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Whether to Choose Tariffs or Subsidies to Protect a Domestic Industry

Dominik Egli
Universität Bern

Frank Westermann
UCLA and CESifo

Abstract

The use of tariffs in the absence of subsidies in small countries is an empirical observation which stands in sharp contrast to the theoretical literature of trade policy. We analyze the welfare effects of tariffs and subsidies in a homogeneous good duopoly game with cost asymmetries between the two firms, allowing for distortionary taxation. We find that for reasonable values of the distortion parameter or for a large cost disadvantage of the home firm, a tariff is the optimal policy tool.

- **JEL Classifications:** F12, F13, O20
- **Key words :** Strategic trade, Economies in transition, Cost asymmetries, Distortionary taxation

I. Introduction

From Bhagwati's seminal papers on optimal trade policy, we know that the use of tariffs is inferior to subsidization. Therefore, the empirical observation of tariffs stands in sharp contrast to the theoretical literature. Attempts to explain this phenomenon have recently sparked a lively discussion in the literature on the political economy of trade, started by Rodrik (1986) and summarized in Rodrik

*Corresponding address: Professor Frank Westermann, Bunche Hall 9357, Department of Economics, UCLA, Los Angeles, CA 90095-1477 USA E-mail: westermann@econ.ucla.edu

(1995). This literature explains the use of tariffs by lobby groups or utility-maximizing policymakers.

In this paper, we investigate the question whether to choose tariffs or subsidies in a model of strategic trade. The general idea of the literature on strategic trade is that trade policy can be used to influence the strategic game of oligopolistic firms thereby allowing the government to shift profits to the home firm (see Brander and Spencer (1981 and 1985). A common feature in this literature is the method with which the results are derived. Using comparative statics it is shown that welfare can be increased by imposing a nonzero amount of the policy tool in consideration. The sign of the expression for the optimal policy determines the use of production subsidies or taxes, import tariffs or import subsidies. This procedure restricts the analysis to comparing trade policy instruments, which enter the reaction function of a firm (home or foreign) with opposite signs - policy tools which are identical, except for a minus sign.

However, a production subsidy enters the home firms reaction function, while an import tariff enters the one of the foreign firm. A comparison of these two policy instruments is thus not feasible by simply determining the sign of an expression in order to determine whether a positive or negative amount of the policy tool improves welfare. The distinguishing characteristic of our paper is that we compute explicit results for the welfare levels, given an optimal use of each policy instrument. This way we are able to rank the two policy instruments according to the achieved welfare levels.

Following Dixit (1983), Cheng (1988) and Eaton and Grossman (1986), we model a situation in which a domestic monopoly faces competition from a foreign firm. We analyze a two-stage game, where the government sets an optimal trade policy in the first stage and the firms engage in competition in the second stage. Both firms sell their homogeneous commodity in the home market.

We assume a specific quadratic utility function of the representative agent and specific linear cost functions of the firms. Welfare is given as the sum of the profits of the home firm, consumer surplus, and government revenue. In case of a subsidy, the government has to impose taxes in order to finance its trade policy. Following Neary (1994), we allow for distortionary taxation. This captures the possibility that public funds are not in perfectly elastic supply. The relevance of this possibility was first pointed out by Brander and Spencer (1988) and was empirically documented by Browning (1987) and Carmichael (1991).

Throughout the paper, we concentrate on the case of a cost differential in favor of the foreign firm. The cost differential is defined as the di.erence of marginal costs of the foreign and the home firm. Under this assumption, the home country is always an importer of the commodity, which is the situation we want to investigate.

The main result of our model is the following. For low distortion of taxation and high demand relative to the cost differential, a subsidy is the optimal policy tool. If the cost differential is high relative to the market size, or the distortion is high, a tariff is the optimal policy tool. We find that the comparison of the two instruments is extremely sensitive with respect to the distortion of taxation.

For a distortion of more than 20%, a subsidy ceases to be optimal irrespective of cost differential and market size.

The intuition for a subsidy being optimal in some cases is that the subsidy works as a trade policy and an antitrust policy tool at the same time. Antitrust policy means here that it reduces the effciency loss from imperfect competition.

This effect benefits the consumers at the expense of negative government revenue.

If demand is low, possible gains for the consumers are small, and the tariff becomes the optimal policy tool. With a tariff, government revenue is positive and makes up for the effciency loss due to imperfect competition. The advantage of a subsidy decreases when taxation is distortionary, because the use of the antitrust instrument becomes increasingly costly. The trade-off a policy maker faces, therefore, is to either use an anticompetitive tool and get the revenue, or to use a pro-competitive tool despite its cost. This paper derives conditions under which the two alternative options lead to a maximum of national welfare. In a general equilibrium model without rent shifting, Bhagwati *et al.* (1969) and Bhagwati (1971) compare tariffs and subsidies for the case of equal marginal costs and show that a subsidy is always optimal. The results of our model are therefore not directly comparable to those in the earlier literature. Our result di.ers for four reasons. First, the country we are considering is not necessarily small. The only restriction we make on the size of the country is that it is smaller than the rest of the world. Second, we assume a cost disadvantage of the home firm. Thus, the gain from a subsidy is lowered since the funds flow to the ineffcient firm. Third, a tariff also serves as a rent shifting tool. Fourth and most importantly, we consider distortionary taxation.

The model presented in this paper is highly stylized. The policy conclusions which emerge from it depend on the strength of demand relative to the cost differential, and the distortionary effect of taxation. Which one of the two policy instruments is more recommendable is thus ultimately an empirical issue. The distortionary effect of taxation was estimated for the US economy by Browning (1987) and Carmichael (1991). Browning arrives at a range of 32 to 47% as a reasonable estimate, Carmichael estimates a distortion of 34%. Both studies suggest that a tariff would be the optimal trade policy tool in our model.

II. The Model

We consider an economy with a representative consumer and two commodities, a tradeable commodity G_1 and a nontradeable commodity G_2. The utility function is assumed to be quasilinear with the specific form of

$$u(G_1,G_2) = \mathrm{A}G_1 - G_1^2/2 + G_2.$$

We normalize the price of commodity G_2 equal to one, and we call the relative price p. The budget of the household is assumed to be exogenous. The resulting inverse demand function for commodity G_1 and the consumer surplus S of consumption of commodity G_1 are

$$p = A - G_1$$

and

$$S = (G_1)_2/2$$

The commodity G_1 is produced by two firms, one in the home country, the other in a foreign country. We call the production of commodity G_1 by the home firm x, by the foreign firm y, where $G_1 = x + y$. We assume constant marginal costs c_1 for the home firm and c_2 for the foreign firm. We introduce the following notation: $m = \mathrm{A} - (c_1 + c_2)/2$, as an indicator for the potential market size, or the strength of demand in the home country; and $d = c_1 - c_2$, the cost differential of the two firms. As mentioned in the introduction, we assume a cost disadvantage of the home firm, $d > 0$. Additionally, we assume that demand is strong enough to guarantee positive production in case of a monopolized home market ($\mathrm{A} > c_1$), leading to m $> d/2$. This implies $m > 0$.

The profit functions of the firms depend on the policy tool. For a tariff t, they are given by

$$\pi(h)_t = x_t\ (p_t - c_1)$$

$$\pi(f\,)_t = y_t\ (p_t\,.\ c_2 - t).$$

For a subsidy s, the profits are

$$\pi(h)_s = x_s(p_s - c_1 + s)$$

$$\pi(f\,)_s = y_s(p_s - c_2).$$

Both firms maximize their profits under Cournot competition. Besides households and firms, we have a home government, which can either set import tariffs or production subsidies. The goal of the government is to use its policy instruments to maximize national welfare, given as the sum of producer and consumer surplus and government revenues or expenditures. As the profits, the welfare function depends on the policy tool.

$$\text{Tariff: } W_t = (h;\ x_t,\ y_t) + S(x_t,\ y_t) + ty_t$$

$$\text{Subsidy: } W_s = (h;\ x_s,\ y_s) + S(x_s,\ y_s) - sx_s.$$

In order to be able to subsidize, the government has to tax. The deadweight loss of such a taxation, as discussed in the introduction, is captured by $\lambda \geq 1$.

One justification for the introduction of a deadweight loss is the usual argument of distortionary taxation, where $\lambda = 1$ for a lump-sum tax and $\lambda > 1$ for any other tax. Another justification follows Neary (1994): If the home firm is partly owned by foreigners, profits of the home firm are valued lower than the types of income on which the tax is levied.

We investigate a two-stage game in which the government chooses to use a tariff or a subsidy as policy tool and the optimal value of the chosen tool in the first stage. The firms then play the market game in the second stage.

In the following we derive benchmark results for the cases of free trade and complete protection. Free trade is denoted by subscript f, maintaining complete protection by the subscript a for autarky. The analysis for the two cases is straightforward, and we show the results directly:

Lemma 1. A: For free trade, the optimal values are given by:

(i) $m>3d/2$

$$x_f^* = m/3 - d/2$$

$$y_f^* = m/3 + d/2$$

$$W_f^* = (m/3 - d/2)^2 + 2m_2/9$$

(ii) $m \leq 3d/2$

$$x_f^* = 0$$

$$y_f^* = m/2 + d/4$$

$$W_f^* = (m/2 + d/4)_2/2$$

B: For autarky, the optimal values are given by:

$$x_a^* = m/2 - d/4$$

$$W_a^* = 3(m/2 - d/4)_2/2$$

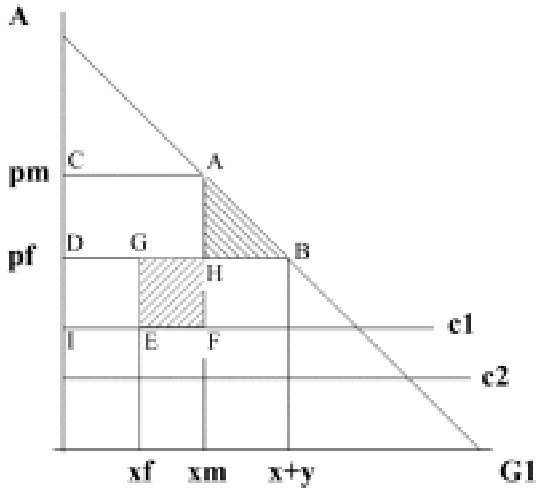
For the free trade case, we have to consider that the production levels have to be positive. Since m, $d > 0$ by assumption, this is always the case for y_f^*. If m < 3d / 2, optimal production of the home firm would be negative. In this case, the foreign firm acts as a monopolist. In a market with low demand relative to the cost differential, only the more effcient foreign firm produces. The foreign firms produc-tion never goes to zero, because we assumed that $A > c_1 > c_2$. For m > 3d/ 2, the results reveal the effects of the cost differential and market size on optimal output and the elements of the national welfare function. Comparing the welfare levels of free trade and monopoly leads to an interesting result:

Lemma 2. If the market is large relative to the cost differential, welfare under autarky is higher than welfare under free trade.

Proof. $W_a^* > W_f^*$ solved for m leads to $m > 5d/2$. ■

Moving from monopoly to free trade enhances the consumer surplus by the area *ABCD*, but reduces the producer surplus of the home firm by the areas *EFGH* and *ACDH*. The net effects are *ABH*, the consumers' gain, and *EFGH*, the producer's

Figure 1. Sheds some light on the driving forces of the result.



loss. The remaining area *ACDH* is a redistribution from producers to consumers.

If free trade is the only alternative to a closed market, liberalization is not optimal for markets which are large relative to the cost di.erence. Our Lemma 2 is consistent with Cordella (1993), who argues that the prescription of free trade as a unilateral option is valid only if foreign competition is very strong, and only in this case consumers gains offset producers losses. It is furthermore consistent with Collie (1996) and thus not new to the literature. In our paper we need it as a benchmark case for our further calculations.

III. Import Tariff

Relative to free trade, the profit function of the foreign firm changes since it has to pay a tariff t for every imported unit:

$$\pi(f)_t = y_t(m + d/2 - x_t - y_t - t)$$

In the second stage of the game, the two firms maximize their profits given the tariff t set by the government in the first stage. This leads to the reaction functions

$$x_t(t) = m/3 - d/2 + t/3$$

$$y_t(t) = m/3 + d/2 - 2t/3 \tag{1}$$

Government revenue is given by the tariff income ty_t. The government maximizes welfare given the optimal production levels and the feasibility constraints:

$$\max_t W_t = \pi(h)_t + (x_t + y_t)^2/2 + ty_t$$
$$\text{subject to: (A) equation (1)}$$
$$\text{(B) } x_t > 0,\ y_t > 0 \qquad (2)$$

The subgame perfect equilibrium is described in Proposition 3.

Proposition 3. The government sets $t^* = m/3 + d/6$.
The firms choose production values

$$\left.\begin{aligned} x_t^* &= 4(m-d)/9 \\ y_t^* &= m/9 + 7d/18 \end{aligned}\right\} \text{for } m > d$$

$$\left.\begin{aligned} x_t^{**} &= 0 \\ y_t^{**} &= \mathrm{m/3 + d/6} \end{aligned}\right\} \text{for } m \leq d$$

The resulting welfare levels are

$$w_t^* = (4m/9 - 4d/9)^2 + (5m/9 - d/18)^2/2 + (m/3 + d/6)\ (m/9 + 7d/18)$$

$$w_t^{**} = 3(m/3 + d/6)^2/2$$

Proof. The second derivative of the welfare function with respect to t is –1, which confirms that t is a maximum. $x_t^* > 0$ leads to $m > d$. For $m \leq d$, the importing firm becomes a monopolist. Maximizing the welfare function for this case with respect to the tariff leads to the same optimal tariff, where the second derivative with respect to t is –3/4. Last, the protective tariffs are not binding for both cases: $t^* < t_p^* = t^*(y_t^* = 0)$ and $t^* < t_p^{**} = t^*(y_t^{**} = 0)$. ■

As in Lemma 1A, the foreign firm is the unique supplier of the commodity for low demand relative to the cost differential. In the welfare levels, W, it is possible to identify some of the previous terms. The first term in the W_t^* expression is the square of x_t^*, reflecting the producer surplus. The second term is the sum of x_t^* and y_t^*, representing the consumer surplus, $S = (G_1)_2/2$, where G_1 is the sum of x_t^* and y_t^*. The final part of the expression for W_t^* is t^* multilplied by y_t^*, the government revenue. As in W_t^* only the foreign firm produces, the term reported in the pro-position reflects the consumer surplus plus the government revenue. As the op-timal tariff, t^*, and the optimal quantity y_t^* are identical in this case, terms can be collected and the expression is reduced to only one term. While the effects of m and d on welfare are ambiguous, their effect on the optimal tariff is in accordance to those found in the literature (see Dixit 1984). In fact, for $d = 0$, the optimal tariff is identical to the one found in several other studies.

IV. Home Firm Subsidy

The profit function of the foreign firm is the same as under unrestricted trade, but the profit function of the home firm changes since it gets a subsidy proportional to output. One can interpret it as a subsidy on costs per unit produced or as a subsidy per unit sold.

$$\pi(h)_s = (p_s + \mathrm{s} - c_2)x_s$$

Government revenue is negative for a positive subsidy, such that we write the welfare function as

$$W_s = \pi(h)_s + (x_s + y_s)^2/2\text{-}\lambda s x_s,$$

where $\lambda \geq 1$ captures the distortionary effect of taxation.

We omit the complete description of the maximization problem and move to the results.

Proposition 4. The government sets

$$s^* = \frac{4(m-d) - \lambda(2m-3d)}{4\lambda - 3}$$

as long as $m > m_1 = \frac{6\lambda - 1}{2(2\lambda + 1)}d$

The firms choose

$$x_s^* = \frac{2m + d + \lambda(4m - 6d)}{6(4\lambda - 3)}$$

$$y_s^* = \frac{-5(2m + d) + \lambda(10m - 9d)}{6(4\lambda - 3)}$$

and the resulting welfare level is

$$W_s^* = \frac{\lambda^2(2m-3d)^2 + \lambda 8m(2m+d) - 2d^2 - 8md - 8m^2}{24(4\lambda + 3)}$$

For $m < m_1$, the home firm does not produce. The production level of the foreign firm and the welfare level are as in Lemma 1A, part (ii).

For $m > m_1$ and $\lambda < 2, s^* > 0$. For $\lambda > 2, s^* > 0$ if $m < m_2 = \dfrac{3\lambda - 4}{2\lambda - 2}$

Proof. $x_s^* > 0$ demands $m > m_1$. For $m \leq m_1$, the foreign firm acts as a monopoly. The protective subsidy sp is not binding: $s^* < s_p = s^*(y_s^* = 0)$.

The merits of strategic trade policy are quite different than in the case of a tariff. While before we had a trade off between consumer surplus and government revenue on one hand and profits on the other hand, we now have to compare the positive effects on profits and consumer surplus to the negative effect on government revenue. In our model, the positive effect on consumer surplus is the strength of a subsidy. Additionally to the rent shifting effect, the subsidy works as anti trust policy tool.

Since the home firm has a relative cost disadvantage, the optimal subsidy is set such that the home and foreign firm share the market. This familiar result again reflects the possible increase in total effciency due to a low cost firm entering the market. A negative subsidy does not make sense, since the distortion would have a positive impact on welfare. We therefore demand $s^* > 0$ for $\lambda > 1$. As the Proposition shows, the condition m2 for $s^* > 0$ is not binding for $1 \leq \lambda < 2$.

The intuition for this result is best understood if one considers the extreme cases $\lambda = 1$ and $d = 0$. In this case, the subsidy is equal to the di.erence between the demand intercept and the marginal cost (recall the definition of m in section 2). This is a well known result from the industrial organization literature (see Tirole, 1988). If one relaxes the assumption of $d = 0$, the optimal subsidy decreases as d increases. The intuition for this is that it becomes less and less attractive to subsidize an ineffcient firm. If m increases, the subsidy increases because, in a larger market, the adverse effect of imperfect competition on consumers is larger. The effect of the distortion, λ, on the optimal subsidy, is always negative. Allthough not immediately apparent from the expression, it can be shown that the derivative of s.with respect to can only be positive for $m < 7d/10$, which cannot be the case as $x_s^* > 0$ demands $m > m_1$ and $m_1 > 7\ d/10$.

V. Comparison of Trade Policy Instruments

By comparing welfare levels, we will now derive the welfare implications of the different trade policy instruments.

Proposition 5 The optimal subsidy is the welfare maximizing policy tool if $\lambda \in [1, (8 - \sqrt{19})/3)$ and $m > m_3$, where

$$m_3 = \frac{9\lambda^2 - 26\lambda + 21 + 2\sqrt{3}\sqrt{(4\lambda-3)(2\lambda-3)^2}}{2\{\lambda - (8+\sqrt{19})(3\lambda - 8 + \sqrt{19})\}}d$$

The optimal tariff is welfare maximizing if $\lambda \geq (8-\sqrt{19})/3$ or $d/2 < m \leq m_3$. Additionally,

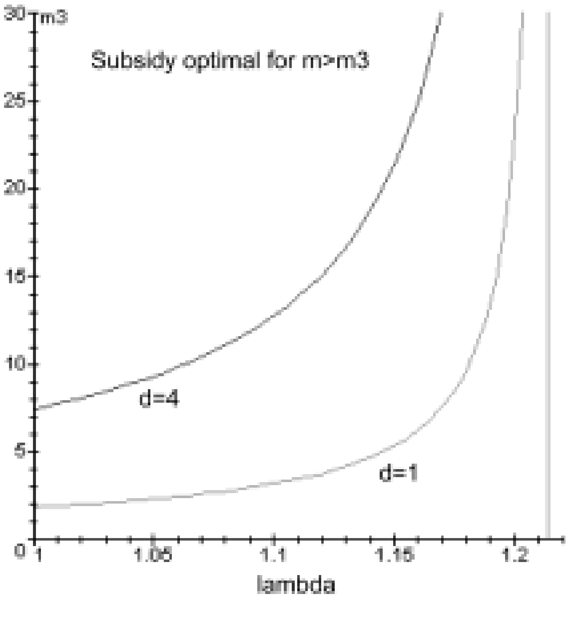
Proof. See Appendix.

A tariff can thus dominate a subsidy in terms of welfare, depending on the market size, the cost differential and the distortionary effect of taxation necessary to subsidize. A subsidy is preferable for low distortion and a large market size relative to the cost differential. As illustrated in figure 2, the market size necessary for the subsidy to be optimal increases very quickly with the distortion factor λ.

Again, we start by considering the extreme cases. If we abstract completely from the distortionary effect of taxation ($\lambda = 1$), we are on the y-axis of figure 2. If we also abstract from the cost differential ($d = 0$), the point where the $d = 0$ line hits the *y*-axis denotes a critical market size m_3. If the market is larger than this critical value, the subsidy is optimal and if it is not, the tariff is the optimal policy tool.

For a distortion factor $\lambda \gtrsim 1.21$, a subsidy is never optimal. Neary (1994) also looks at subsidies with distortionary taxation and derives an upper limit of $\lambda = 4/3$.

Figure 2.



The limit of our study cannot be directly compared to that of Neary, however. Since we consider competition on the home market and not competition on a third market as Neary does, we have to include consumer surplus. Doing the same as Neary, namely comparing benefits and losses of a subsidy, would lead to a higher level in our model due to the antitrust effect of the subsidy which benefits consumers. It is surprising that the presence of an alternative policy tool more than compensates for this effect.

The ranking of policy instruments has initially been done in a general equilibrium model by Bhagwati *et al.* (1969) and Bhagwati (1971) without distortionary taxation. In his setup, a subsidy is always welfare-maximizing, because it removes the ineffciency of imperfect competition. For $\lambda = 1$, our result states that a tariff is optimal for low demand relative to the cost differential ($m < d(2 + \sqrt{3})/2$). The different result is due to the cost differential in our model. For $m \leq d$, the home firm does not produce. A tariff still leads to higher welfare than free trade, where the foreign firm acts as a monopoly. The import level is lower for the tariff, but this loss on consumer surplus is outweighed by the government revenue. For $d < m < d$ $(2 + \sqrt{3}/2)$, the home firm produces, and a tariff is still optimal. Sub-sidizing a high cost firm is costly whereas levying a tariff on the effcient foreign firm leads to high government revenues. These two effects make up for the loss in consumer surplus due to the foregone antitrust effect of a subsidy.

VI. Concluding Remarks

In our model, the foreign government is passive, i.e. it is accepting the strategic trade policy of the home government silently. One is tempted to ask for which real world situation this setting offers an appropriate description. We think it is appropriate for two groups of countries: developing countries merging from protection to integration in the world market, and former communist countries in transition. In both types of countries, monopolies have emerged which supplied highly homogeneous commodities, such as steel, copper or other raw materials or major inputs. Opening for international trade inevitably leads to the question as to how this opening could be accompanied by supporting policies. Of course, strategic trade policy harms the foreign firm compared to unrestricted trade, and the question arises why the foreign government does not react. Three reasons can be given. First, the economies of these countries are relatively small and therefore relatively unimportant for the rest of the world. This need not be true for every industry.

Second, opening the economy accompanied by trade policies leads to profits for the foreign firm, which did not occur under protection.

Since this is better than nothing, the foreign government could accept it. Third, the passiveness of the foreign government can be seen as a form of financial aid to the home country.

Appendix

Proof of proposition 5. We will show that $W_t^{**} > W_f^{**}$, $W_t^{*} > W_f^{**}$, $W_t^{**} > W_s^{*}$, and $W_t^{*} \geq W_s^{*}$ for the parameters given in the Proposition.

(i) W_t^{*} and W_s^{*} are relevant for $m > \max(d, m_1)$. $W_t^{*} = W_s^{*}$ for $m \in \{m_3, m_4\}$, where m_3 is given in the Proposition and

$$m_4 = \frac{9\lambda - 26\lambda + 21 - 2\sqrt{3}\sqrt{(4\lambda-3)(2\lambda-3)^2}}{2\{\lambda - (8 + (\sqrt{19})/3)/(3\lambda - 8 + \sqrt{19})\}}d$$

$$W_s^{*} > W_t^{*} \text{ if} \begin{cases} m < m_4 \text{ or } m > m_4 & \text{for } \lambda \in [1, (8-\sqrt{19})/3) \\ m_3 < m < m_4 & \text{for } \lambda \in ((8-\sqrt{19})/3), (8+\sqrt{19})/3)) \\ m < m_4 \text{ or } m > m_4 & \text{for } \lambda > ((8+\sqrt{19})/3) \end{cases}$$

A subsidy is feasible if $m = m_1$ and additionally $m = m_2$ for $\lambda > 2$, see Proposition 4.
$\lambda \in [(1, 8 - \sqrt{19})/3)$: Since $m_3 > \max(d, m_1)$, $W_s^{*} > W_t^{*}$ for $m = m_3$.
Note that $m_4 < d$ for $\forall\lambda$. Therefore, $d < m < m_4$ is not possible. For $\lambda > (8/\sqrt{19}/3)$, $m_3 = m_3$ and $m_2 > m > m_3$ is not possible.
Finally, we have to consider the case $\lambda = (8 - \sqrt{19})/3$. Solving $W_t^{*} - W_s^{*}$ for m at $\lambda = (8 - \sqrt{19})$ /3 shows that $W_t^{*} - W_s^{*}$ for m, $d > 0$.
(ii) W_t^{**} and W_s^{*} are relevant for $m_1 < m \leq d$. $W_t^{**} = W_s^{*}$ for $m \in \{m_5, m_6\}$,
where

$$m_5 = \frac{3\lambda^2 + 2\lambda - 1 - 2\sqrt{\lambda^2(4\lambda - 3)}}{2(\lambda^2 + 1)}d$$

$$m_6 = \frac{3\lambda^2 + 2\lambda - 1 + 2\sqrt{\lambda^2(4\lambda - 3)}}{2(\lambda^2 + 1)}d$$

$W_s^{*} > W_t^{**}$ for $m < m_5$ or $m > m_6$. Since $d < m_6$, $d \geq m > m_6$ is not possible. Since $m_5 < m_1$, $m_5 < m_1$, $m_1 < m < m_5$ is not possible.
(iii) $W_s^{**} < W_t^{*}$ for all parameter values.
(iv) $W_s^{**} < W_t^{*}$ for all parameter values.

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