



Is tied aid bad for the recipient countries?☆

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ARTICLE INFO

Article history:

Accepted 20 November 2015

Available online 5 January 2016

Keywords:

Foreign aid

Tied aid

Untied aid

Humanitarian and self-interested motivation of aid

Official development assistances

ABSTRACT

This paper examines the welfare effects of the exclusivity of foreign aid taking consideration of donor countries' strategic and self-interested economic motivations. Based on an oligopolistic model with strategic interactions between firms and governments providing foreign aid, we demonstrate that a higher exclusivity of foreign aid, taking the form of tied aid, increases the equilibrium amount of aid and the social welfare of the recipient country when the foreign aid policies are decided in a non-cooperative fashion between donor countries. However, when donor countries coordinate aid policies to maximize joint-welfare including recipient country's welfare, the lower exclusivity of foreign aid, taking the form of untied aid, will increase the equilibrium amount of aid and the global social welfare. The results implicate that when a credible enforcement mechanism for the cooperative regime for foreign aid is not available, tied aid is welfare dominant policy for both donor and recipient countries than untied aid.

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1. Introduction

Development Assistance Committee (DAC) of OECD has encouraged Official Development Assistance (ODA) to be provided as untied aid with no exclusivity by introducing an explicit guideline for tied and partially tied ODA in April 1987 based on humanitarian motivation.³ Since then, the share of tied aid has decreased significantly from 48% in 1987 to 15% in 2011 worldwide.⁴ Nonetheless, tied aid still plays a big role in many countries including the US that provides 34.5% of the total aid as tied aid, and other OECD countries as Austria, Italy, Portugal, and South Korea.

Untied aid has been widely supported with the belief that tied aid is more likely to be provided with the strategic purpose to support

domestic corporate sectors of donor countries. Japan is also often cited as a typical example of the donor country with the strategic purpose to support her own firms with tied aid.⁵ In contrast to some critical views on tied aid, Kihara (2012) shows that there is a higher correlation between the per capita GDP growth rate of the recipient countries and the tied aid from Japan than untied aid from other countries. China has also attracted criticism for her huge amount of tied aid in Africa as self-interested efforts to increase the market power of the Chinese firms in Africa notwithstanding possible positive impacts for economic development in the region (Bräutigam, 2011; Sun, 2014).⁶

Although non-exclusivity of aid is emphasized by DAC, one striking finding is that the majority of aid exclusively benefits firms from the donor country in both cases of tied and untied aid. During the 10 years after the Paris Declaration in 2001, contrary to the international community's expectation, two-thirds of formally untied aid has actually benefited corporate sectors of donor countries (Ellmers, 2011).

Confronted with these conflicting features with respect to exclusivity of foreign aid, a more rigorous analysis of the welfare effects of two different types of aid is wanted since many arguments are still raised on the efficiency of the DAC policy guideline to encourage untied aid and to discourage tied aid. Based on these backgrounds, this paper

☆ Many valuable comments by the two anonymous reviewers and participants at the ETSG annual meeting in Munich, INFER annual meeting in Pescara and KIEA meeting in Seoul are deeply appreciated. This work was supported by the National Research Foundation of Korea Grant funded by the Korean Government (NRF-2014S1A5B8060964).

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³ OECD defines tied aids as follows: "Tied aid credits are official or officially supported loans, credits or associated financing packages where procurement of the goods or services involved is limited to the donor country." Therefore tied aid provides exclusive benefits only to firms from donor countries since procurement is limited to the donor country. Refer to the OECD Glossary of Statistical Terms at <http://stats.oecd.org/glossary/detail.asp?ID=3089>.

⁴ 'OECD.Stat DAC7b Tying Status of Bilateral ODA' shows that the total bilateral aid in 2011 reached US\$ 104.5 bn, while the amount of tied aid was US\$ 15.1 bn with partially untied aids at the amount of US\$ 4.0 bn.

⁵ Due to the high exclusivity of aid, Japan was ranked as the lowest among 22 OECD donor countries, according to the index of donor performance evaluated by the Center for Global Development.

⁶ Regarding this region, Hisali and Ddumba-Ssentamu (2013) analyze the aid–tax revenue relationship in Uganda and provides deeper insights into the nature of the relationship.

aims to determine when DAC's policy for untied aid can be a welfare improving policy and conditions make tied aid welfare dominant.

Among huge literature about the welfare effects of foreign aid, a dominant perspective is to regard the foreign aid as a public good (Dudley, 1979; Kasuga and Morita, 2012; Olson and Zeckhauser, 1966; Raffer, 1999; Reisen et al., 2004; Schweinberger and Lahiri, 2006). In addition to the general welfare analysis of international aid of earlier literature, Kemp and Kojima (1985) study the endogenous price distortion of tied aid that affects welfare of recipient negatively while affecting welfare of donors positively. Reconsidering the transfer paradox, Lahiri and Raimondos (1995) find out the Pareto improving condition that makes both donor and recipient better off. Svensson (2000a,b) shows that tied aid works as welfare-improving policy, resulting in a poverty reduction of the recipient. Abe and Takarada (2005) examine the condition under which the donor suffers from tied aid while the recipient benefits from it.

In addition, Burnside and Dollar (2010) argued that foreign aid raises growth only in a good policy environment of recipient countries driving attention to the soundness of the recipient country's economic policies. However, Easterley et al. (2003) argue through extended studies with updated data that there is no strong correlation between the soundness of the recipient country's policies and the effectiveness of aid in promoting growth of recipient countries. In the spirit of Easterley et al. (2003), instead of focusing on the soundness and goodness of recipient countries' policies, we focus on the effects of different types of motivation of donor countries and the different types of the aid regime such as the cooperative regime and non-cooperative regime.

Knack and Eubank (2009) shows that the harmonization among donor countries and alignment with the major development issues of recipient countries are the key factors to determine the efficiency of aid.

Using an endogenous growth model incorporating leisure choice of individual, Liu et al. (2014) show that a foreign aid can lower growth and the welfare by providing to individuals less incentive for working and more incentive for playing.

The major difference between earlier studies and this paper lies in that this paper examines the equilibrium aid strategies considering strategic and self-interested economic motivation lying behind international aid. To the best of our knowledge, this study is the first work to provide a theoretical framework to understand the welfare effects of varying levels of the exclusivity in both tied and untied aid. Based on a spatial oligopoly model with strategic interactions between firms and governments providing aid, we demonstrate that the higher exclusivity of aid, taking the form of tied aid, increases the equilibrium amount of aid and the social welfare of the recipient country when the ODA policies are made in a non-cooperative fashion between donor countries. However, when donor countries can coordinate aid policies for joint-welfare maximization including the recipient country's welfare, the lower exclusivity of aid, taking the form of untied aid, will increase the equilibrium amount of aid and the global social welfare. These results implicate that the policy recommendation of OECD DAC for untied aid can be a welfare improving approach only when the international coordination mechanism for cooperative aid works effectively.

Section 2 explains the basic model setting where representative firms from two donor countries compete in a recipient country's market while governments of donor countries have varying levels of self-interested motivations of aid provision. Section 3 discusses the equilibrium when aid is provided in a non-cooperative fashion between donor countries, while Section 4 determines the equilibrium under a cooperative regime of aid provision. Section 5 examines the conditions for the cooperative regime of aid provision to be sustainable, and Section 6 discusses the policy implications and concludes.

2. Stylized features of tied and untied aid

We examine how tied aid differs from untied aid in terms of the contexts the aid is provided in reality and the effects caused by the two different types of aid based on available data in the following.

First, the difference between the tied and untied aid is defined as follows: According to the definition of the Development Aid Committee of OECD, "tied aid describes official grants or loans that limit procurement to companies in the donor country or in a small group of countries. Tied aid therefore often prevents recipient countries from receiving good value for money for services, goods, or works.

Untying aid – removing the legal and regulatory barriers to open competition for aid funded procurement – generally increases aid effectiveness by reducing transaction costs and improving the ability of recipient countries to set their own course. It also allows donors to take greater care in aligning their aid programs with the objectives and financial management systems of recipient countries."⁷

The backgrounds for the strong supports and recommendation for untying aid are as follows⁸:

- i) Tied aid decreases value for money provided by the aid. DAC recommendation on untying ODA to the least developed countries (LDCs) showed that tied aid increases costs of supplies by 15% to 40% mainly due to limited competition and resulted monopoly prices with higher transport costs compared to the local purchases.
- ii) Tied aid undermines the recipient country's ownership of the development process. Tied aid is criticized as preventing developing countries from taking full responsibility of their own development in utilizing the aid. Tied aid puts purchasing decisions in donors' hands resulting in the purchase of inadequate purchasing mainly benefiting firms from donor countries.
- iii) Tied aid is criticized as undermining the right to development. That is, tied aid deprives developing countries from full potentials of the long-term sustainable development that untied aid might have provided with local procurement products and services from the developing recipient country.

Based on the above arguments, DAC of OECD has adopted a strong policy drive to untie aid, especially recommending untied aid for least developed countries since 2001. Thereafter, there has been a rapid growth of the share of the untied aid as shown in the following table.

⁷ The definition of the tied and untied aid is quoted from OECD official site, <http://www.oecd.org/development/untyingaidtherighttochoose.htm>.

⁸ Refer Ellmers (2011) for the details of the discussions about the shortcomings of tied aid.

According to the OECD creditor data, the share of untied aid to least developed countries (LDCs) rose from 57% in 1999–2001 to 83% in 2005–2007 period.⁹

DAC donor countries: tying status of bilateral ODA to LDCs and non-LDCs in 1999–2001 and 2005–07 (percentage based on three year averages).

Period	Recipient country grouping	Untied (%)	Partially tied (%)	Tied (%)	Not reported (%)	Total
1999–2001	LDCs	57	3.5	8	32	100
	Non-LDCs	49	2.0	9	40	100
	All DCs	51	2.3	9	38	100
	All DCs (including EC)	46	7.5	8	39	100
2005–2007	LDCs	83	0.3	13	4	100
	Non-LDCs	70	0.8	22	7	100
	All DCs	73	0.7	20	6	100
	All DCs (including EC)	65	12.1	18	5	100

Source: OECD Creditor Reporting System (CRS) database.

Notes: Data are based on commitments in current US\$.

Notwithstanding the sharp increase of the formally reported untied aid since 2001, it was reported that although the official figure for the share of tied aid is decreasing, two thirds of formally untied aid contracts still go to firms from rich donor countries as developing countries are squeezed out of the equation by powerful transnational companies and complex procurement systems.¹⁰

As shown in the following table, the major beneficiaries from the aid of donor countries that reported fairly high ratio of untied aid were domestic firms of donor countries. For examples, although the share of untied aid of Canada, Denmark, Finland, and Netherlands ranges from 70% to 88%, 100% of total contracts made from the aid by these countries were awarded to domestic firms of donor countries. On average, 60% of total contracts based on DAC member countries' aid were awarded to domestic firms of donor countries, while 82% of total DAC member countries' aid was officially reported as untied aid. These features show that although most DAC member countries provide aid in the type of untied aid formally, the majority of the de facto beneficiary of the aid is the domestic firms of donor countries just as the case of tied aid.

DAC donors: geographical distribution of contracts awarded in 2007.

Donor	Total contracts awarded		Within donor country				Share of Untied aid		Developing countries (excl. LDCs)		LDCs	
	No of contracts	US\$ mn	No of contracts	US\$ mn	As % of total contracts awarded (n)	As % total contracts awarded (value)	Share of untied aid (%)		No of contracts	US\$ mn	No of contracts	US\$ mn
Australia	12	100.5	10	96.3	83.3	95.8	96.7		1	1.4	1	2.8
Austria	–	–	–	–	–	–	82.5		–	–	–	–
Belgium	5	18.2	1	2.8	20.0	15.4	92		2	2.1	2	13.3
Canada	1	16.1	1	16.1	100.0	100.0	70		0	0.0	0	0.0
Denmark	6	6.5	5	6.5	83.3	100.0	88		0	0.0	0	0.0
Finland	3	5.5	3	5.5	100.0	100.0	85		0	0.0	0	0.0
France	66	350.3	16	57.4	24.2	16.4	90		32	134.3	11	38.9
Germany	52	171.8	29	75.9	55.8	44.2	73		4	6.4	16	82.9
Greece	0	0.0	–	–	–	–	56.5		–	–	–	–
Ireland	–	–	–	–	–	–	95		–	–	–	–
Italy	0	0.0	–	–	–	–	83.5		–	–	–	–
Japan	23	–	20	–	87.0	–	77.5		0	–	1	–
Luxembourg	–	–	–	–	–	–	100		–	–	–	–
Netherlands	1	4.0	1	4.0	100.0	100.0	78		0	0.0	0	0.0
New Zealand	7	10.5	6	9.1	85.7	86.7	85		0	0.0	0	0.0
Norway	1	6.0	0	0.0	0.0	0.0	100		1	6.0	0	0.0
Portugal	1	1.4	0	0.0	0.0	0.0	64.2		1	1.4	0	0.0
Spain	0	0.0	–	–	–	–	77.6		–	–	–	–
Sweden	0	0.0	–	–	–	–	86		–	–	–	–
Switzerland	–	–	–	–	–	–	98		–	–	–	–
UK	54	293.7	44	258.4	81.5	88.0	100		4	12.6	2	9.3
USA	95	1917.0	65	1207.4	68.4	63.0	66.8		20	650.2	4	39.2
Total DAC	327	2901.3	201	1739.4	61.5	60.0	82.1		65	814.3	37	186.4

Source: Clay et al. (2010): Untying Aid: Is it working?, p. 17 and p. 12.

The above feature can be interpreted as evidence that since the current system of development aid can be interpreted as a non-cooperative regime of aids without the credible enforcement mechanism for the untied aid, the majority of the aid is provided as de facto tied aid benefiting mainly the firms of donor countries.

Although the current DAC's guideline for untying aid has no credible enforcement mechanism, with the repeated policy coordination forum, DAC member countries are under international pressure for the policy coordination for aid. However, a non-member country of DAC such as China is completely out of the control by DAC, and thus behaves in a completely non-cooperative way. As a result, China would be a classic example of a

⁹ Foreign aid takes various formats such as economic aid, humanitarian aid, military aid, and aid to former colonies. In this model analysis, all different types and formats of aid are categorized into two groups, i.e., tied aid with the aim to benefit donor country's firm and untied aid without any condition to benefit donor's firm. Even the military aid from the US to Israel can be categorized into two groups in that if the military aid provides specific benefits to the US firms, it is categorized as tied aid. If the military aid does not provide specific benefits to donor's firms, it is categorized as untied aid. In general, military aid can be considered as a typical case of tied aid. In the same context, aid to former colonies can be categorized as tied aid if the aid provide exclusive benefits to donor's firm, while it can be categorized as untied aid if donor's firms do not obtain benefits from the aid. In most cases, aid to former colonies is observed to take the form of tied aid in reality.

¹⁰ See Bodo Ellmers (2011) for the details of the empirical evidences for exclusive benefits given to the firms of donor countries. (Ellmers, 2011, How to spend it: Smart procurement for more effective aid, European Network on Debt and Development).

donor country providing aid in a non-cooperative fashion. Literatures including Berthelemy (2011) and Pehnelt (2007) show that China has been quite active in providing aid outside of DAC circle.

Chinese aid (unit: US\$ million).

	Total	Untied aid (debt relief)	Tied aid	Share of untied aid (%)	Share of tied aid (%)
2001	1147	400	747	35%	65%
2002	1227	400	827	33%	67%
2003	1314	400	914	30%	70%
2004	1498	400	1098	27%	73%
2005	1787	400	1387	22%	78%
2006	2172	400	1772	18%	82%
2007	3046	400	2646	13%	87%

Source: Bräutigam (2009).

Notes: Figures in "debt relief" are estimated by the authors based on Bräutigam (2009).

As shown in the above table, the total amount of aid provided by China, that provides aid in a non-cooperative fashion, has been increasing sharply with the increasing share of tied aid. These observations provide a conjecture that when there is no binding condition for the cooperative regime for aid, such as the DAC's recommendation for untied aid with credible enforcement mechanism, tied aid is the dominant strategy as have been shown from the above example of Chinese aid and contacts awarded to firms from donor countries.¹¹ The validity of the conjecture will be examined based on a simple model assuming strategic concerns of donor countries favoring their domestic firms competing with firms of other donor countries in the next section.

3. Basic model

Suppose that firm 1 from a developed country 1 (DC 1) and firm 2 from DC 2 compete in a third country, which can be a least developed country (LDC). Along a linear market of the third country with unit interval $[0, 1]$, firm 1 locates at a while firm 2 locates at $1 - b$ within the unit interval of the market. Each firm produces and sells an identical product. In the model, governments of DC 1 and DC 2 provide foreign aid to the third country, a LDC. This aid might be used either to provide public good with no excludability or to benefit donor country's firms exclusively. The exclusivity of aid is allowed to be continuous to reflect various types of exclusivity of aid. The amount of aid provided by country 1 is g_1 while country 2 provides aid at the amount of g_2 .

Each consumer buys one unit of the product, and obtains the utility equal to v regardless of purchasing it from firm 1 or firm 2 since two

products are homogeneous. The utility function of the consumer living at location $x \in [0, 1]$ is as follows:

$$u_x = \begin{cases} v - p_1 - t(x-a)^2 + g_1 + \beta g_2 & \text{if she buys from firm 1,} \\ v - p_2 - t((1-b)-x)^2 + g_2 + \beta g_1 & \text{if she buys from firm 2,} \end{cases}$$

where p_i represents the market price of product i and t represents a unit transaction cost. β measures the level of exclusivity of the aid provided by the foreign government.^{12,13}

The utility of the consumer living at x is indifferent between buying from firm 1 and firm 2 if the following condition holds:

$$v - p_1 - t(x(p_1, p_2, g_1, g_2, a, b) - a)^2 + g_1 + \beta g_2 = v - p_2 - t((1-b) - x(p_1, p_2, g_1, g_2, a, b))^2 + g_2 + \beta g_1.$$

¹¹ Another example of officially untied aid, nonetheless working as de facto tied aid, is the aid provided by the UK government for the funding of a hydroelectric dam on the Pergau River in Malaysia in 1991. In the UK, the Overseas Development Administration (ODA), was under the supervision of the Foreign Secretary and the Foreign and Commonwealth Office, which led, on at least one occasion, to allegations of a connection between the granting of aid and the achievement of either foreign policy goals or British companies winning export orders. A scandal erupted concerning the UK funding of a hydroelectric dam on the Pergau River in Malaysia, near the Thai border. Building work began in 1991 with money from the UK foreign aid budget. Concurrently, the Malaysian government bought around £1 billion worth of arms from the UK. The suggested linkage of arms deals to aid became the subject of a UK government inquiry from March 1994. In November 1994, after an application for Judicial Review brought by the World Development Movement, the High Court held that the then Foreign Secretary, Douglas Hurd had acted *ultra vires* (outside of his power and therefore illegally) by allocating £234 million toward the funding of the dam, on the grounds that it was not of economic or humanitarian benefit to the Malaysian people. In 1997 the administration of the UK's aid budget was removed from the Foreign Secretary's remit with the establishment of the Department for International Development (DfID) which replaced the ODA. For the details of the case, refer OECD (2006). 2005 Development Co-operation Report. Volume 7, No. 1. Paris: OECD.

¹² When the exclusivity is lowest, foreign aid is equivalent to public goods with the property of non-exclusivity and non-rival goods. If $\beta = 1$, foreign aid provided by the foreign government is a public good with no exclusivity. When $\beta = 0$, foreign aid provided by the foreign government is completely exclusive, and therefore equivalent to exclusive supports for the donor country's firm.

¹³ To examine the welfare effects of tied aid taking consideration of the strategic incentives of donor countries, we focus on the fact that tied aid provides a strategic advantage to the donor country's firm operating in the recipient's market. The strategic advantage caused by the tied aid is assumed to be reflected as the relative increase of the sales of donor country's firm at the expense of the relative decrease of the competing firm. To introduce the relative increase of the demand for donor country's firm as a result of tied aid, we assume that tied aid will provide higher benefit from the donor's aid when the product of donor's firm is consumed as shown in the utility function.

In addition, the reviewer suggested checking out the possible new implications based on a different type of consumer utility function as follows:

$$u_x = \begin{cases} v - p_1 - t(x-a)^2 + \beta g_1 + (1-\beta)g_2 & \text{if she buys from firm 1,} \\ v - p_2 - t((1-b)-x)^2 + \beta g_2 + (1-\beta)g_1 & \text{if she buys from firm 2.} \end{cases}$$

The strong point of the new consumer utility function suggested by an anonymous reviewer is that various different types of effects caused by aid can be examined with the new consumer utility function. For example, in case $\beta = 1/2$, aid provided by each country plays no strategic role providing a public good type support for all firms and consumers. However, if $1/2 < \beta < 1$, a donor's aid provides higher consumer utility when the product of donor country's firm is consumed resulting in the higher demand for the product of donor country's firm.

When $\beta = 1$, a country's aid provide no utility when a product of the competing firm of other country is consumed, only increasing the demand for the product of donor country's firm as a completely exclusive aid.

In the same context, if $1/2 < \beta < 1$, aid from a donor country provides higher consumer utility when the product of competing firm of other country is consumed, resulting in a decreased demand for donor country's firm. This is the opposite case of strategic provision of aid that provide altruistic effect at the expense of donor country's firm. When $\beta = 0$, aid of a donor provides no benefit when the product of the donor country's firm is consumed, an extreme case of altruistic aid providing no benefit to the donor's firm.

The major findings from the analysis with a new utility function suggested by an anonymous reviewer provide the same intuition as the model based on the original type of the utility function. However, since the weight of the additional consumer utility from the aid of country 1 and 2 is changed over the critical value of β , $\beta = 1/2$, the analysis with a new utility function provides more explicit features with differing levels of exclusivity of aid, β . Nonetheless, the original type of utility function is used in the remains of the analysis since the main findings of this paper, that the optimal types of aid is mainly affected by the types of aid regime, i.e., the cooperative regime and non-cooperative regime, can be demonstrated more explicitly with the original type of the utility function. The details of the analysis based on a new utility function are given in the Appendix A.3.

The market demand function for the product of firm 1 is derived from the utility function of the indifferent consumer as follows:

$$x = \frac{p_2 - p_1}{2(1-a-b)t} + \frac{(a+1-b)}{2} + \frac{(1-\beta)(g_1 - g_2)}{2(1-a-b)t}.$$

Firm 1 produces and sells the product to consumers located at $[0, x]$, denoted as d_1 while firm 2 sells to consumers located at $[x, 1]$ denoted as $d_2 (= 1 - d_1)$. d_1 and d_2 are formally defined as follows:

$$d_1(p_1, p_2, g_1, g_2, a, b) = \min\{\max(x(p_1, p_2, g_1, g_2, a, b), 0), 1\}$$

$$d_2(p_1, p_2, g_1, g_2, a, b) = 1 - d_1(p_1, p_2, g_1, g_2, a, b).$$

When the foreign government's aid is partially exclusive with $0 < \beta < 1$, the provision of aid of government i increases firm i 's market demand and decreases firm j 's market demand in the recipient country as follows:

$$\begin{aligned} \frac{\partial d_i(p_i, p_j, g_i, g_j, a, b)}{\partial g_i} &= \frac{(1-\beta)}{2(1-a-b)t} > 0, \quad \frac{\partial d_i(p_i, p_j, g_i, g_j, a, b)}{\partial g_j} \\ &= -\frac{(1-\beta)}{2(1-a-b)t} < 0. \end{aligned}$$

With the market demands depending on the level of aid provided by governments of competing firms, each firm competes in a Bertrand fashion with given marginal production cost c .

$$\pi_1 = (p_1 - c)d_1(p_1, p_2, g_1, g_2, a, b), \quad \pi_2 = (p_2 - c)d_2(p_1, p_2, g_1, g_2, a, b). \quad (1)$$

Consumer surplus of the recipient country is given by¹⁴

$$\begin{aligned} CS &= \int_0^{d_1} (v - p_1 - t(x-a)^2 + g_1 + \beta g_2) dx \\ &\quad + \int_{d_1}^1 (v - p_2 - t((1-b)-x)^2 + g_2 + \beta g_1) dx. \end{aligned} \quad (2)$$

We consider a three-stage game. In the first stage, each government determines the size of aid to be provided to a third country,

simultaneously and independently. In the second stage, after observing the aid provided by both governments, each firm chooses the location in the third market, which is a LDC, simultaneously. In the third stage, after knowing the provision level and the location, each firm simultaneously chooses the profit maximizing price.¹⁵

4. Foreign aid provision game: non-cooperative regime for aid provision

We consider a game in which two advanced countries provide foreign aid to a third country, a LDC. Governments may help its own firm to sell more products to local consumers in the third market by providing foreign aid that can exclusively benefit firms from donor countries, eventually providing strategic advantages to increase the market share and profits. This idea might be closely related to strategic trade policy literature; the government has an incentive to implement various types of trade policies such as export subsidies or import tariffs, in order to shift profits from rival firms to its domestic firms, enhancing national welfare at expense of rival firms of other countries (Brander and Spencer (1985); Lahiri et al. (2002)). In this sense, government's provision of foreign aid might produce the same effect as a strategic trade policy.

Hence, we analyze the effect of foreign aid on firms' location and equilibrium pricing strategy. The equilibrium prices, locations, and the amount of aid are derived from backward induction of three stages game. Working backward, first we determine the optimal corporate pricing strategies in the third stage of the game in which each firm maximizes the profits over its price. The reaction functions from the first-order condition for profit maximization problem are given as:

$$p_1^{BR}(p_2) = \frac{1}{2}(t(1-a-b)(1+a-b) + (1-\beta)(g_1 - g_2) + c + p_2)$$

and

$$p_2^{BR}(p_1) = \frac{1}{2}(t(1-a-b)(1+a-b) + (1-\beta)(g_2 - g_1) + c + p_1)$$

The profit-maximizing prices of firm 1 and firm 2 are determined from the first-order conditions as Nash equilibrium as follows:

$$\begin{aligned} p_1^N &= \frac{1}{3}(t(1-a-b)(3+a-b) + (1-\beta)(g_1 - g_2) + 3c), \\ p_2^N &= \frac{1}{3}(t(1-a-b)(3-a+b) + (1-\beta)(g_2 - g_1) + 3c). \end{aligned} \quad (3)$$

The above equations show the effect of international aid on the Nash equilibrium prices. Country 1's aid g_1 increases firm 1's equilibrium price and decreases firm 2's equilibrium price while government 2's aid lowers firm 1's price and raises firm 2's price. Thus, the equilibrium price set by firm i is positively associated with the provision of the foreign aid by government i but negatively related to the provision by the government j . The intuition behind this result is that government i 's aid provision helps firm i to obtain larger profits by increasing the equilibrium price of firm i through exclusive benefits to the consumers

¹⁴ An anonymous reviewer suggested considering the case that consumers have the option to consume the products of the recipient country's local firm. As suggested by the referee, we added an analysis on the case where a local firm of the recipient country competes with a firm from the donor country in the Appendix part, A. The major findings and implications from this extension introducing a local firm of the recipient country can be summarized as follows: Even when a local firm of the recipient country is introduced as competing with the donor country's firm in the model, the donor country provides more aids to the recipient when the exclusivity of aid is high. When the donor country is more self-interested, the positive effect of aid's exclusivity on donor country firm's profit is further increased. The background for this result is that the strategic benefits given to the donor country's firm by foreign aid is not reduced even if a local firm is introduced to compete with the donor country's firm in the recipient country's market. The reason why the strategic benefits given to the donor country's firm is not reduced with the introduction of a local firm in the recipient country is that the recipient country's government has no strategic variable in this model implying that the social welfare of the recipient country is not considered in this model.

Therefore, when local consumers of the recipient country make consumption decision between two products of local firm and foreign firm, the rational local consumers maximize their consumer surplus paying no attention to the local firm's producer surplus in this one-shot game model. If a strategic variable of recipient country's government is introduced to the model taking consideration of local firm's producer surplus, the recipient country's government might take an action to strategic advantage to her local firm such as production subsidies or consumption subsidies for the local firm's products. This counteraction of the recipient country's government is an interesting topic for future studies while this paper focuses on the impact of policy coordination between multiple donor countries taking consideration of wide range of excludability aid and self-interested motivation of donor countries.

¹⁵ Although tied aid might reduce choices and options for the recipient countries with possible inefficiency in comparison to untied aid, any positive tied aid definitely improves the welfare of the recipient countries in comparison to no aid. In that context, since donors have dominant bargaining power in the aid decision making process in most cases, little evidence can be found for the active reaction of recipient countries against tied aid. In addition, the model in this paper focuses on the issue of policy coordination between donors, and possible strategic interactions between donors and recipients are another topic for future extensions of the researches.

of the donor country's products.¹⁶ Substituting the above prices to the profit functions gives the profits in the equilibrium as follows:

$$\pi_1^N = \frac{((1-a-b)(3+a-b)t + (1-\beta)(g_1-g_2))^2}{18(1-a-b)t}, \quad (4)$$

$$\pi_2^N = \frac{((1-a-b)(3-a+b)t + (1-\beta)(g_2-g_1))^2}{18(1-a-b)t}.$$

Next, we consider the second stage in which the firms choose their location simultaneously and independently. Profit-maximizing location of firm 1 can be found from the first order condition with respect to a as follows:

$$\frac{\partial \pi_1^N}{\partial a} = -\frac{((1-a-b)(1+3a-b)t + (1-\beta)(g_2-g_1))(1-a-b)(3+a-b)t + (1-\beta)(g_1-g_2)}{18(1-a-b)^2t}$$

$$\frac{\partial \pi_2^N}{\partial b} = -\frac{((1-a-b)(1+3a+b)t + (1-\beta)(g_1-g_2))(1-a-b)(3-a+b)t + (1-\beta)(g_2-g_1)}{18(1-a-b)^2t}. \quad (5)$$

Consider the first derivative of each firm's profit function with respect to each firm's location. The derivatives take a negative value when the levels of foreign aid provided by two countries are relatively similar, which is consistent with the result of D'Aspremont et al. (1979). Firm 1 has an incentive to move toward the far end of the left-hand side in the linear market while firm 2 moves toward the far end of the right-hand side along the market, $[0, 1]$, with firm 1 located at 0 while firm 2 located at 1. As in the typical linear city model, it is optimal for firm 1 to locate at 0 when firm 2 locates at 1.¹⁷ Substituting $a^* = 0$ and $b^* = 0$ into π_1^N, π_2^N, d_1 , and d_2 give the profits and the market shares in the equilibrium as follows:

$$\pi_1^N(a^*, b^*) = \frac{(3t + (1-\beta)(g_1-g_2))^2}{18t}, \quad \pi_2^N(a^*, b^*) = \frac{(3t - (1-\beta)(g_1-g_2))^2}{18t} \quad (6)$$

$$d_1(a^*, b^*) = \frac{1}{2} + \frac{(1-\beta)(g_1-g_2)}{6t}, \quad d_2(a^*, b^*) = \frac{1}{2} - \frac{(1-\beta)(g_1-g_2)}{6t}. \quad (7)$$

Finally, the optimal amount of foreign aid by each government is decided by solving the maximization problem of the government objective function, i.e., political weighted social welfare function as defined in the following.

Various types of motivations for providing foreign aid to LDC may boil down to two main reasons: 1) altruistic, ethical and humanitarian motivation, and 2) strategic and economic motivation based on self-interests of donor countries. If the donor country supplies the aid to the recipient country for humanitarian causes, she will assign heavier weight on the consumer surplus of the recipient country in her objective function. If the strategic and economic motivation is dominant for the aid provision, however, the government is more concerned with the

¹⁶ To reflect the concept of the tied aid that provides exclusive benefits to the firms from the donor countries, the utility function assumed that the consumers obtain higher utilities from consuming products of the firm from a donor country. Therefore, the aid provided by the firm j 's government will provide a relatively lower consumer utility from consuming the products of firm i . Consequently, government j 's aid lowers the equilibrium price of firm i .

¹⁷ Firms locate at the median of the unit interval in the linear city model when they compete with identical products with zero transportation or transaction cost and non-exclusive aid. When products are identical with zero transportation cost and non-exclusive aid, market-share effect is dominant to strategic effect to reduce competition inducing both firms to locate at the median of the linear city model.

However, when transportation cost over the linear city model is positive and donor's exclusive aid provides exclusive benefits to donor country's firms, the products are no more identical, but differentiated products. When firms compete over differentiated products in the linear city model, they are located at the far end of each different side of the linear city market since strategic effects dominate market-share effect. Extension of the model integrating the asymmetry of the exclusivity of aid would be an interesting topic for the future researches while this paper focuses on the welfare implication of the exclusivity of aid and the different aid policy regimes.

profits of the domestic firm. Then, the government will pay more attention to the firm's profits with a bigger weight on the domestic firm's producer surplus, α_i , which should be larger than 1 in this case. To consider the political economic factors lying behind foreign aid provision, we consider the political economic objective function as in political economy literature.¹⁸ Thus, $G_i(g_i)$ denotes the government's objective function equal to the consumer surplus in the recipient country h plus the producer surplus in the donor country i minus the aid provision cost as follows:

$$\text{Max } G_i(g_i) = CS_h(g_i) + \alpha_i PS_i(g_i) - kg_i^2/2, \quad i = 1, 2 \quad (8)$$

where α_i denotes the political weight given to domestic producer surplus, and k is the parameter representing cost efficiency of international aid provision.

Accordingly, the optimal provision of the foreign aid is determined from the maximization problem of the government objective function, which is the weighted sum of the recipient country's consumer surplus, donor country's producer surplus, and international aid provision cost. The first-order for this problem is given by¹⁹

$$\frac{\partial G_i(g_i)}{\partial g_i} = \frac{3t(3(1+\beta) + 2(1-\beta)\alpha_i) + (1-\beta)^2(1+2\alpha_i)(g_i-g_j)}{18t}$$

$$-kg_i = 0 \quad \text{where } i \neq j.$$

From the first order condition, the best response function shows how government i reacts to government j 's foreign aid policy: $g_1 = f_1(g_2)$ and $g_2 = f_2(g_1)$. The unique Nash equilibrium aid policy can be derived from solving the two best response functions simultaneously as follows:

$$g_i^* = \frac{3(9kt - (1-\beta)^2)(1+\beta) + 2(1-\beta)(9kt - 2(1-\beta)^2\alpha_i)\alpha_i - 2(\beta^3 - 3\beta + 2)(\alpha_i + \alpha_j)}{6k(9kt - (1-\beta)^2(1+\alpha_i + \alpha_j))}. \quad (9)$$

The equilibrium amount of the foreign aid is obtained as the subgame-perfect equilibrium of the three-stage game. Next, substituting the governments' equilibrium foreign aid into Eqs. (6) and (7) yields the firms' profits and market share in the equilibrium. Then, substituting the government's equilibrium aid and the equilibrium location into Eq. (3) gives the equilibrium price. Finally, substituting government's equilibrium provision of the foreign aid, the equilibrium location, and the equilibrium market share into Eq. (2), we obtain the equilibrium consumer surplus in the recipient country as summarized in Lemma 1.²⁰

¹⁸ Grossman and Helpman (1994) do not make the restriction on the size of the parameter α , which represents the political weight given to domestic producer surplus.

¹⁹ The sufficient condition for the interior solution of the maximization problem is:

$$\partial^2 \pi_i^N(g_i)/\partial g_i^2 = (1-\beta)^2(1+2\alpha_i)/18t - k < 0.$$

²⁰ Products in this model can be identical only when the transportation cost is zero and foreign aid is non-exclusive. If products are identical products, competing firms are located at the same median part of the linear city. However, when the transportation cost is positive and exclusive aid is provided, products supplied are equivalent to differentiated products to consumers in the linear city market with the firms located at the far end of each different side of the linear market. The equilibrium location problem when there are more than 2 countries and products is examined in the circular city model of Salop (1979). When there are multiple firms and products, the main outcome is that if the transportation cost is increasing, the equilibrium number of firms is increased eventually leading to too much entry of competing firms over the socially optimal level. This would be the case where the business-stealing effect or trade diversion effect dominates strategic effects when there are multiple firms and products.

It was assumed that products are substitutes with differences in the level of elasticity of substitution in terms of differentiation. If products are complements, strategic interaction and competition problem in this model is gone, and the firms will be located at the same location to maximize the profits and consumer surplus.

Lemma 1. (a) The governments' equilibrium level of the foreign aid is g_i^* . (b) The equilibrium locations of representative firms are $a^* = 0$, $1 - b^* = 1$. (c) The equilibrium prices, market shares and profits of firm i are respectively:

$$p_i^* = t + c + \frac{(1-\beta)(g_i^* - g_j^*)}{3}, d_i^* = \frac{1}{2} + \frac{(1-\beta)(g_i^* - g_j^*)}{6t}, \text{ and}$$

$$\pi_i^* = \frac{(3t + (1-\beta)(g_i^* - g_j^*))^2}{18t}$$

(d) The equilibrium consumer surplus of the recipient country is:

$$CS = \int_0^{d_i^*} (v - p_1^* - t(x - a^*)^2 + g_1^* + \beta g_2^*) dx$$

$$+ \int_{d_i^*}^1 (v - p_2^* - t((1 - b^*) - x)^2 + g_2^* + \beta g_1^*) dx.$$

From Lemma 1, we observe that a higher level of aid g_i^* increases the donor country firm's price p_i^* and profits π_i^* , while lowering those of competing firm in the foreign country. This strategic effect is strengthened with the higher exclusivity of aid as in the case of tied aid, represented by a lower β . The intuition behind the result is that the firm supported by its own government's tied aid can have strategic advantage with respect to the competing firm. Two firms are located at the opposite end of the linear market as usual in a linear city model.

Part (c) shows that the equilibrium price, market share, and profits of a firm depend on the level of aid and the exclusivity of the aid provided. In fact, a relative size of the aid between the governments is important in determining the equilibrium prices, market shares, and profits of the supported firm by the aid. If country 1 provides a relatively larger aid than government 2, the firm 1 will set a higher price and take a larger market share, eventually making larger profits with the tied aid. The intuition behind the result is that the government helps the domestic firm by providing more exclusive aid that gives more benefit to the consumers of the domestic firm's products. Part (d) of Lemma 1 shows that consumers obtain a higher surplus with the higher level of aid from both governments, and therefore, have no specific preference on aid from a specific country. These results are summarized in Proposition 1.

Proposition 1. The government with a higher strategic motivation provides the higher level of aid than the government with a less strategic motivation when aid is provided in a non-cooperative fashion.

Proof. See Appendix A.1.

As shown in Eq. (9) about the equilibrium provision of aids, g_1^* and g_2^* vary with self-interest parameters, α_1 and α_2 . For $\alpha_1 > \alpha_2$, we obtain: $g_1^* > g_2^*$, $p_1^* > p_2^*$, $d_1^* > d_2^*$, and $\pi_1^* > \pi_2^*$. The government with a higher incentive to support her corporate sector is more likely to provide higher tied aid, not surprisingly, which enables the domestic firm to take a larger market share and to set a higher price, resulting in more profits than its competitor. The larger the level of aid, the higher consumer surplus of the recipient country is.

The basic structure of the game follows Hotelling's location model, except that the self-interested government may choose the level of aid as a strategic tool. To demonstrate our main argument in a more explicit way, for the rest of the analysis, it is assumed that both governments have the symmetric self-interests in providing aid, that is, $\alpha_1 = \alpha_2 = \alpha$.

Given the symmetric level of self-interest, the equilibrium level of aid, (Eq. (9)), is simplified as follows:

$$g_i^* = \frac{3(1+\beta) + 2\alpha(1-\beta)}{6k} \quad (10)$$

Corollary 1. Given symmetric strategic motivation for aid between donor countries, a higher strategic motivation for international aid drives the donor governments to provide more aid under non-cooperative aid provision game.

Proof. For any $\alpha_i = \alpha_j$, the equilibrium amount of aid is increased with the strategic motivation of aid provision as follows: $\partial g_i^* / \partial \alpha = \frac{1-\beta}{3k} > 0$. Q.E.D.

The equilibrium aid is positively correlated with self-interest of the donors who cares more about the domestic firm's profits.

Proposition 2. When the exclusivity of the aid is increased, self-interested government provides a higher level of aid than humanitarian government does under the non-cooperative aid provision regime.

Proof. The proof is straightforward: $\partial g_i^* / \partial \beta = (3 - 2\alpha)/6k$. If $\alpha > (<) 1.5$, then $\partial g_i^* / \partial \beta < (>) 0$. Q.E.D.

Proposition 2 is derived from differentiating the equilibrium provision of aid with respect to β . The higher the exclusivity of aid is as tied aid and the more self-interested the donor government is, with $\alpha > 1.5$, the higher the equilibrium provision of aid is under the non-cooperative aid provision regime. On the contrary, when the donor country is motivated by humanitarian concerns with $\alpha < 1.5$, the lower the exclusivity of aid is as untied aids, the higher is the equilibrium provision of aid. The intuition behind this result is that the strategically and economically motivated government is more concerned with the domestic firm's profit than the humanitarian government. Through aid, the strategically motivated government provides the domestic firm a higher chance of being well positioned to win the competition in the recipient country of the aid. Since self-interested country is more concerned with an increase in the domestic firm's profits over the recipient's consumer surplus, it has an incentive to provide more aids when the domestic firms benefit more from the aid provided to the recipient countries with the higher exclusivity of the aid.

When the decision on the aid provision is made in a non-cooperative fashion, the equilibrium amount of aid provision is increased with the higher exclusivity of aid via tied aid when donor countries are motivated by egoistic economic concerns, while the opposite outcome is observed when the donor country is motivated by humanitarian concerns, that emphasize consumer surplus of the aid recipient country.

When we assume all donor countries are symmetric in terms of the level of self-interested motivation in aid provision, with the symmetric α , Lemma 1 is reduced to the simplified version in Lemma 2.

Lemma 2. If $\alpha_1 = \alpha_2 = \alpha$, (a) The governments' equilibrium level of aid are $g_1^* = g_2^* = \frac{1+\beta}{2k} + \frac{\alpha(1-\beta)}{3k}$. (b) The equilibrium locations are $a^* = 0$, $1 - b^* = 1$. (c) The equilibrium prices and profits for firms are $p_i^* = t + c$, $d_i^* = 1/2$, and $\pi_i^* = t/2$ respectively. (d) The consumer surplus in the least developed country is $CS = v - c - \frac{13t}{12} + (1+\beta)g_i^*$ in the equilibrium.

Given the symmetric level of self-interested motivations to provide ODAs, i.e., $\alpha_1 = \alpha_2$, we obtain: $g_1^* = g_2^*$, $p_1^* = p_2^*$, $d_1^* = d_2^*$, and $\pi_1^* = \pi_2^*$. Lemma 2 shows the same type of equilibriums in the location-price model of D'Aspremont et al. (1979) where $a^* = 0$, $1 - b^* = 1$, $p_i^* = t + c$, $d_i^* = 1/2$, and $\pi_i^* = t/2$ and $CS = v - c - 13t/12$. When both governments have the same approaches in providing aid with the symmetric level of aid, $g_1^* = g_2^*$, all features caused by the strategic aspects of aid are removed. Lemma 2 shows that the total amount of aid provided reaches:

$$g_{total}^* = g_1^* + g_2^* = \frac{1+\beta}{k} + \frac{2\alpha(1-\beta)}{3k} = \frac{3+2\alpha-\beta(2\alpha-3)}{3k}$$

Therefore, the total amount of aid is increased with the higher exclusivity of aid, i.e., the lower β when the donor countries are motivated by the self-interested economic concerns with $\alpha > \alpha^* = 3/2$.

The impact of the exclusivity of aid on the recipient country's welfare is summarized in [Proposition 3](#).

Proposition 3. *The higher exclusivity of aid improves the social welfare of the aid recipient country since the exclusivity of aid increases the incentives of self-interested donor countries to provide more aids under non-cooperative regime of aid provision.*

Proof. See [Appendix A.2](#).

The comparative statics of the recipient country's welfare with respect to β shows that if the government is motivated by self-interested economic concerns ($\alpha > \alpha^*$), the higher exclusivity of aid represented by the lower β provides higher social welfare, while the less exclusivity of aid represented by the higher β lowers the recipient country's social welfare. Under the non-cooperative regime of aid provision, when donor countries are motivated by self-interests, the higher exclusivity of aid increases the amount of aid provided by the donor countries as shown in [Lemma 2](#), and eventually improves the recipient country's social welfare.

5. Foreign aid provision game: cooperative regime for aid provision

Now, we examine the cooperative aid provision regime where aid is provided in a coordinated fashion as recommended by OECD's DAC (Development Assistance Committee) to maximize the joint welfare of donor countries and recipient countries. The joint welfare maximization problem as governments' objective function is defined as follows in a similar fashion as [d'Aspremont and Jacquemin \(1988\)](#):

$$\text{Max } G_c(g_i, g_j) = CS_h(g_i, g_j) + \alpha_i PS_i(g_i) + \alpha_j PS_j(g_j) - k(g_i^2 + g_j^2)/2 \quad \text{where } \alpha_i = \alpha_j = \alpha.$$

In the cooperative regime, the optimal provision level of aid is derived from joint welfare maximization problem of two donor countries. Considering the symmetric solution, $g_i = g_j = g_c$, we derive the optimal provision level of aid from the maximization problem of the joint welfare of the two donor countries. From the first-order condition of the maximization problem, the optimal level of aid is given as follows:

$$g_c^* = \frac{1 + \beta}{2k}.$$

It is shown that the optimal level of aid is decided by the level of exclusivity, not affected by the level of self-interested motivation of aid. In a cooperative regime of aid provision, the strategic interaction between donor countries reflecting the self-interested motivations of donor countries are removed. Therefore, the level of self-interest plays no role in determining the equilibrium level of donation as summarized in [Lemma 3](#).

Lemma 3. *In a cooperative regime, the donors' self-interest has no effect on the equilibrium level of aid since strategic interactions between donor countries based on self-interested motivation for aid are removed from the game.*

Given that the exclusivity of aid is the only factor that influences the equilibrium level of aid, it is shown that in a cooperative aid regime, the lower exclusivity of aid increases the equilibrium level of aid provided.

Proposition 4. *In a cooperative aid regime, when the exclusivity of the aid is lowered as in the case of untied aids, the level of equilibrium aid is increased.*

Proof. The fact that a lower exclusivity of aid with higher property of public goods increases the equilibrium amount of aid under a

cooperative regime of aid is proved in a straightforward way as follows: $\partial g_c^* / \partial \beta = 1/2k > 0$. Q.E.D.

[Proposition 4](#) shows that when aid are provided in a coordinated way, if the exclusivity of aid is lower as in the case of untied aids, the higher is the level of the equilibrium aid. In other words, when aid has the property of public goods with non-excludability, each country provides higher aid in a cooperative regime of aid provision. The intuition lying behind this result is that when aid is provided in a cooperative fashion, the incentives to free ride the other country's aid provision are removed. Therefore, when the strategic incentives to take advantage of her own aid at the expense of the other country are gone, each country has a higher incentive to provide aid if the aid benefits all donor countries with no discrimination in addition to the recipient country under the cooperative regime of aid provision. The equilibrium under the cooperative regime of aid provision is defined in [Lemma 4](#).

Lemma 4. (a) *The governments' equilibrium level of the development aids is g_c^* .* (b) *The equilibrium locations are $a^{**} = 0$, $1 - b^{**} = 1$.* (c) *The equilibrium price, market share and profits of firm i are respectively: $p_i^{**} = t + c$, d_i^{**} , and $\pi_i^{**} = t/2$.* (d) *The equilibrium consumer surplus of the aid recipient country is $CS = v - c - \frac{13t}{12} + (1 + \beta)g_c^*$.*

[Lemma 4](#) shows that the equilibrium level of aid under cooperative regime is lower than that of non-cooperative regime since strategic incentives to provide more aid to benefit domestic firm at the expense of the foreign are removed in the cooperative game.²¹ In addition, the equilibrium location strategy and the market share of each representative firm are the same as the case of non-cooperative aid regime since the total market size is assumed to be limited to the size of linear city with symmetric firms competing in the linear city. Moreover, under a cooperative regime of aid provision, it is shown that the total amount of aid increases when the exclusivity of aid is lowered with higher property of public goods of non-excludability as follows: $\frac{\partial g_i^* + g_j^*}{\partial \beta} =$

$$\frac{\partial g_i^*}{\partial \beta} + \frac{\partial g_j^*}{\partial \beta} = \frac{1}{k} > 0.$$

Under the cooperative regime of aid provision, the equilibrium level of aid is increased when the exclusivity of aid is lowered with higher property of public goods. When donor countries make decisions on aid to maximize joint welfare, the strategic incentives to provide exclusive benefits to the domestic firm at the expense of the foreign competing firm is not considered. Therefore, as the complementarity of each country's aid is increased with lower excludability of aid, the equilibrium amount of aid is increased. Consequently, the social welfare of the aid recipient country is improved with the lower excludability of aid with donor countries' higher incentives to provide non-exclusive aid, as summarized in [Proposition 5](#).

Proposition 5. *Under the cooperative regime of aid provision, the social welfare of the aid recipient country is maximized with the minimum exclusivity of aid via untied aid that increases the incentives of donor countries to provide more aid in a complementary fashion.*

²¹ Analytically, the difference between the equilibrium amount of aid under the non-cooperative aid regime and the cooperative regime is given as follows:

$$g_{NC}^* - 2g_c^* = \frac{2\alpha(1-\beta)}{3k} \geq 0$$

Therefore, as long as aid is partially exclusive, i.e., $\beta < 1$, the equilibrium amount of aid under non-cooperative aid is dominant to that under cooperative regime. However, as shown in the above result, the equilibrium amount of aid in both regime can be equivalent when $\beta = 1$ or $\alpha = 0$. This implies that the equilibrium amount of aid under the non-cooperative aid regime is always higher than that under cooperative regime unless the aid is equivalent to the public good, i.e., $\beta = 1$ or the donor country is absolutely altruistic country only caring recipient country's welfare disregarding domestic firm's welfare, i.e., $\alpha = 0$.

The social welfare of the recipient country is composed of the consumer surplus of the recipient country mainly affected by donor countries' aid provision. Under the cooperative regime of aid provision, as in the case where donor countries are coordinated under the governance of DAC (Development Assistance Committee) of OECD, the social welfare of the recipient country is monotonically increased with a lower exclusivity of aid such as untied aid.

6. Concluding remarks

Motivated by the conflicting arguments about the exclusive foreign aid under the type of tied aid while untied foreign aid is strongly recommended by OECD Development Aid Committee (DAC), this paper examined the equilibrium aid strategies considering strategic and self-interested economic motivation lying behind foreign aid provision. Based on a linear city model where representative firms from donor countries compete a la Bertrand fashion, we demonstrate that the firms' profits are directly increased with their governments' aid when aid is provided in an exclusive way as tied or partially tied aids.

Moreover, when aid is provided in a non-cooperative fashion, if the strategic and self-interested economic motivation for aid is higher, the equilibrium amount of aid gets higher. When the exclusivity of aid is higher, taking the form of tied aids, the level of aid provided is increased.

Appendix A

A.1. Proof of Proposition 1

The argument that the equilibrium amount of international aid is increased with the higher strategic motivation is proved by showing that $\frac{\partial g_i^*}{\partial \alpha_i} > 0$ via the implicit function theorem as follows:

$$\frac{\partial G_i(g_i)}{\partial g_i} = H(g_i, \alpha_i) = \frac{3t(3(1+\beta) + 2(1-\beta)\alpha_i) + (1-\beta)^2(1+2\alpha_i)(g_i - g_j)}{18t} - kg_i = 0$$

$$\frac{\partial g_i}{\partial \alpha_i} = -\frac{\partial H(g_i, \alpha_i)/\partial \alpha_i}{\partial H(g_i, \alpha_i)/\partial g_i} = -\frac{\frac{2(1-\beta)(3t + (1-\beta)(g_i - g_j))}{18t}}{\frac{(1-\beta)^2(1+2\alpha_i)}{18t} - k} \geq 0.$$

Since $d_1(a^*, b^*) = \frac{1}{2} + \frac{(1-\beta)(g_1 - g_2)}{6t} = \frac{1}{6t}(3t + (1-\beta)(g_1 - g_2)) \geq 0$ in Eq. (6) and the second-order condition for an interior solution is given by $\frac{\partial^2 \pi_i^N(g_i)}{\partial g_i^2} = \frac{(1-\beta)^2(1+2\alpha_i)}{18t} - k < 0$, it is straightforward that $\frac{\partial g_i^*}{\partial \alpha_i} > 0$. Q.E.D.

A.2. Proof of Proposition 3

The social welfare function of the aid recipient country is given as:

$$SW_r(g_i) = CS_r(g_i) = v - c - 13t/12 + (1+\beta)g_i(\beta).$$

Substituting the equilibrium aid into the social welfare function yields the welfare level in the equilibrium and differentiating it with respect to β gives:

$$\frac{\partial SW_r(g_i^*, g_j^*)}{\partial \beta} = \frac{6 + 2\beta(3-2\alpha)}{3k} < 0 \quad \text{if} \quad \alpha > \alpha^{**} = \frac{3(\beta+2)}{2\beta}$$

The above result proves that the higher exclusivity of international aid improves social welfare of the recipient country when donor countries are driven by self-interested motivation. Q.E.D.

Therefore, when international coordination mechanism for aid does not work effectively, the welfare of the recipient country is increased with a higher level of aid when aid are provided as tied aids with higher exclusivity.

However, if aid is provided in a cooperative fashion, the equilibrium level of aid is increased with a lower exclusivity of aid, i.e., untied aids. Therefore, when the international coordination mechanism for cooperative aid works effectively, untied aid with lower exclusivity improves social welfare of both recipient country and donor countries. These results implicate that policy recommendation of OECD DAC for untied aid can be rationalized only when the international coordination mechanism for cooperative aid works effectively.

The findings of this paper are based on an assumption of the government objective function as a linear combination of humanitarian motivation and strategic and self-interested economic motivation for aid. The extension of the government objective function to general functional form might provide more generalized perspectives on the equilibrium aid regime. In addition, the issue of how to interpret the current system of OECD DAC as an effective cooperative regime for aid or a nominally cooperative regime with no enforcement mechanism is the topic to be studied further. The equivalence between the tied-ness of aid and the exclusivity should be examined further in the continuing studies, as well.

A.3. An extension with a new utility function

An anonymous reviewer suggested checking out the possible new implications based on a different type of consumer utility function as follows:

$$u_x = \begin{cases} v - p_1 - t(x-a)^2 + \beta g_1 + (1-\beta)g_2 & \text{if she buys from firm 1,} \\ v - p_2 - t((1-b)-x)^2 + \beta g_2 + (1-\beta)g_1 & \text{if she buys from firm 2.} \end{cases}$$

The strong point of the new consumer utility function suggested by an anonymous reviewer is that various different types of effects caused by aid can be examined with the new consumer utility function. For example, in case $\beta = 1/2$, aid provided by each country plays no strategic role in providing a public good type support for all firms and consumers. However, if $1/2 < \beta < 1$, a donor's aid provides higher consumer utility when the product of donor country's firm is consumed resulting in the higher demand for the product of donor country's firm. When $\beta = 1$, a country's aid provides no utility when a product of the competing firm of other country is consumed, only increasing the demand for the product of donor country's firm as a completely exclusive aid.

In the same context, if $0 < \beta < 1/2$, aid from a donor country provides higher consumer utility when the product of competing firm of other country is consumed, resulting in a decreased demand for donor country's firm. This is the opposite case of strategic provision of aid that provides altruistic effect at the expense of donor country's firm. When $\beta = 0$, aid of a donor provides no benefit when the product of the donor country's firm is consumed, an extreme case of altruistic aid providing no benefit to the donor's firm.

Based on the new consumer utility function defined above, the location of the consumer who obtains the same level of utility from consuming two products is defined as:

$$x = \frac{p_2 - p_1}{2(1-a-b)t} + \frac{(a+1-b)}{2} - \frac{(1-2\beta)(g_1-g_2)}{2(1-a-b)t}.$$

From the definition of critical consumer, x , the impact of aid by each country on the amount of demand for the donor's firm is determined as follows:

$$\frac{\partial d_i(p_i, p_j, g_i, g_j, a, b)}{\partial g_i} = \begin{cases} \frac{(2\beta-1)}{2(1-a-b)t} < 0 & \text{if } 0 < \beta < 1/2 \\ \frac{(2\beta-1)}{2(1-a-b)t} > 0 & \text{if } 1/2 < \beta < 1 \end{cases},$$

With the new consumer utility function, it is shown explicitly that when a donor's aid is altruistic with $0 < \beta < 1/2$, the amount of demand for the product of donor country's firm will be decreased, and vice versa if donor's aid is exclusive with $1/2 < \beta < 1$.

Consequently, the profits of two competing firms are obtained as follows with the new utility function:

$$\pi_1^N = \frac{((1-a-b)(3+a-b)t - (1-2\beta)(g_1-g_2))^2}{18(1-a-b)t}, \quad \pi_2^N = \frac{((1-a-b)(3-a+b)t - (1-2\beta)(g_2-g_1))^2}{18(1-a-b)t}.$$

Location in the far opposite part of linear city market is obtained as the optimal strategies even with the new utility function, $a^* = 0$ and $b^* = 0$. Substituting these optimal location strategies, we end up with the following equilibrium profits and demands for each firms:

$$\pi_1^N(a^*, b^*) = \frac{(3t + (2\beta-1)(g_1-g_2))^2}{18t}, \quad \pi_2^N(a^*, b^*) = \frac{(3t + (2\beta-1)(g_2-g_1))^2}{18t}$$

$$d_1(a^*, b^*) = \frac{1}{2} + \frac{(2\beta-1)(g_1-g_2)}{6t}, \quad d_2(a^*, b^*) = \frac{1}{2} + \frac{(2\beta-1)(g_2-g_1)}{6t}.$$

These equilibrium values show that when the aid is exclusive, $1/2 < \beta < 1$, if the a donor country's aid is larger than the other country, the profits of the donor country's firm is increased due to the strategic effects.

The optimal level of aid is derived from the following social welfare maximization problem: $\text{Max } G_i(g_i) = CS_h(g_i) + \alpha_i PS_i(g_i) - kg_i^2/2, i = 1, 2$

The unique Nash equilibrium aid policy is derived from solving the two best response functions simultaneously as follows:

$$g_i^* = \frac{3(9kt - (1-2\beta)^2) - 2\alpha_i(1-2\beta)(9kt - \beta^2 - 2\beta^2 - 2(1-2\beta)^2\alpha_j + 1) - \alpha_j(8\beta^3 - 6\beta + 2)}{6k(9kt - (1-2\beta)^2(1 + \alpha_i + \alpha_j))}.$$

If we assume that both governments have the symmetric self-interests in providing aid, $\alpha_i = \alpha_j = \alpha$, for simplicity without loss of generality, we obtain a simplified equilibrium level of aid as follows: $g_i^* = \frac{3+2(2\beta-1)\alpha}{6k}$.

Proposition A.1. Given symmetric strategic motivation for aid between donor countries, a higher strategic motivation for international aid drives the donor governments to provide more (less) aid when $1/2 < \beta < 1$ ($0 < \beta < 1/2$).

Proof. For any $\alpha_i = \alpha_j$, the equilibrium amount of aid is increased with the strategic motivation of aid provision as follows: $\partial g_i^* / \partial \alpha = \frac{2\beta-1}{3k} > 0$ if $1/2 < \beta < 1$. Q.E.D.

Proposition shows that the effect of the political weight given to the producer surplus, α , on the optimal amount of the aid depends on the exclusivity of the aid represented by β . If the donor's aid has strong enough exclusivity, i.e., $1/2 < \beta < 1$, the amount of aid will be increased with a higher strategic motivation of aid, α .

The marginal effect of the strategic motivation on aid provision is positive and is maximized at the highest level of the exclusivity, that is $\beta = 1$. The intuition behind this result is that the strategic donor has a higher incentive to provide aid when the exclusivity of the aid is higher. However, when $\beta = 1/2$, the aid of a donor is equivalent to a public good providing equal benefits to consumers of all products with no exclusivity. If $0 < \beta < 1/2$, the aid of a donor is altruistic providing larger benefits to consumers of competing firm's products at the disadvantage of the donor country's firm. Therefore, strategic and self-interested donor has an incentive to reduce the aid when $0 < \beta < 1/2$.

Finally, the impact of the exclusivity of the aid on the equilibrium amount of aid is demonstrated in the following proposition.

Proposition A.2. *As the exclusivity of the aid is increased, the equilibrium amount of aid is always increased.*

Proof. The proof is straightforward: $\partial g_i^*/\partial \beta = 2\alpha/3k > 0$. Q.E.D.

When the exclusivity of aid is increased, the equilibrium amount of aid is always increased unless the donor does not care surplus of the donor country's firm at all. As long as a donor assigns a positive weight on the donor's domestic firm's surplus, the donor has a higher incentive to provide larger aid with higher exclusivity.

All these findings outline that the major outcomes from the new type of utility function suggested by an anonymous reviewer²² provides the same intuition as the model based on the original type of the utility function. However, since the weight of the additional consumer utility from the aid of country 1 and 2 is changed over the critical value of β , $\beta = 1/2$, the analysis with a new utility function provides more explicit features with differing levels of exclusivity of aid, β . Nonetheless, the original type of utility function is used in the remains of the analysis since the main findings of this paper, that the optimal types of aid is mainly affected by the types of aid regime, i.e., the cooperative regime and non-cooperative regime, can be demonstrated more explicitly with the original type of the utility function.

Appendix A.4. An extension with a local firm of the recipient country

Suppose that a foreign firm (firm 1) from a donor country and a local firm (firm 2) from a recipient country compete in the recipient country. Each firm produces and sells identical products but with different production costs. In the model, the donor's government provides a foreign aid to the recipient country. The amount of aid provided by country 1 is g_1 .

Each consumer buys one unit of the product, and obtains the utility equal to v regardless of purchasing it from firm 1 or firm 2 since two products are homogeneous. The utility function of the consumer living at location $x \in [0, 1]$ is as follows:

$$u_x = \begin{cases} v - p_1 - t(x-a)^2 + g_1 & \text{if she buys from firm 1 of the donor country,} \\ v - p_2 - t((1-b)-x)^2 + \beta g_1 & \text{if she buys from firm 2, a local firm of the recipient country} \end{cases}$$

where p_i represents the market price of product i and t represents a unit transaction cost. β measures the level of exclusivity of the aid provided by the foreign government.

The utility of the consumer living at x is indifferent between buying from firm 1 and firm 2 if the following condition holds:

$$v - p_1 - t(x(p_1, p_2, g_1, a, b) - a)^2 + g_1 = v - p_2 - t((1-b) - x(p_1, p_2, g_1, a, b))^2 + \beta g_1.$$

The market demand function for the product of firm 1 is derived from the utility function of the indifferent consumer as follows:

$$x = \frac{p_2 - p_1}{2(1-a-b)t} + \frac{(a+1-b)}{2} + \frac{(1-\beta)g_1}{2(1-a-b)t}.$$

Firm 1 produces and sells the product to consumers located at $[0, x]$, denoted as d_1 while the local firm, i.e., firm 2, sells to consumers located at $[x, 1]$ denoted as $d_2 (= 1 - d_1)$. d_1 and d_2 are formally defined as follows:

$$d_1(p_1, p_2, g_1, a, b) = \min\{\max(x(p_1, p_2, g_1, a, b), 0), 1\}$$

$$d_2(p_1, p_2, g_1, a, b) = 1 - d_1(p_1, p_2, g_1, a, b).$$

The foreign firm from the donor country is more efficient than the local with a lower marginal production cost by Δ . Each firm competes a la Bertrand fashion with given marginal production cost c .

$$\pi_1 = (p_1 - c)d_1(p_1, p_2, g_1, g_2, a, b), \pi_2 = (p_2 - c - \Delta)d_2(p_1, p_2, g_1, g_2, a, b). \quad (A1)$$

We consider the three-stage game. In the first stage, a donor government determines the size of aid to be provided to a recipient country. In the second stage, after observing the aid provided by the government, a foreign firm and a local firm chooses the location in the market of the recipient country, simultaneously. In the third stage, after observing the provision level of aid and the location, two firms simultaneously choose the profit maximizing price.

²² $u_x = \begin{cases} v - p_1 - t(x-a)^2 + \beta g_1 + (1-\beta)g_2 & \text{if she buys from firm 1,} \\ v - p_2 - t((1-b)-x)^2 + \beta g_2 + (1-\beta)g_1 & \text{if she buys from firm 2.} \end{cases}$

First, we analyze the effect of foreign aid on firms' location and equilibrium pricing strategy. The profit-maximizing prices of firm 1 and firm 2 are determined from the first-order conditions as Nash equilibrium as follows:

$$\begin{aligned} p_1^N &= \frac{1}{3}(t(1-a-b)(3+a-b) + (1-\beta)g_1 + 3c + \Delta), \\ p_2^N &= \frac{1}{3}(t(1-a-b)(3-a+b) - (1-\beta)g_1 + 3c + 2\Delta). \end{aligned} \quad (\text{A2})$$

The above equations show the effect of a foreign aid on the Nash equilibrium prices. The donor's aid g_1 increases firm 1's equilibrium price while it decreases firm 2's equilibrium price. The aid's marginal effect on the equilibrium price is decreased with its level of excludability. The intuition behind this result is that the provision of a foreign aid helps the foreign firm to obtain larger profits through exclusive benefits to the consumers of the donor country's products. Substituting the above prices to the profit functions gives the profits in the equilibrium as follows:

$$\pi_1^N = \frac{((1-a-b)(3+a-b)t + (1-\beta)g_1 + \Delta)^2}{18(1-a-b)t}, \quad \pi_2^N = \frac{((1-a-b)(3-a+b)t - (1-\beta)g_1 - \Delta)^2}{18(1-a-b)t}. \quad (\text{A3})$$

Next, we consider the second stage in which the firms choose their location simultaneously and independently. Profit-maximizing location can be obtained from taking the first derivatives as $\partial\pi_1^N/\partial a$ and $\partial\pi_2^N/\partial b$. The two derivatives have negative signs implying that firm 1 has an incentive to move toward the far end of the left-hand side in the linear market while firm 2 moves toward the far end of the right-hand side along the market, $[0, 1]$, with firm 1 located at 0 while firm 2 located at 1. Substituting $a^* = 0$ and $b^* = 0$ into π_1^N , π_2^N , d_1 , and d_2 gives the profits and the market shares in the equilibrium as follows:

$$\pi_1^N(a^*, b^*) = \frac{(3t + (1-\beta)g_1 + \Delta)^2}{18t}, \quad \pi_2^N(a^*, b^*) = \frac{(3t - (1-\beta)g_1 - \Delta)^2}{18t} \quad (\text{A4})$$

$$d_1(a^*, b^*) = \frac{1}{2} + \frac{(1-\beta)g_1}{6t} + \frac{\Delta}{6t}, \quad d_2(a^*, b^*) = \frac{1}{2} - \frac{(1-\beta)g_1}{6t} - \frac{\Delta}{6t}. \quad (\text{A5})$$

Finally, the optimal amount of foreign aid is decided by solving the maximization problem of the donor government objective function, i.e., politically weighted social welfare function as defined in the follows. $G_1(g_1)$ denotes the donor government's objective function equal to the consumer surplus of the recipient country plus the producer surplus of the donor country minus the aid provision cost as follows:

$$\text{Max } G_1(g_1) = CS_2(g_1) + \alpha PS_1(g_1) - kg_1^2/2, \quad (\text{A6})$$

The optimal aid policy can be derived from solving the first order condition as follows:

$$g_1^* = \frac{t(9(1+\beta) + 6\alpha(1-\beta)) + (1-\beta)(1+2\alpha)\Delta}{18kt - (1-\beta)^2(1+2\alpha)}. \quad (\text{A7})$$

The equilibrium when a local firm of the recipient country competes with a firm from the donor country is defined as follows.

Lemma A.1. (a) The equilibrium level of the foreign aid is given as g_1^* . (b) The equilibrium locations of representative firms are $a^* = 0$, $1 - b^* = 1$. (c) The market shares and profits of foreign firm are respectively:

$$d_1^*(g_1^*) = \frac{1}{2} + \frac{(1-\beta)g_1^*}{6t} + \frac{\Delta}{6t} \text{ and } \pi_1^*(g_1^*) = \frac{(3t + (1-\beta)g_1^* + \Delta)^2}{18t}$$

Lemma A.1 shows that the market share and profits of the foreign firm increase with the aid provided by the foreign country.

Proposition A.3. The equilibrium amount of aid is increased with a higher exclusivity of aid and a larger technology difference between the donor and recipient.

Proof. The proof is straightforward:

$$\partial g_1^* / \partial \beta = - \frac{\partial H / \partial \beta}{\partial H / \partial g_1^*} = - \frac{t(6\alpha - 9) + \Delta + 2\alpha\Delta + 2(1+2\alpha)(1-\beta)g_1^*}{18kt - (1-\beta)^2(1+2\alpha)} < 0$$

where H is the first order condition for the welfare maximization problem for the donor.

In addition, the bigger technology gap increases the equilibrium amount of aid as follows: $\frac{\partial g_1^*}{\partial \Delta} = \frac{(1-\beta)(1+2\alpha)}{18kt - (1-\beta)^2(1+2\alpha)} > 0$. Q.E.D.

Proposition A.3 is proved with the implicit function theorem. The donor country provides more aids to the recipient when the exclusivity of aid is high with lower β . When the donor country is more self-interested with a higher α , the positive effect of aid's exclusivity on donor country firm's profit is further increased. The background for this result is that the strategic benefits given to the donor country's firm by foreign aid is not reduced even if a local firm is introduced to compete with the donor country's firm in the recipient country's market. The reason why the strategic benefits given to the donor country's firm is not reduced with the introduction of a local firm in the recipient country is that the recipient country's government has no strategic variable in this model implying that the social welfare of the recipient country is not considered in this model.

Therefore, when local consumers of the recipient country make consumption decision between two products of local firm and foreign firm, the rational local consumers maximize their consumer surplus paying no attention to the local firm's producer surplus in this one-shot game model. If a strategic variable of recipient country's government is introduced to the model taking consideration of local firm's producer surplus, the recipient country's government might take an action to strategic advantage to her local firm such as production subsidies or consumption subsidies for the local firm's products. This counteraction of the recipient country's government is an interesting topic for future studies while this paper focuses on the impact of policy coordination between multiple donor countries taking consideration of wide range of excludability aid and self-interested motivation of donor countries.

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