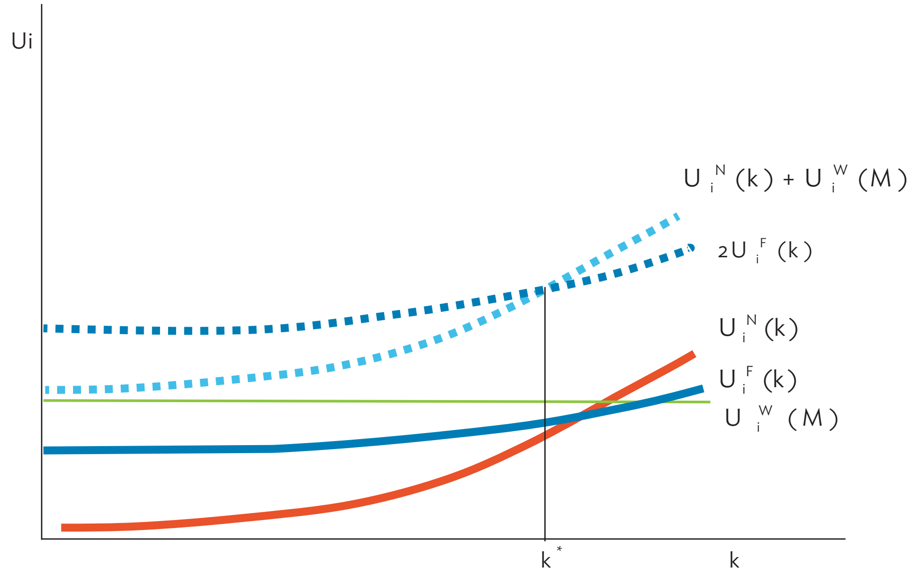
Two more variations are examined based on different assumptions in terms of signs of $U_i^F(k)$ and $U_i^N(k)$ as investigated in Section II. As shown in Figure 4, no FTA equilibrium in period 1 is attainable as long as the sum of payoffs from no FTA participation and a global trade regime rises faster than that of an FTA strategy. More importantly, Figure 5 shows how fast the deceasing payoff from FTA participation—in terms of the number of participants through negative effects such as noodle bowls—can ensure a global trade regime in period 1 even when the payoff from no FTA participation strategy also falls.

Figure 3: Existence of Global Trade Regime Nash Equilibrium under Decreasing $U_i^F(k)$



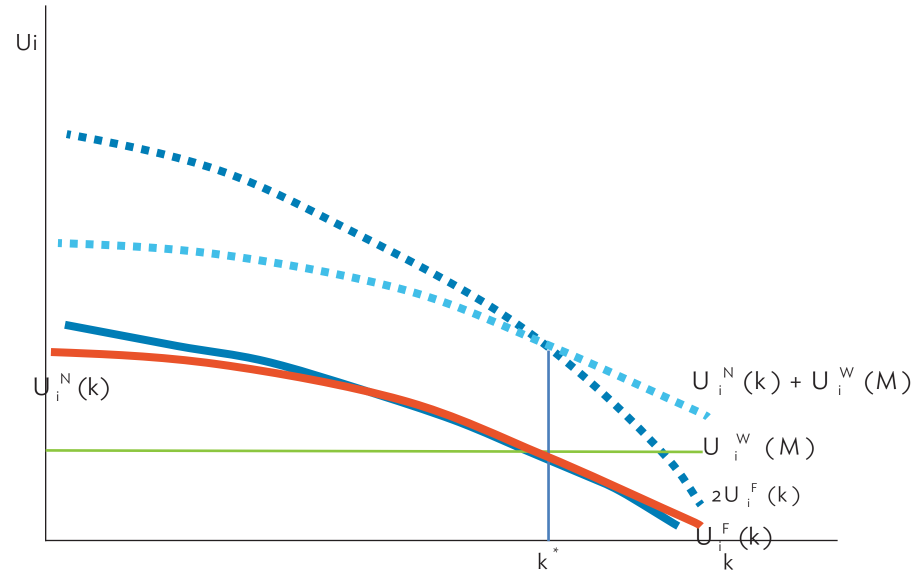
Source: Author's calculations.

Figure 4: Nash Equilibrium under Increasing $U_i^F(k)$ $U_i^N(k)$



Source: Author's calculations.

Figure 5: Nash Equilibrium under Decreasing $U_i^F(k)$ $U_i^N(k)$



Source: Author's calculations.

IV. INFINITELY REPEATED GAME

Now we turn to an infinitely repeated game between an FTA and a global trade regime to examine whether it is possible to uphold the global trade regime once established without being undermined by the prevalence of FTAs. Here, we expand the time horizon into an infinite game. Thus, consider the intermittent FTA game in the context of continuity of the entire global trading regime. For example, viewed from the WTO framework, current FTA trends could be seen as deviations from the global trade regime, while multilateral efforts toward the Doha Development Agenda could be an initiative to uphold the previous global trade regime.[2] Here, we consider an infinite time horizon where each country plays against each other. Country i follows a trigger-strategy in this manner: in the first stage, country i plays cooperative strategy a_{Ni}. And it keeps playing a_{Ni} at subsequent stages as long as the outcome of all preceding stages has been $\left(a_{N1,........}a_{Nn}\right)$. If there has been any deviation in previous stages—such as a_{di}—then it plays a_{Fi}.

In our FTA game, we can regard cooperative strategy a_{Ni} as a non-FTA strategy for each period. A deviation strategy could enter into an FTA with one trading partner—and then trigger-strategy a_{Fi} will become the FTA strategy with all trading partners due to each country's FTA entrance strategy triggered by the deviation of one country.

Proposition 5: There exists a critical value of δ that guarantees these cooperative and trigger-strategies as a Nash equilibrium.

2 We have seen efforts to uphold the global free trade regime in intervals—such as through the Uruguay Round and Doha Round.

Proof: We denote country *i*'s payoff from cooperation strategy as $U_i^W(M)$—which represents the payoff from abiding by the global trade regime among M countries. Hence, we are interested in each country's incentive to support the existing global trade regime against possible bilateral FTAs and global noodle bowl effects due to trigger-strategies engaged by all countries. We denote country *i*'s payoff from cooperative strategy $U_i^W(M)$ and the payoff from deviation at a certain stage, which represents the payoff from the first bilateral FTA as $U_i^F(2)$ and denote the payoff from the trigger strategy for subsequent stages $U_i^F(k)$. By playing a_{Ni}, country *i* will get a payoff of $U_i^W(M)$ and face the same choice between a_{di} and a_{Ni} in the next stages.

We denote the stage game payoff as X_i, $X_i = U_i^W(M) + \delta X_i$. Hence, $X_i = \dfrac{U_i^W(M)}{1-\delta}$. (7)

If playing deviation is optimal, then $X_i = U_i^F(2) + \dfrac{\delta}{1-\delta} U_i^F(k)$. (8)

As we are interested in whether we can have this cooperative and trigger strategy as a Nash equilibrium, we look for the condition which guarantees the global trade regime as an outcome. From (7) and (8),

$$\frac{U_i^W(M)}{1-\delta} > U_i^F(2) + \frac{\delta}{1-\delta} U_i^F(k), \text{ then } \delta \geq \frac{U_i^F(2) - U_i^W(M)}{U_i^F(2) - U_i^F(k)}. \quad (9)$$

The subgame perfect Nash equilibrium of this game is as follows: in each stage—including the initial stage—country *i*'s optimal strategy is cooperation in keeping the global trade regime (provided other countries have adopted the trigger strategy), if and only if condition (9) is met. As country *i*'s best response is to enter into FTAs with trading partners a_{Fi}—leading to payoff $U_i^F(N)$ if the outcome of previous stages are different from $(a_{N1,\ldots\ldots}a_{Nn})$—trigger-strategy a_{Fi} becomes a Nash equilibrium if and only if

$$\delta \geq \max_i \frac{U_i^F(2) - U_i^W(M)}{U_i^F(2) - U_i^F(k)}. \quad (10)$$

From the lower boundary condition $U_i^W(M) > U_i^F(k)$, we can infer that the maximum level of this critical value will be less than 1. As the trigger strategy of this FTA game is a Nash equilibrium for both subgames—where all previous outcomes have been $(a_{N1,\ldots\ldots}a_{Nn})$ and subgames where at least one outcome is different from $(a_{N1,\ldots\ldots}a_{Nn})$—this strategy is subgame perfect.[3]

Now we look for the conditions that make the critical value of δ lower. The following inferences can be drawn from (10). First, the value becomes less when $U_i^W(M)$ is large. This implies that the global trade regime becomes more likely to be upheld when individual countries can get larger benefits from the global regime. Second, the value becomes smaller when $U_i^F(k)$ is smaller. Finally,

3 See Gibbons (1992) for greater detail on strategies and Nash equilibrium of infinitely repeated games.

the larger the $U_i^F(2)$, the value becomes higher, making upholding the global trade regime more difficult. These results were based on the assumption that $U_i^F(2)$ is bigger than both $U_i^W(M)$ and $U_i^F(k)$. However, if $U_i^W(M) > U_i^F(2)$, then when $U_i^F(2) > U_i^F(k)$, the global trade regime can be upheld in each period with certainty. From $U_i^F(2) > U_i^F(k)$, negative spillovers, including noodle bowl effects from more than two FTA participants due to country *i*'s trigger strategy in the subgames play a significant role in ensuring maintenance of the global free trade regime.

V. CONCLUSION

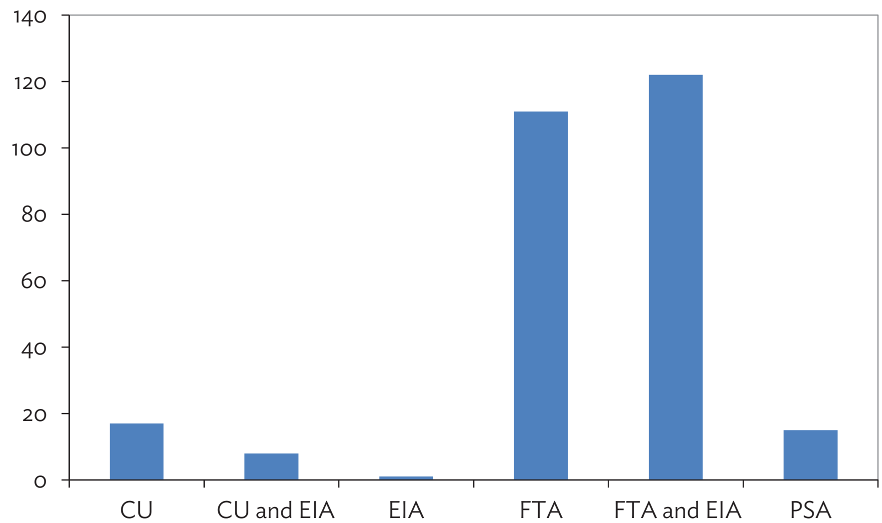
While the plethora of FTAs fosters freer trade by reducing transaction costs and enhancing factor mobility across borders, the first best optimum for economic efficiency and people's welfare can be attained through a global free trade regime. In order for an equilibrium number of FTA participants to be obtained, the negative impact of FTAs should be significant. Otherwise, there will be either a race to the bottom or race to the top, without allowing a stable number of FTA participants. Negative effects of FTAs—such as noodle bowl effects—play a significant role in this regard. In this sense, noodle bowl effects could function as a countervailing factor against a rush toward entering FTAs.

Globally, the side effects of FTAs—centered on noodle bowl effects—could contribute to inducing a global free trade regime and also increase the viability of a global trade regime once established. Ironically, the argument then goes that, in order to promote a global trade regime and contain the explosion of FTAs, we need to encourage more FTAs across countries to facilitate the spread of greater noodle bowl effects—instead of trying to curb the rush toward negotiating more FTAs.

Various extensions of the approaches taken in this paper could be explored. One option would be to explicitly net out negotiation costs from gross payoff functions. As global trade negotiations entail huge negotiation and time costs compared with bilateral FTAs, this cost inclusion might have significant impact on the outcome of the analyses.

APPENDIX 1

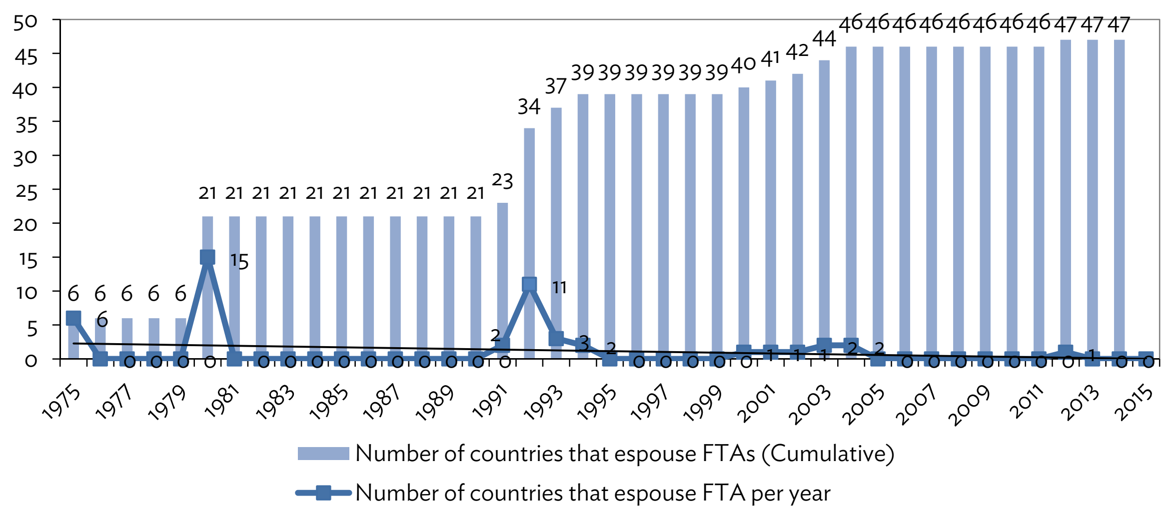
Types of Worldwide Regional Trade Agreements (WTO notified)



CU = Customs Union, EIA = Economic Integration Agreement, FTA = free trade agreement, PSA = Partial Scope Agreement, WTO = World Trade Organization.
Source: World Trade Organization. Regional Trade Agreements Information System. http://rtais.wto.org/UI/PublicAllRTAList.aspx (accessed 12 June 2015).

APPENDIX 2

Number of Countries Espousing Free Trade Agreements in Asia*



FTA = free trade agreement.
* A country is considered to have "espoused" an FTA once a Framework of Agreement is signed or negotiations begun. An FTA is included in the ARIC FTA database once under negotiation—either a Framework of Agreement has been signed or negotiations launched).
Source: ADB. Asia Regional Integration Center database. http://aric.adb.org/fta (accessed 17 June 2015).

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The Noodle Bowl Effect: Stumbling or Building Block?

The paper explores an economy's incentive for entering a free trade agreement (FTA) rather than anticipating a global trade regime. Using basic game theories, it shows that in order for an equilibrium number of FTA participants to be obtained, the negative impact of FTAs should be significant. Globally, the side effects of FTAs—centered on noodle bowl effects—could contribute to inducing a global free trade regime and also increase the viability of a global trade regime once established. In order for an equilibrium number of FTA participants to be obtained, the negative impact of FTAs should be significant.

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