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# State Trading Enterprises And Price Stabilization

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## Abstract

The widespread use of State Trading Enterprises (STEs) in international trade of commodities is often justified by price-stabilizing objectives. In investigating the theoretical underpinnings of such interventions, we point out that STEs combine the possibility to stabilise domestic prices with the opportunity to redistribute custom duty proceeds to producers. Using a two-country general equilibrium model with import STEs, we show that global welfare is maximized when a non-zero, non-prohibitive tariff is applied. Whatever the restriction on the border, letting farmers be the only recipients of tariff revenues is optimal, because it allows income insurance to be provided.

## 1 Introduction

By one often-quoted estimate, 91 percent of wheat imports were made by countries using State Trading Enterprises (STEs) during the period 1973-77 (Schmitz et al., 1981), and similar orders of magnitude were generally referred to for rice (Falcon & Monke, 1980). As a matter of fact, the use of STEs have been widespread in many commodity markets

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(especially staple food) for a long time. As such, they have been a contentious issue of negotiation, and the Marrakesh Agreement included stricter reporting requirements under the World Trade Organization (WTO), based on a long-awaited “working definition” of STEs, in the Understanding on the Interpretation of Article XVII of GATT 1994.<sup>1</sup>

The use of STEs is less pervasive now than it used to be, partly because of international regulation, but also largely because their inefficiencies led a number of states to reform unilaterally, sometimes in the context of adjustment programs (Young, 1999; Barrett & Mutambatsere, 2008). Still, STEs remain key elements of commodity markets, used by a large number of developed and developing countries, including China, India, Indonesia and Japan.

Their economic consequences have been studied in an extensive literature, mainly focused upon the monopolistic features of STEs and on the ensuing rent-seeking behaviors<sup>2</sup> (see McCorriston & MacLaren (2012) for a recent survey). The trade distortions originated by importing STEs have also been shown to be equivalent to those of import tariffs or subsidies (McCorriston & MacLaren, 2005b). Noteworthily, this literature embeds the economic analysis of STEs in a deterministic framework.

Against this background, it is increasingly glaring to see the literature on the economic impact of STEs leaving unaddressed questions about “the extent to which STEs dissipate the impact of price volatility that arises on domestic and world markets” (McCorriston & MacLaren, 2012). Filling this gap is the objective of this paper.

The volatility of staple food prices is a growing concern at national and international levels. It has a major impact on consumers in developing countries. On the production

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<sup>1</sup>STEs are defined as “governmental and non-governmental enterprises, including marketing boards, which have been granted exclusive or special rights or privileges, including statutory or constitutional powers, in the exercise of which they influence through their purchases or sales the level or direction of imports or exports”. These companies must operate in a manner consistent with the principles and rules of the WTO.

<sup>2</sup>STEs are accused of having important distorting effects on trade (McCorriston & MacLaren, 2002) as they can manipulate prices through market operations (monopoly power, monopsony power, market segmentation, price pooling, income pooling...), through regulation (setting consumer prices, the level of production, limits to cultivated areas or to the quantities sold) or through direct aids.

side, farmers' income volatility tends to decrease investment in agriculture in favor of sectors deemed less risky. With access to financial markets, farmers could smooth their income so that working in agriculture or in other sectors would be equivalent. Thus it would avoid under-production of agricultural goods. However, financial markets are often imperfect or incomplete (Mahul & Stutley, 2010). Government intervention on commodity markets is a second-best tool for dealing with volatility in both developing and developed countries and may take the form of import STEs that allow at the same time to set import duties that stabilize the domestic price and redistribute tariff receipts to its stockholders.<sup>3</sup>

To analyze the economic rationale of such combination of price stabilization with targeted redistribution of tariff proceeds, we consider a general equilibrium model similar to the one proposed by Shy (1988). This allows us to compute the optimal trade restrictions in a world economy composed of two large countries that trade an agricultural commodity affected by productivity shocks and an industrial (non-risky) good. Idiosyncratic risks affecting the agricultural productivity of the two countries cancel out at the global level. Under free trade, while the staple food price is stabilized, farmers face an income risk which discourages investment in agriculture. Under autarky, the farmers' revenue is stabilized but consumers face a price (and availability of the agricultural good) risk. International financial markets would restore the optimality of free trade, but we assume such markets unavailable<sup>4</sup>.

This framework leads us to four main results. First, welfare improvements from non-prohibitive trade restrictions can only be expected from the redistribution of custom duty

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<sup>3</sup>Governments have several tools at their disposal to deal with food price volatility. Public stocks are a classical instrument that have lost popularity as it became clear that the costs of even partial stabilization schemes were high, often higher than the benefits (Newbery & Stiglitz, 1981; Williams & Wright, 1991). Countries also often resort to trade taxes or quotas to compensate for the absence of private insurance or other financial hedging instruments. While the use of trade policies for domestic price stabilization is by no mean new (Anderson & Nelgen, 2012), trade policy interventions aimed at sheltering domestic market from world price spikes are widely believed to have been among the key drivers of the 2007-2008 crisis (Martin & Anderson, 2012; Headey, 2011; Anderson & Nelgen, 2010), pointing to the need of international coordination for price stabilization purposes.

<sup>4</sup>Income redistribution within a country can also increase welfare under free trade but does not eliminate risk at the international level.

proceeds. Indeed, assuming dissipative trade frictions like iceberg costs (Samuelson, 1952) we show that the optimum is either autarky or free trade depending on the level of agents' risk aversion. If risk aversion is low, free trade is preferred: consumers enjoy a stabilized crop price while farmers are subject to an income risk without compensation. Since the corresponding risk premium is relatively low, in this case the contraction of the agricultural sector is not too prejudicial. If risk aversion is high, opening borders induces a large rural exodus and the reduction of price volatility is achieved around an average agricultural price exceeding its optimal level. Autarky is optimal in this case. Second, when custom duty proceeds are collected, it is optimal to make farmers recipient of them all. Redistributing to farmers allows their income variability to be reduced, thereby limiting the contraction of the agricultural sector. Third, assuming farmers collect these border revenues, global welfare is maximized when both countries agree ex-ante upon a non-zero, non-prohibitive import tariff. Such policy makes it possible to reap the benefits of partial farmers' compensation while maintaining some degree of price stabilization. Fourth, this cooperative policy corresponds to higher restraints than the trade policy chosen non-cooperatively. Each country benefits from its partner committing to higher tariffs, because this increases the number of farmers in the partner country, thus reducing import prices when the commodity is affected by a negative shock. Whatever the policy chosen, it can be implemented by farmers cooperatives such as marketing boards as long as it is the government which sets the level of the trade barrier.

The literature on STEs does not explore the market stabilization objective often assigned to them. Instead, they mostly focus on the distorting effects that they provoke. Krishna & Thursby (1992) show that it is optimal for a government to implement tariffs to correct the distortions created by a marketing board. Hamilton & Stiegert (2002) study the Canadian Wheat Board (CWB) to confirm the existence of "rent-shifting" behaviors. Alston & Gray (2000) compare a marketing board (such as the CWB) and the use of export subsidies, concluding that they have very similar effects. Dong et al. (2006) get mixed results on the effect of marketing boards when considering products differentiation. McCorrison & MacLaren (2007, 2005a,b) use a partial equilibrium model in which marketing boards seek

to protect a group (producers or consumers) or to maximize profits like a private firm. They show that this action may be equivalent to the use of tariffs, with strong transfers between consumers and producers and between importing and exporting countries.

But as far as we know market stabilization objectives have been left aside in those analyzes, even though it is a major objective of marketing boards. As it is our focus, we use a competitive model with risk to understand the effects of marketing boards on price and income stabilization in the spirit of Newbery & Stiglitz (1984) which study on the effect of trade when financial markets are incomplete is a landmark in the literature on risk and trade. They show in a partial equilibrium framework that free trade may be Pareto inferior to autarky, which runs counter to the classical results of trade theory.<sup>5</sup> Shy (1988) obtains the same results in a general equilibrium framework. Here, we study the optimality of a trade barrier that corresponds to an intermediate situation between free trade and autarky. Eaton & Grossman (1985) also analyzes the effects of a tax-subsidy on imports on a small country that seeks to protect itself from volatile international markets, assuming that the proceeds of the border tax are equally shared among producers. As it is a costless transfer realized after uncertainty is resolved, redistribution corresponds to a partial insurance against price volatility. We generalize this approach by allowing any sharing of the border tax proceeds between the two sectors of the economy and we show that it is optimal to allow farmers to collect the entire revenue of the trade restrictions. In an approach very close to ours, Basu & Sarkar (2014) develop the Newbery-Stiglitz-Shy framework to include gains from trade due to comparative advantages. They compare the respective gains from comparative advantages to those of restricting trade for risk sharing purposes in the context of a small country. When uncertainty is high enough, autarky is the optimum. However, the optimality of free trade is restored with income tax or subsidies that provide domestic risk sharing. In our model, domestic risk sharing comes from the collection of tax proceeds by producers. The tax on

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<sup>5</sup>Helpman & Razin (1978) show that many fundamental theorems of the theory of international trade can be extended to uncertain environments, provided international capital markets are functional. Hence, the problem with agricultural markets is not productivity risk *per se* but market incompleteness with regards to risk sharing mechanisms.

imports also allows us to investigate international risk sharing between two large countries.

The rest of the article is organized as follows. In the next section, we describe our setup. Trade policies are analyzed in section 3. Section 4 investigates the empirical relevance of our framework. Section 5 concludes. All proofs are in the appendix.

## 2 The model

Consider a world economy composed of two countries. Each country has a population normalized to one -which also corresponds to the labor supply- and comprises two sectors, agriculture and industry. We denote by  $\alpha$  ( $\alpha^*$ ) the share of workers that choose to work in the industry in the domestic (foreign) country and  $1 - \alpha$  ( $1 - \alpha^*$ ) those who work in agriculture. Industry uses one unit of labor to produce one unit of good which serves as the numeraire. Hence, we have  $p_x = 1$  and assuming competitive markets, the industrial wage in industry satisfies  $w_x = 1$ , where subscript  $x$  refers to the industrial sector.

Productivity in agriculture (hereafter sector  $y$ ) of both countries is stochastic: with one unit of labor, production is either  $\theta_H$  or  $\theta_L < \theta_H$ , with equal probabilities. We assume that at the worldwide level, the idiosyncratic risks of the two countries cancel each other. If the share of agriculture is the same in the two countries (i.e.,  $\alpha = \alpha^*$ ), there is not systemic risk at the global level.

The preferences of the representative individual on her consumption of goods  $x$  and  $y$  are given by

$$U(x, y) = -(x^a y^b)^{-\rho} / \rho$$

where  $b = 1 - a$  and  $\rho > 0$  measures risk aversion ( $\rho + 1$  corresponds to the coefficient of relative risk aversion). With income  $w$  and prices equal to 1 in the industry and  $p$  in agriculture, these preferences lead to the demand functions  $x_D = aw$  and  $y_D = bw/p$  and thus to an indirect utility function

$$V(w, p) = -\kappa(w/p^b)^{-\rho}$$

where  $\kappa = (a^a b^b)^{-\rho} / \rho$  is a positive constant.



Individuals must decide on the sector they will offer their unit of labor before uncertainty is resolved. In autarky, equilibrium on the agricultural market leads to a constant agricultural revenue irrespective of the productivity level. Indeed, denoting by  $p_k$  the price of the agricultural good in state  $k \in \{H, L\}$ , and by  $w_k = \theta_k p_k$  the corresponding equilibrium wages, state- $k$  total demand of agricultural products is equal to

$$b[\alpha + (1 - \alpha)w_k]/p_k = b[\alpha + (1 - \alpha)\theta_k p_k]/p_k$$

while total supply is  $(1 - \alpha)\theta_k$ , leading to an equilibrium price

$$p_k = \frac{(1 - a)\alpha}{a(1 - \alpha)\theta_k}$$

and thus

$$w_k = (1 - a)\alpha/[a(1 - \alpha)]$$

for all  $k$ . Individuals are indifferent between the two sectors if the revenues in both sectors are equal, which leads to  $\alpha = a$ . The revenue in the agricultural sector is constant. However, consumers bear the cost of the productivity risk.

The situation is reversed under free trade since it is assumed that the productivity risks of the two countries are perfectly anti-correlated. The equilibrium price satisfies

$$p_w = \frac{b}{a} \frac{\alpha + \alpha^*}{\theta_L(1 - \alpha) + \theta_H(1 - \alpha^*)},$$

when the productivity at home is low, and

$$p_w = \frac{b}{a} \frac{\alpha + \alpha^*}{\theta_H(1 - \alpha) + \theta_L(1 - \alpha^*)},$$

when the productivity at home is high. The variability of prices is lower than in autarky and if the share of agriculture is the same in the two countries (i.e.,  $\alpha = \alpha^*$ ) the equilibrium price is constant, given by

$$p_w = \frac{b\alpha}{a(1 - \alpha)} \frac{2}{\theta_L + \theta_H}. \quad (1)$$

Hence, albeit free trade cancels out idiosyncratic risks, individual farmers face an income risk. This risk leads to a lower level of labor supply in the agricultural sector ex-ante ( $\alpha$  is

lower than under autarky) which in turn induces a lower level of agricultural production. As a result, welfare is lower under free trade than under autarky.

This is the main result of Newbery & Stiglitz (1984): with uncertainty and incomplete markets, free trade may be Pareto inferior to autarky. However the optimality of free trade is restored if there exist international financial markets as shown by Helpman & Razin (1978). These markets can be used as an insurance scheme whereby agricultural producers in the country affected by a negative productivity shock receive a financial transfer  $X = (\theta_H - \theta_L)p_w/2$  from those in the other country. Income in agriculture is then constant across periods and equal to  $w = (\theta_H + \theta_L)p_w/2$ . Both goods (industrial and agricultural) are produced in the two countries if expected utilities are equalized across sectors, implying that incomes are also equalized. Using (1), this gives  $a = \alpha$ . The result is an optimal situation where there is no income risk (thanks to the financial transfers), no price risk (thanks to free trade) and no under-production of the agricultural good<sup>6</sup>.

When such international financial markets are missing, governments may resort to contingent income redistribution across their citizens. With such state-contingent transfers  $X_k$ , revenues are  $1 - X_k/\alpha$  and  $\theta_k p_w + X_k/(1 - \alpha)$  in the industry and in agriculture respectively. Governments use these transfers to perfectly share risk across their citizens, leading to revenue  $w_k = \alpha + (1 - \alpha)\theta_k p_w$  and expected utility

$$EV = -\frac{\kappa}{2}(w_H^{-\rho} + w_L^{-\rho})p_w^{b\rho}$$

where  $p_w$  is given by (1). Deriving this with respect to  $\alpha$  shows that the optimum is reached for  $\alpha = a$ . Notice that this value of  $\alpha$  also equalizes transfers across dates ( $X_H = -X_L$ ) so that the agricultural sector gives as much in state  $H$  as it receives in state  $L$ . While this income redistribution scheme increases welfare, it does not allow these economies to reach the first best level: risk is perfectly shared across agents within each economy, but is not removed at the macroeconomic level.

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<sup>6</sup>Indeed  $\alpha = a$  corresponds to the production level in autarky when farmers face no income risk. Increasing income variability decreases this amount and leads to an under-production of the agricultural good.

### 3 Trade policies

Because of the impossibility to share risk between agents due to defective financial markets and of the government inability to mitigate this market failure by engaging in a contingent redistribution of agents' incomes<sup>7</sup>, governments may consider implementing trade restrictions on the agricultural good through a STE which profit is shared by its stockholders. We formalize such a policy as an import tariff applied on the agricultural good and we suppose that the proceeds (if any) are collected without cost. A "redistribution" policy of the tax proceeds between industrial workers and farmers (with respective shares denoted  $\beta$  and  $1-\beta$ ) is equivalent to defining a specific allocation of the marketing board's property rights. A farmers' cooperative corresponds to 100% of the rights given to farmers (i.e  $\beta = 0$ ).

Trade restrictions on agricultural goods create a price wedge between the countries that we formalize as  $p_L = (1 + t)p_H^*$  where  $t \geq 0$  when the domestic country experiences a low productivity level, and a symmetric expression when the foreign country is adversely affected.<sup>8</sup> Free trade corresponds to  $t = t^* = 0$  while autarky prevails if  $t \geq \theta_H/\theta_L - 1$ .

We formalize the regulation problem as a game between the governments and the individuals. Such a game entails the following two steps:

1. First, states announce their tax levels  $(t, t^*)$  and the sharing rules of the tax proceeds  $(\beta, \beta^*)$  simultaneously.
2. Individuals then use this information to compute prices and incomes in all states and decide on the sector they will offer to work simultaneously.

At equilibrium, expected utilities in both sectors must be the same, resulting in a distribution of labor between the two sectors  $(\alpha, 1-\alpha)$  with  $\alpha \in (0, 1)$ . In this approach, individuals' choices are either the result of a mixed strategy (the individuals choose the sector according

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<sup>7</sup>This may be the case because a lack of information prevents the government from suitably implementing the policy, or because of excessive administrative costs.

<sup>8</sup>While the literature on marketing boards mainly focuses on the case of exporters, our model considers a country that is neither a structural importer nor a structural exporter. Accordingly, we focus on import STEs.

to a random device) or the result of incentives (not modeled) given by governments that allow individuals to coordinate on the equilibrium repartition of workers. Alternatively, and consistent with this second interpretation, we can also consider the one-step game where the governments choose simultaneously  $t, \beta$  and  $\alpha$  under the constraint that  $\alpha$  must correspond to individuals' expectations. We pursue this simpler approach in what follows.

The optimal level of tariff maximizes the ex-ante welfare of the representative agent. In order to have diversified economies, the representative agent must be indifferent between working in industry or in agriculture.

### 3.1 International trade discipline

Consider first the case where governments cooperate in defining common trade rules with the objective of global welfare maximization. As noted above, reaching the first-best outcome requires international risk-sharing arrangements. Absent such arrangements, some aggregate risk remains at the national level that trade policy may influence through two effects: import duties by state- $L$  country reduce the smoothing effect of trade on the domestic price -a welfare loss for consumers but an increase in farmers' revenue - and tax proceeds can be shared among agents. The first effect allows for risk sharing between countries, while the second provides risk sharing at the national level. In order to disentangle the corresponding welfare impacts, we first insulate the former effects by neglecting tax proceeds. This corresponds to the so-called "iceberg cost" assumption, where trade costs are assumed to be purely dissipative. In this framework, trade taxes only impact farmers' income and the consumer's welfare through agricultural prices. We then consider the effect of tax revenues on the agents' welfare and determine the best way to share these proceeds before assessing the optimal level of protection.

With iceberg cost, the expected utility of an industrial worker is given by

$$EV_y = -\kappa(p_H^{b\rho} + p_L^{b\rho})/2$$

while for a farmer it is given by

$$EV_x = -\kappa([\theta_H p_H^{1-b}]^{-\rho} + [\theta_L p_L^{1-b}]^{-\rho})/2.$$

At a symmetric cooperative equilibrium, a trade policy leading to  $p_L = (1 + t)p_H^* = (1 + t)p_H$  equalizes these expected utilities if

$$p_H = \left[ \frac{\theta_H^{-\rho} + [\theta_L(1 + t)^{(1-b)}]^{-\rho}}{1 + (1 + t)^{b\rho}} \right]^{1/\rho}. \quad (2)$$

Maximizing the resulting global expected utility  $EV(t)$  with respect to  $t$  allows us to obtain

**Proposition 1** *In a context of international cooperation and domestic commitment, if trade restrictions are purely dissipative and agents are strongly risk averse ( $\rho > 0$ ), global welfare is maximal under autarky.*

Proof: See appendix A.

The fact that autarky is optimal when no border revenues are collected means that the benefits of moving away from autarky, i.e. more stable prices, are outweighed by the reduction of agricultural supply.

Consider now that revenues from trade restrictions are fully collected and shared between agents following a distribution rule chosen by the government. More specifically, imports of the country with productivity  $\theta_k$  are given by  $M = y_D - y_S$  where  $y_S = (1 - \alpha)\theta_k$  is the production,  $y_D = bI_k/p_k$  the demand and, where  $I_k$  is the income in state  $k$ . These incomes can be expressed as

$$\begin{aligned} I_H &= \alpha + (1 - \alpha)\theta_H p_H \\ I_L &= \alpha + (1 - \alpha)\theta_L p_L + T \end{aligned} \quad (3)$$

where  $T = tMp_H$  denotes tariff receipts. Thus, the country with a negative productivity shock (state  $L$ ) imports:

$$M = \frac{b\alpha - a(1 - \alpha)\theta_L p_L}{(1 + at)p_H} \quad (4)$$

which leads to a revenue equal to

$$I_L = \frac{\alpha(1 + t) + (1 - \alpha)\theta_L p_L}{1 + at}.$$

Balance of supply and demand on the world market allows us to express the prices as

$$p_H = \frac{p_L}{1 + t} = \frac{b\alpha}{a(1 - \alpha)} \frac{2 + at}{(\theta_H + \theta_L)(1 + t) - bt\theta_H} \quad (5)$$

which reduces to  $p_H = p_L = p_w$  given by (1) when  $t = 0$ .

A redistribution policy is characterized in the following by parameter  $\beta \in [0, 1]$  which corresponds the share of the tax revenues collected by industrial workers. Hence, if  $\beta = 0$  the proceeds are fully collected by farmers (the STE can be compared to a farmers' cooperative) while if  $\beta = 1$  they are fully collected by industrial workers (i.e., agents other than farmers).

Equalization of the expected utilities gives an expression of the size of the industrial sector,  $\alpha$ , as a function of the tax level  $t$  and the sharing rule  $\beta$ . Another distribution of the labor force across sectors would not be consistent with agents' expectations and could not be implemented. The government maximizes the global expected utility  $EV(\beta, t)$  with respect to  $\beta$  and  $t$ . We show in the appendix that

**Proposition 2** *It is optimal that farmers fully collect the revenue of the trade tax.*

Proof: see appendix B.

Tariff receipts allow farmers to benefit from a partial insurance on their income risk to which they are negatively correlated. It is optimal to let farmers fully collect these receipts which do not fully compensate the income loss they suffer during an adverse productivity shock episode.<sup>9</sup>

When tariff receipts are fully collected by farmers ( $\beta = 0$ ), we obtain the following result

**Proposition 3** *In the cooperative situation, welfare is maximized by imposing a non-zero, non-prohibitive import tariff (i.e., the optimal trade tax level  $t_{cc}$  verifies  $0 < t_{cc} < \theta_H/\theta_L - 1$ ).*

Proof: See appendix C.

Letting farmers perceive the entirety of tariff receipts is a cost-efficient risk-sharing arrangement: the benefits associated with the improved stability of farmers' income outweigh the costs of distortions associated with import tariffs. Noteworthy, part of this benefit is channelled through labor force allocation across sectors: by limiting income uncertainty in

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<sup>9</sup>This result is also linked to our focus on import STEs, where proceeds are positive only when farmers' income is relatively low.

agriculture, this state-contingent import tariff prevent an under-allocation of labor in agriculture, which would be detrimental to the whole economy. This can be understood as a way to counteract the excessive rural exodus induced by the uncertainty attached to farming activities. While this stabilization is not complete, unlike under autarky, it nevertheless allows the government to reduce the distortive cost of trade.

	Share of agriculture in the labor force ( $1 - \alpha$ )	Tax level ( $t$ )	Price when production is high ( $p_H$ )	Variation in prices ( $p_H - p_L$ )	Expected utility ( $EV$ )
Autarky	0,5	0,5	0,833	0,417	-2.031
Free trade	0,490	0	1,042	0	-2.041
Optimal STE (receipts collected by farmers, $\beta = 0$ )	0,498	0,287	0,901	0,259	-2.026
Best achievable situa- tion when $\beta = 0,5$	0,496	0,298	0,902	0,269	-2,026

Table 1: Optimal cooperative policy,  $\theta^H = 1,2$ ;  $\theta^L = 0,8$ ;  $a = b = 0,5$ ;  $\rho = 1$ .

Simulations reported in Table 1 illustrate. They were carried out assuming  $\theta^H = 1,2$ ,  $\theta^L = 0,8$ ,  $a = b = 0,5$  and  $\rho = 1$ . With these parameter values, the agricultural share of labor is lower under free trade (49%) than under autarky (50%). The import STE leads to a very high tariff (28,7%), even though it is only a fraction of the tariff level that leads to autarky, equal to 50%. The optimal policy limits very substantially the under allocation of labor to the agricultural sector (by 20%), and significantly improves welfare compared to autarky.

The case where tariff receipts are equally redistributed among the labor force ( $\beta = 0,5$ ) as in Eaton & Grossman (1985) is also reported Table 1. The need to stabilize the farmer's income commend a higher tariff (29,8%), but does not allow the government to limit the rural exodus in the same proportion.

## 3.2 International competition

International cooperation of the sort characterized above supposes that governments are able to commit to a given course of action. Indeed governments cooperate with their trading partner, in the sense of adhering to ex-ante commonly defined disciplines. They also commit nationally to the policy to allow workers to allocate adequately in each sector. We now investigate the cases where they are unable to do so.

### Commitment at the national level without international cooperation

Without international cooperation, the maximization problem takes the foreign policy  $t^*$  and the repartition of labour  $\alpha^*$  as constant. As previously, governments move first by choosing and announcing a tax level  $t$  ( $t^*$  for the foreign government) that maximizes ex-ante expected utility of their agents. Then agents choose the allocation of labour that equalizes expected utilities across sectors. Consistently with the previous section, we consider the one-step game where governments choose simultaneously  $t, \beta$  and  $\alpha$  under the constraint that  $\alpha$  must equalize expected utilities. In this game however, trade policies at home and abroad do not result from cooperation but are instead a Nash equilibrium between the two states: countries maximize their domestic agents' welfare taking both the foreign tariff and the workers allocation abroad as given. We focus on a symmetric equilibrium, i.e.  $t = t^*$  and  $\alpha = \alpha^*$ .

We consider the case where revenues from trade restrictions are fully collected by farmers, i.e.  $\beta = 0$ . Incomes  $I_H$  and  $I_L$  are still given by (3) but with  $p_L = (1+t)p_H^*$  and  $T = tMp_H^*$ . The country with a negative productivity shock (state  $L$ ) imports:

$$M = \frac{b\alpha - a(1-\alpha)\theta_L p_L}{(1+at)p_H^*} \quad (6)$$

which allows us to obtain

$$p_H = \frac{[\alpha(1+at^*) + \alpha^*]b/a}{\theta_H(1+at^*)(1-\alpha) + \theta_L(1+t^*)(1-\alpha^*)} \quad (7)$$

and the symmetric expression for  $p_H^*$ .



Individuals are indifferent between the two sectors if  $EV_x = EV_y$ , which yields

$$\phi(\alpha, t) \equiv p_H^{b\rho} + [(1+t)p_H^*]^{b\rho} - [\theta_H^{-\rho} p_H^{-a\rho} + R^{-\rho} (1+t)^{-a\rho} p_H^{*-a\rho}] = 0 \quad (8)$$

where

$$R = \theta_L + at \frac{(\theta_H + \theta_L)(1+t) - bt\theta_H - (2+at)(1+t)\theta_L}{(2+at)(1+t)(1+at)}.$$

This expression defines  $\alpha$  as a function of  $t$ ,  $t^*$  and  $\alpha^*$ . It follows that the expected utility is given by

$$EV = -\frac{\kappa}{2} \left[ p_H^{b\rho} + (1+t)^{b\rho} p_H^{*b\rho} \right].$$

Governments maximize this expression with regards to  $t$  under the constraint (8). At the symmetric equilibrium,  $p_H^* = p_H$  and (7) collapses to (5). However, as countries do not cooperate, their optimal policy differ from the collusive situation.

Numerical simulations give us the same qualitative result as previously: welfare is maximized by imposing a non-zero, non-prohibitive import tariff that we denote  $t_{cn}$  (i.e., the optimal trade tax level  $t_{cn}$  verifies  $0 < t_{cn} < \theta_H/\theta_L - 1$ ).

### No international cooperation nor national commitment

Without commitment, the country with a low productivity shock maximizes ex-post welfare, i.e. welfare in state  $L$  after the labour allocation has been chosen. Hence without international cooperation nor commitment at the national level, the government takes the foreign variables  $t^*$  and  $\alpha^*$  as given, as well as the national repartition of labour  $\alpha$ . This corresponds to a Nash equilibrium between the two states where countries maximize their domestic agents' welfare taking both the foreign variables  $t^*$  and  $\alpha^*$  and the domestic workers allocation  $\alpha$  as given. At equilibrium, the labour allocations result from equalization of expected utilities and symmetry ensures that  $t = t^*$  and  $\alpha = \alpha^*$ .

As previously we assume  $\beta = 0$ . Equations (6) and (7) still hold in the case of no cooperation and no commitment. However, the government takes  $t^*$ ,  $\alpha$  and  $\alpha^*$  as given. It maximizes welfare in state  $L$  with regards to the tax, which is expressed as

$$W_L = -\kappa \left( (I_x/p^b)^{-\rho} + (I_y/p^b)^{-\rho} \right) / 2$$

where  $I_x = 1$ , while for a farmer it is given by

$$I_y = \theta_L p_L + T/(1 - \alpha) = p_L R$$

where, using (6),

$$R = \theta_L + \frac{t[b\alpha - a(1 - \alpha)\theta_L(1 + t)p_H^*]}{a(1 - \alpha)(1 + t)p_H^*(1 + at)}.$$

Using numerical simulations, we find that the government maximizes welfare in state  $L$  by imposing a non-zero, non-prohibitive import tariff that we denote  $t_{nn}$  (i.e., the optimal trade tax level  $t_{nn}$  verifies  $0 < t_{nn} < \theta_H/\theta_L - 1$ ).

Analysing how cooperation and commitment interact with trade protection requires comparing the optimal tariff levels in all three cases:<sup>10</sup> the international cooperation case of the previous section and the two cases of international competition above. While a direct analytical comparison is not possible, we use numerical simulations to illustrate how tax levels differ between the cooperative and non-cooperative equilibria (see Figure 1).

### **The role of commitment**

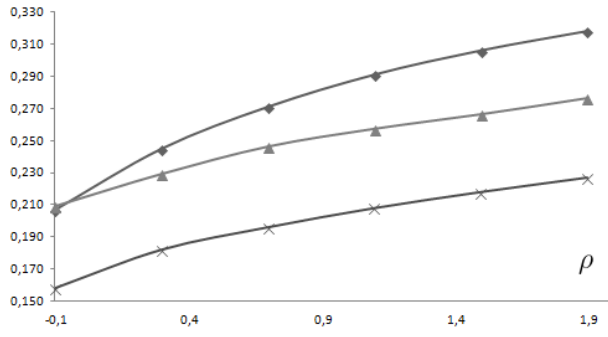
For a government, the possibility to commit toward domestic agents can be used to limit the negative impact of uncertainty upon the attractiveness of the agricultural sector. Indeed, by committing to tax significantly import in bad years, the government can signal that it will limit the unstability of farmers' income, actually supporting their income. As a result, a lower level of tariff is necessary to obtain the same size of agricultural sector than in the previous cases. This is why simulations show that  $t_{cn} > t_{nn}$ .

### **The role of international cooperation**

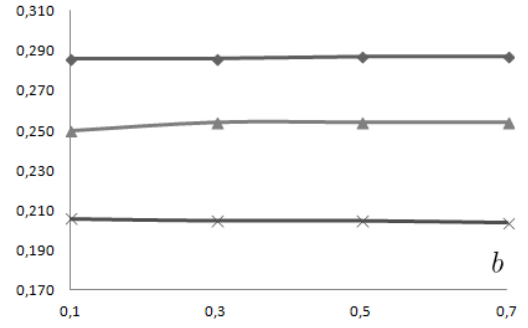
While it is usually held that the main interest of international cooperation through trade disciplines is to limit the extent of protection, the opposite holds here: international cooperation actually prevents countries from decreasing their protection level. To disentangle

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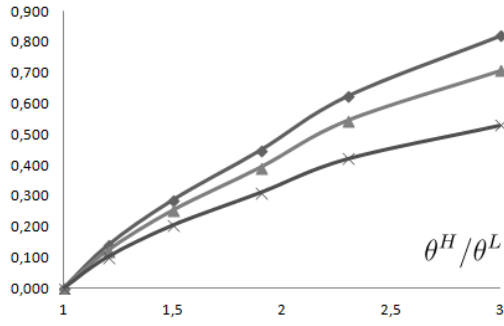
<sup>10</sup>The case of international cooperation but no commitment at the national level was not studied as we can assume agents are aware of international agreements, in which case international cooperation implies national commitment.



$$\theta^H = 1,2; \theta^L = 0,8; a = b = 0,5$$



$$\theta^H = 1,2; \theta^L = 0,8; \rho = 1$$



$$a = b = 0,5; \rho = 1$$

- ◆ Commitment and cooperation (tcc)
- ▲ No commitment and no cooperation (tnn)
- × Commitment and no cooperation (tcn)

Figure 1:  $t_{cc}$ ,  $t_{cn}$  and  $t_{nn}$  for different parameters.

the various general equilibrium effects, we first consider the case  $\alpha = a$ . Labor allocation is optimal in this case, allowing us to focus on other aspects. To ensure a constant value of  $\alpha$ , we assume that revenues are equalized between sectors so that both sectors are equivalent for workers.

When countries cooperate on a common trade policy, imports are given by (4) and prices by (5). Contrary to section 3.1 however,  $\alpha$  is considered constant and incomes are equalized across sectors. It follows that  $w_L = \alpha + (1 - \alpha)\theta_L p_L + T$  and  $w_H = \alpha + (1 - \alpha)\theta_H p_H$  where  $T$  is defined in appendix B. The expected utility for an agent is  $EV = -\kappa \left[ w_H^{-\rho} p_H^{b\rho} + w_L^{-\rho} p_L^{b\rho} \right] / 2$  which is maximized by governments.

Without international cooperation, each country takes the foreign policy as given, so  $p_H$  is expressed by equation (7) and the symmetric expression for  $p_H^*$ . Incomes are equalized across sectors so  $w_L = \alpha + (1 - \alpha)\theta_L p_L + T$  and  $w_H = \alpha + (1 - \alpha)\theta_H p_H$  where  $T$  is given by  $T = t[b\alpha - a(1 - \alpha)\theta_L(1 + t)p_H^*] / [a(1 + at)]$ . Governments maximize the expected utility given by  $EV = -\kappa \left[ w_H^{-\rho} p_H^{b\rho} + w_L^{-\rho} p_L^{b\rho} \right] / 2$ .

Numerical simulations were carried out for  $a = b = 0,5$ ,  $\rho = 0,5$ ,  $\theta_H = 1,5$  and  $\theta_L = 0,5$ . With these parameter values, the cooperative tax amounts to 0,194 and the non-cooperative tax to 0,342. When considering  $\alpha = a$  -and thus avoiding second-round effects due to reallocation of labor- we find that the tax level reached in the cooperative case is lower than that of the non-cooperative case which is coherent with the usual rationale for international cooperation. When governments take labor allocation issues into account, the results are reversed and cooperation leads to higher taxes which suggests that the results are mainly driven by the objective of maintaining a minimum level of agricultural production.

The intuition is the following. Suppose that cooperating is expected by everyone, but that one of the two governments decides to deviate from the agreed level of protection,  $t_{cc}$ , if its agriculture is affected by the negative productivity shock, a change in the policy that is anticipated neither by the other government nor by individuals ( $\alpha$  and  $\alpha^*$  are thus at the cooperative level). This deviation only materializes if this country is indeed affected by the negative productivity shock and is importing. In such case, the deviant government is tempted to increase imports to reduce its domestic agricultural price which is as its highest

level  $p_L$ . As a result, farmers revenues from tax proceeds are slightly reduced (the custom tax is lower but quantities imported are higher), but total agricultural production remains the same and all individuals benefit as consumers of the lower price of agricultural products. Such a deviation leads to an ex-ante expected utility gain. However, this is not the case at the non-cooperative equilibrium where both countries are worse-off compared to the cooperative situation.

Put differently, the short term effect of cutting protection is to lower the domestic price of agricultural products, hence limiting economic distortions. The long-term cost of such policy lies in its impact upon the distribution of the workforce across sectors. Indeed, a lower expected protection level will limit the share of the workforce employed in agriculture. In the present context of risk-averse agents, agricultural output is already inferior to its optimal level, meaning that this decrease deteriorates welfare. In other words, the interest of international cooperation lies in the possibility for each country to benefit from the commitment by its partner to produce a minimum level of agricultural output, hereby putting a floor to international prices.

## 4 Discussion

In practice efforts to stabilize prices and manage markets through STEs have been counter-productive (Minot, 2012). We can find many reasons why it is the case: STEs suffer from sometimes high administrative costs; they create distortions; they lead to inefficiencies; they are believed to be less responsive to the market than private firms; tariffs reduce market access which reduces the benefits from trade; public policies that provide insurance (such as the tariff/redistribution scheme we introduced) create disincentives for private insurances and financial markets; etc. Fulton & Reynolds (2012) describes the political features of STEs in Vietnam and argue that they take advantage of food price spikes by monopolizing the rent from ad hoc export restrictions. The same mechanism should be expected with import taxes. We show that as long as the costs of the mechanism are not higher than the tax proceeds, it still improves welfare. In the present context, rent-seeking behaviours may be investigated

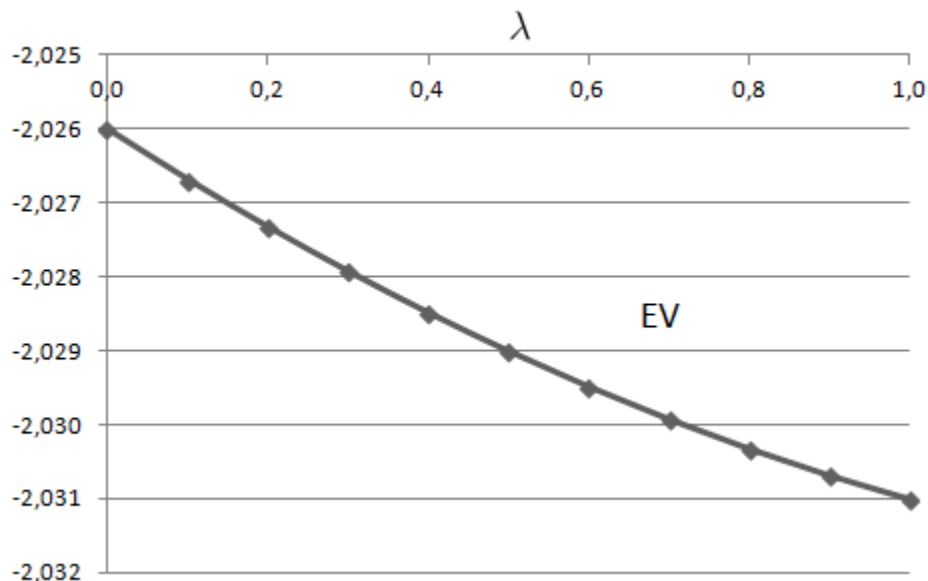


Figure 2: Losses in tax revenues,  $\theta^H = 1, 2$ ,  $\theta^L = 0, 8$ ,  $a = b = 0, 5$ ,  $\rho = 1$ .

by assuming that part of the tax revenue is kept as a rent to be used for some other purposes. We denote  $\lambda$  the share of the tax revenue that is kept as a rent. As tax proceeds are partly lost for farmers (in a proportion  $1-\lambda$ ), the optimality of STEs is questionable. The coefficient  $\lambda$  could also be interpreted as a measure of the inefficiency of the marketing board. Given administrative costs for marketing boards in developing countries, it is not clear whether the tax would be fully redistributed. As reported in Figure 2, as  $\lambda$  moves away from 0, welfare decreases slowly but remains higher than what would be obtained under autarky: as long as some tariff proceeds remain, autarky is not optimal. This warrants the desirability of such a policy even when a proportion of the tax revenue is kept as a rent. However, the experience of stabilizing STEs in Africa show that such a policy should be carefully monitored.

## 5 Conclusion

Marketing boards and more generally STEs play a key role in international trade of commodities, but the rationale has significantly evolved over the last decades. Accordingly, the purpose of this paper is to complement the economic analysis of the rationale for the use of

STEs: while the economic literature has focused on their rent-seeking behavior and on their restrictive impact on market access, we analyze their price stabilization capabilities.

We focus on import STEs, emphasizing the possibility they offer to implement tariff-like interventions while targeting the redistribution of tariff proceeds to a specific group of agents, namely their stakeholder. We use a two-country general equilibrium model with production shocks in agriculture, and assume that international financial markets (the first best) are absent. While income redistribution within the country appears to reduce welfare losses more than trade policies, trade policy instruments may also be used as alternative tools to compensate for the absence of financial markets. Under these assumptions, we show that trade policies can actually improve global welfare: a non-prohibitive, non-zero level of import tax maximizes global welfare when tax proceeds are fully redistributed to farmers. This illustrates how import STEs may be used to achieve both price stabilization and risk-sharing across agents within the importing economy.

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## A Proof of proposition 1

We assume there are iceberg trade costs that correspond exactly to the revenue of the tax, so there is no redistribution. Agents are indifferent ex ante between the two sectors if  $EV_x = EV_y$  which leads to

$$p_H^{b\rho} + p_L^{b\rho} = (\theta_H p_H^{1-b})^{-\rho} + (\theta_L p_L^{1-b})^{-\rho}.$$

Dividing by  $p_H^{b\rho}$  and using  $p_L = (1+t)p_H$  yields

$$f(t) = g(t)p_H^{-\rho}$$

where

$$f(t) = 1 + (1+t)^{b\rho}$$

and

$$g(t) = \theta_H^{-\rho} + [\theta_L(1+t)^a]^{-\rho}$$

which gives (2). Using  $EV_x = -\kappa f(t)p_H^{b\rho}/2$  where  $p_H = [g(t)/f(t)]^{1/\rho}$  and knowing that the expected utilities are the same across sectors but also across countries we get the global expected utility

$$EV(t) = 2EV_x = -\kappa f(t)[g(t)/f(t)]^b = -\kappa f(t)^a g(t)^b.$$

Differentiating, we get

$$EV'(t) = \kappa f(t)^{-b} g(t)^{-a} ab\rho(1+t)^{b\rho-1} ([ (1+t)\theta_L ]^{-\rho} - \theta_H^{-\rho})$$

We have  $EV'(t) = 0$  if  $t = \theta_H/\theta_L - 1$  and  $EV'(t) > 0$  iff  $t < \theta_H/\theta_L - 1$  so the optimum is  $t^* = \theta_H/\theta_L - 1$  which corresponds to autarky. (More generally, convexity of  $EV$  depends on  $\rho$ . If  $\rho < 0$ ,  $EV'(t) < 0$  for all  $t < \theta_H/\theta_L - 1$  so the optimum is free trade.)

## B Proof of proposition 2

Define

$$A(t) = \frac{(2+at)(1+t)}{(\theta_H + \theta_L)(1+t) - bt\theta_H}.$$

We have

$$p_L = p_H(1 + t) = A(t)b\alpha/[a(1 - \alpha)], \quad (9)$$

and, using (4),

$$M = \frac{b\alpha[1 - \theta_L A(t)]}{(1 + at)p_H}$$

which gives

$$T = tMp_H = b\alpha[1 - A(t)\theta_L]t/(1 + at).$$

With a sharing rule  $\beta$ , the revenue of the industrial worker in state  $L$  is

$$I_x = 1 + T(\beta/\alpha) = 1 + b\beta[1 - A(t)\theta_L]t/(1 + at)$$

while for a farmer it is given by

$$I_y = \theta_L p_L + T(1 - \beta)/(1 - \alpha) = p_L R$$

where

$$R = \theta_L + (1 - \beta)at[1 - A(t)\theta_L]/[A(t)(1 + at)].$$

The individuals are indifferent between the two sectors if  $EV_x = EV_y$  which yields

$$p_H^{b\rho} + I_x^{-\rho} p_L^{b\rho} = (\theta_H p_H^a)^{-\rho} + (I_y p_L^{-b})^{-\rho}$$

or (dividing by  $p_H^{\rho b}$  and using  $p_L = p_H(1 + t)$ ),

$$f(t, \beta) = g(t, \beta) p_H^{-\rho}$$

where

$$f(t, \beta) = 1 + I_x^{-\rho} (1 + t)^{b\rho}$$

and

$$g(t, \beta) = \theta_H^{-\rho} + [(1 + t)^a R]^{-\rho}.$$

Using (9), we obtain  $\alpha$  as a function of  $\beta$  and  $t$  satisfying

$$\frac{\alpha}{1 - \alpha} = \left[ \frac{g(t, \beta)}{f(t, \beta)} \right]^{1/\rho} \frac{a(1 + t)}{bA(t)}.$$

Using  $p_H = [g(t, \beta)/f(t, \beta)]^{1/\rho}$  and  $EV_x = -\kappa f(t, \beta) p_H^{b\rho}/2$  gives the equilibrium expected utility

$$EV(t, \beta) = -\kappa f(t, \beta)^a g(t, \beta)^b$$

which is the same for all agents in both countries. Hence, the optimal international discipline is solution of  $\max_{\beta, t} EV(\beta, t)$ . We have

$$\begin{aligned} \frac{\partial EV}{\partial \beta} &= -\kappa f(t, \beta)^{-b} g(t, \beta)^{-a} \left\{ ag(t, \beta) \frac{\partial f(t, \beta)}{\partial \beta} + bf(t, \beta) \frac{\partial g(t, \beta)}{\partial \beta} \right\} \\ &= \kappa f(t, \beta)^{-b} g(t, \beta)^{-a} \rho (1+t)^{b\rho} \\ &\quad \{ ag(t, \beta) [I_x^{-\rho-1} dI_x/d\beta] + bf(t, \beta) [(1+t)^{-\rho} R^{-\rho-1} dR/d\beta] \} \end{aligned}$$

where

$$dI_x/d\beta = b[1 - A(t)\theta_L]t/(1+at)$$

and

$$dR/d\beta = -a[1 - A(t)\theta_L]t/[A(t)(1+at)]$$

We thus have

$$\begin{aligned} \partial EV/\partial \beta &= \kappa (1+t)^{b\rho} t b a f(t, \beta)^{-b} g(t, \beta)^{-a} [1 - A(t)\theta_L] (1+at)^{-1} \\ &\quad \times [I_x^{-\rho-1} g(t, \beta) - (1+t)^{-\rho} R^{-\rho-1} A(t)^{-1} f(t, \beta)] \end{aligned}$$

As imports are positive, we get from the expression of  $M$  that  $1 - A(t)\theta_L \geq 0$  and thus the first line is positive or equal to zero in autarky or free trade. The last bracketed term has the same sign as

$$A(t)^{-\rho} (1+t)^\rho [A(t)R]^{\rho+1} g(t, \beta) - I_x^{\rho+1} f(t, \beta)$$

which is equal to

$$[A(t)\theta_H/(1+t)]^{-\rho} [A(t)R]^{\rho+1} + (1+t)^{b\rho} A(t)R - [I_x^{\rho+1} + (1+t)^{b\rho} I_x]$$

As  $1+t \leq \theta_H/\theta_L$  we have  $A(t)\theta_H \geq 1+t$  and thus

$$[A(t)\theta_H/(1+t)]^{-\rho} [A(t)R]^{\rho+1} + (1+t)^{b\rho} A(t)R \leq [A(t)R]^{\rho+1} + (1+t)^{b\rho} A(t)R.$$

Finally, as

$$\begin{aligned}
A(t)R &= A(t)\theta_L + (1 - \beta)a[1 - A(t)\theta_L]t/(1 + at) \\
&= [A(t)\theta_L + at]/(1 + at) - \beta a[1 - A(t)\theta_L]t/(1 + at) \\
&\leq 1 - \beta a[1 - A(t)\theta_L]t/(1 + at) \leq 1 \leq I_x
\end{aligned}$$

we deduce that  $\beta = 0$  at the optimum.

## C Proof of Proposition 3

With  $\beta = 0$ , the revenue of the industrial worker is  $I_x = 1$  whatever the state, while for a farmer in state  $L$  it is given by  $I_y = p_L R$  where

$$R = \theta_L + at[1 - A(t)\theta_L]/[A(t)(1 + at)].$$

The individuals are indifferent between the two sector if  $EV_x = EV_y$  which yields the following global expected welfare (see above)

$$EV(t) = -\kappa f(t)^a g(t)^b \tag{10}$$

where

$$f(t) = 1 + (1 + t)^{b\rho} \tag{11}$$

and

$$g(t) = \theta_H^{-\rho} + (1 + t)^{-a\rho} R^{-\rho}. \tag{12}$$

Differentiating we get

$$EV'(t)/EV(t) = af'(t)/f(t) + bg'(t)/g(t).$$

As  $f(0) = 2$ ,  $g(0) = \theta_H^{-\rho} + \theta_L^{-\rho}$ ,  $f'(0) = b\rho$  and  $g'(0) = -a\rho\theta_L^{-(\rho+1)}\{\theta_L + [1 - A(0)\theta_L]/A(0)\}$  where

$$A(0) = 2/(\theta_H + \theta_L)$$

and

$$[1 - A(0)\theta_L]/A(0) = (\theta_H + \theta_L)/2$$

we have

$$g'(0) = -a\rho\theta_L^{-(\rho+1)}(\theta_H + \theta_L)/2$$

which gives

$$\begin{aligned} af'(0)g(0) + bg'(0)f(0) &= ab\rho[\theta_H^{-\rho} + \theta_L^{-\rho}] - ab\rho\theta_L^{-(\rho+1)}(\theta_H + \theta_L) \\ &= ab\rho\theta_H\theta_L^{-(\rho+1)}\{(\theta_L/\theta_H)^{\rho+1} - 1\} \\ &< 0 \end{aligned}$$

and thus  $EV'(0) > 0$ . For  $t = \bar{t} \equiv \theta_H/\theta_L - 1$  we have  $A(\bar{t}) = 1/\theta_L$ ,  $R(\bar{t}) = \theta_L$ ,

$$f(\bar{t}) = 1 + (\theta_H/\theta_L)^{b\rho}$$

and

$$g(\bar{t}) = \theta_H^{-\rho} + (\theta_H/\theta_L)^{-a\rho} \theta_L^{-\rho} = \theta_H^{-\rho} f(\bar{t}).$$

Consequently

$$EV'(\bar{t}) = -\kappa[af'(\bar{t})\theta_H^{-\rho b} + b\theta_H^{\rho a}g'(\bar{t})]$$

where

$$f'(\bar{t}) = b\rho(\theta_H/\theta_L)^{b\rho-1}$$

$$g'(t) = -\rho(1+t)^{-a\rho}R^{-\rho}[a(1+t)^{-1} + R^{-1}R'(t)]$$

with

$$R'(\bar{t}) = \frac{-a\bar{t}A'(\bar{t})\theta_L}{A(\bar{t})(1+a\bar{t})} = \frac{-a(\theta_H - \theta_L)\theta_L^2}{b\theta_L + a\theta_H}A'(\bar{t})$$

which gives

$$g'(\bar{t}) = -a\rho(\theta_H/\theta_L)^{-(a\rho+1)}\theta_L^{-\rho} \left[ 1 - \frac{\theta_H - \theta_L}{b\theta_L + a\theta_H} \theta_H A'(\bar{t}) \right].$$

We finally obtain

$$EV'(\bar{t}) = -\kappa ab\rho\theta_L^{-b\rho+1} \frac{\theta_H - \theta_L}{b\theta_L + a\theta_H} A'(\bar{t})$$

where  $A'(\bar{t}) > 0$  which implies  $EV'(\bar{t}) < 0$ . Consequently, there is an optimal tax level  $t^* \in (0, \bar{t})$ .