Conflict and Policy in General Equilibrium: Insights from a Standard Trade Model

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June 23, 2010

Abstract

We revisit a framework of conflict in a canonic open economy model to examine appropriate policy responses. We derive further implications of the framework, we link them to other results in the literature, and we explore the scope and limits of the analogy between policy analysis in a conflict economy and the policy analysis under distortions offered by the traditional trade literature. We rank alternative economic policies as a response to conflict in terms of welfare implications.

JEL Classification: D72, D74, D78, F13, H23, K42, O1.

Keywords: conflict, civil war, crime, trade policy, intervention, second best.

*We thank Juan Carlos Hallak and Shanker Satyanath as well as the editors Michelle Garfinkel and Stergios Skaperdas for very helpful comments.

1 Introduction

The literature on social conflict is by now large, and deals mainly with the determinants of conflict. Some of these determinants are economic in nature, and therefore economic policy should have an effect on the likelihood and intensity of conflict. But an important question remains: which specific economic policies should be used to reduce the scope for conflict? In this chapter we address the possibility of ranking different economic policies in terms of their suitability for reducing conflict and improving welfare. We carry out our analysis in the context of a model where conflict is seen as tied to appropriation activities. The framework of analysis is taken from a paper we wrote a few years ago (Dal Bó and Dal Bó, 2004).

In that paper we started by analyzing the connection between income, shocks, and conflict, and then we showed how different economic policies could be used to reduce conflict. We studied tax/subsidy schemes on consumption goods, tax/subsidy schemes on production factors, trade policy interventions, and technology policy interventions. However, we did not establish conclusions regarding the relative merits of those policies. This chapter revisits the framework introduced in our earlier paper with the goal of pushing further the policy analysis. We will seize this opportunity to follow the logic of the model to its natural conclusion and establish some corollaries, and also integrate in this framework some other results in theories of conflict.

To provide some context for the modeling approach taken here, note that the literature on conflict has grappled with the complicated connection between income and conflict for a long time. In particular, the observation that income could have diverging effects has long been connected to two different mechanisms operating in opposite directions. Wealth-

ier countries offer better wages for individuals, raising the opportunity cost of engaging in conflict activities. But in wealthier environments there is more to appropriate by resorting to violence, raising the returns to conflict. One can write models where both channels are separately affected by different shocks, yielding a simple characterization: some shocks raise the returns to conflict and therefore increase its likelihood and intensity, while other shocks raise the costs of conflict and therefore have the opposite effect.

There are two problems with that approach. One is that shocks in real life are likely to simultaneously affect both the opportunity costs and the returns to conflict. For example, if a shock raises wages, this not only raises the costs of conflict. If wage income can be targeted by appropriators, the returns to appropriation-motivated conflict must necessarily increase as well. The question is then whether there are explanations that are both simple and systematic regarding which force (costs vs returns) will dominate following a shock. The other problem is that there are many degrees of freedom in writing a model. Our earlier paper overcame these two problems by adopting a general equilibrium approach to conflict that was grounded in mainstream economics: we embedded conflict in the classic Heckscher-Ohlin and Ricardo-Viner models of a small open economy.

Given that framework, there are two main parts to the analysis offered in this chapter. One establishes that a number of implications follow quite directly from a basic trade model augmented with conflict. For example, as stated in our earlier paper the Rybczinski theorem implies that the conflict activity alters the relative factors available for production in a country, and therefore its production mix. That can lead to alterations in the country's trade profile and trade patterns, which in turn affects the scope for policy intervention.

Another implication is that, in the presence of conflict, growth can be immiserizing even in the absence of the terms of trade effects usually considered necessary for the classic immiserizing result (Bhagwati, 1955).

The other part of the analysis concerns the ranking of policies aimed at reducing social conflict. We explore here the extent to which policy analysis under a "social constraint" is analogous to the classic, second best, policy analysis under distortions available in the trade literature. Establishing the scope and limits of such an analogy is important in order to be able to map policy questions in the realm of conflict to classic results in the theory of the second best. We show that important analogies can be found between conflict and two of the distortions traditionally considered in the trade literature, namely externalities in production and factor market imperfections. Moreover, the policy ranking under conflict matches that under factor market distortions in conflict-free economies. However, the ranking of policies under the social constraint cannot be automatically derived from the pre-existing trade literature. Under factor market imperfections in a conflict free-economy, the full control of government over property rights implies that an appropriate Pigovian tax/subsidy scheme over factors can restore the first best. This is not true in the case of a conflict economy, prompting the question of whether a combined intervention in the market for goods must be used. The answer is that it will always be best to use a factor market intervention until it ceases to be effective. At that point, however, other interventions will cease to be effective as well, preserving the classic policy ranking.

The plan for the chapter is as follows. Section 2 presents the model and its main basic results. Section 3 introduces preferences and derives further implications for policy, relating

these results to other findings in the literature. Section 4 explores the analogy between policy analysis in a conflict economy and traditional policy analysis under distortions. That section contains our derivation of the policy ranking. Section 5 concludes.

2 A canonical model of an open economy with appropriation

2.1 The model

We consider the canonical 2x2 international economics model, along the lines of Stolper and Samuelson (1941), comprising an economy with two productive industries, 1 and 2, and two production factors, K and L. The two productive industries are made of many profit maximizing firms utilizing constant returns to scale technologies. All firms in an industry use the same technology. Industry 1 is more capital intensive than industry 2, and there is full factor mobility across the two industries. We denote with r and w the respective rental prices of capital and labor. There are fixed factor endowments in amounts $\overline{K}$ and $\overline{L}$. We denote as p_1 the price of the product from industry 1, and we normalize the prize of the product from industry 2 to one (good 2 is the numeraire). We denote the production levels of each industry as q_1 and q_2.

In addition to the productive sectors, there exists an appropriation sector. This sector can in principle use both labor and capital (see Dal Bó and Dal Bó, 2004 for an extension to this general case) but for simplicity of exposition we assume here that the appropriation sector

uses only labor (L_A) to appropriate wealth.[1] The fraction of the total wealth that is appropriated when L_A units of labor are devoted to appropriation is given by the function $A(L_A)$. We assume that $A(L_A)$ is increasing and strictly concave, with $A(0) \geq 0$ and $A\left(\overline{L}\right) \leq 1$.[2] Given production levels q_1 and q_2 in the two industries, the appropriated value is $A(L_A)[p_1 q_1 + q_2]$. Given that under constant returns to scale payments to factors exhaust the value of production, the appropriated amount can be written as $A(L_A)\left[r\overline{K} + w(\overline{L} - L_A)\right]$. The terms r and w represent the gross (before appropriation) rental prices of capital and labor in the productive sectors.

Workers decide whether to enter the productive sectors or the appropriation sector. The returns to a unit of labor in a productive sector is the wage net of appropriation. The returns to a unit of labor in the appropriation sector are $\left(A(L_A)/L_A\right)\left[r\overline{K} + w(\overline{L} - L_A)\right]$, whereby each unit of labor applied to appropriation gets an even share of the appropriated wealth. We assume that each worker is infinitesimally small and there is free entry into the appropriation sector.[3] Therefore, the amount of labor in this sector is determined by the equality of the return to labor in the productive sectors and the appropriation sector. In this model, appropriators are seen as noncooperatively exploiting a common resource, and our equilibrium condition coincides with the standard equilibrium condition in models of

[1] The key condition is that the appropriation sector be more labor intensive than the economy. The equilibrium conditions and the results do not change if we assume that appropriation targets output, endowments, or paychecks to factor owners.

[2] The assumption of strict concavity is for convenience only—similar results can be obtained with a linear technology featuring a positive intercept.

[3] Our original paper show that results are robust to altering the industrial organization of appropriation to oligopoly and monopoly, as well as to including endogenous enforcement of property rights.

exploitation of common natural resources with free entry (see Dasgupta and Heal, 1979).

Finally, we assume that all agents in the economy have the same homothetic preferences over bundles of the two goods. From the maximization of their utility given output prices (p_1) and income M we obtain aggregate demand functions $c_1(p_1, M)$ and $c_2(p_1, M)$.

2.2 The Equilibrium

Given the technology, output prices (p_1) and factor endowments ($\overline{K}$ and $\overline{L}$), the equilibrium of the model determines the rental price of factors (r and w), the output production levels (q_1 and q_2), and the utilization of factors in each sector (K_1, K_2, L_1, L_2 and L_A).

As is standard, we focus on equilibria without productive specialization (i.e. both q_1 and q_2 are positive). Four sets of conditions must be satisfied in a competitive equilibrium. First, firms in the productive industries must earn zero profits:

$$ra_{1K} + wa_{1L} = p_1 \quad (1)$$

$$ra_{2K} + wa_{2L} = 1. \quad (2)$$

where a_{ij} denotes the minimum-cost requirements of inputs: the amount of input j used to produce one unit of output i at minimum cost given the technology and factor prices (r and w). Given the technologies and output prices (p_1), equations (1) and (2) determining the equilibrium factor prices r and w.

Second, the market for factors must clear:

$$q_1 a_{1K} + q_2 a_{2K} = \overline{K} \quad (3)$$

$$q_1 a_{1L} + q_2 a_{2L} = \overline{L} - L_A. \quad (4)$$

Given the equilibrium factor prices (which determine the equilibrium minimum-cost requirements of inputs) and the total supply of factors to the productive industries, equations (3) and (4) determine the equilibrium level of production in both industries (q_1 and q_2).

Third, a no arbitrage condition must hold for the allocation of labor between the productive industries and appropriation:

$$\frac{A\left(L_A\right)}{L_A}\left[r\overline{K}+w(\overline{L}-L_A)\right]=[1-A\left(L_A\right)]w. \tag{5}$$

This last condition merely says that the individual payoff from appropriation (in the left hand side), the value of appropriated goods per unit of labor deployed to expropriation, must equal the returns from work net of appropriation losses (in the right hand side). This equation determines the amount of labor allocated to appropriation given the equilibrium factor prices and the total endowment of factors.

Finally, the country may be open or closed to international trade. If the country is open to trade we assume that the country is small relative to the rest of the world and it cannot affect the international price of good 1:

$$p_1=p_1^I. \tag{6}$$

In a closed economy output prices must clear the markets of products. That is, we must add the following equilibrium condition to the system:

$$c_1\left(p_1,M\right)=q_1 \tag{7}$$

Our original paper establishes conditions for equilibrium existence for the open economy; a similar analysis can be done for the case of a closed economy.

For the rest of this chapter we will focus on equilibria with positive levels of appropriation. If there exists an equilibrium without specialization for the economy without appropriation, $A(\overline{L})$ is sufficiently small and $A'(0)$ is sufficiently large, then in the economy with an appropriation sector there is an equilibrium with no specialization and positive levels of conflict.

2.3 The effects of conflict

In this section we focus on the open economy and study how the existence of conflict affects the economy.

We start by studying the effect of conflict on the return to production factors. A key feature of the 2x2 Stolper-Samuelson setup is that, under productive diversification, the existence of an appropriation sector does not affect the gross rental prices of factors. These are solely determined by technology. The amount of labor engaging in appropriation is residually determined in equations (3) to (5) so that the market for factors will clear. The presence of appropriation activities, however, does decrease the rental prices net of appropriation that factor owners actually receive, making the owners of capital and labor strictly worse off. Because in equilibrium those in the appropriation sector earn the same as common workers, it follows that in an equilibrium with appropriation everyone is worse off:

Proposition 1 *(Dal Bó and Dal Bó, 2004) The existence of conflict makes the owners of capital and labor worse off.*

Our model also allows us to study how conflict affects the level of activity of the two productive industries. The appropriation activity reduces the amount of labor available for

production making the productive economy less labor abundant. Therefore, by the famous Rybczynski (1955) theorem, we obtain the following proposition.

Proposition 2 *(Dal Bó and Dal Bó, 2004) The existence of conflict increases the production of the capital intensive good and reduces the production of the labor intensive good.*

In fact, the effect of conflict on production may be large enough to overturn trade patterns.

Corollary 1 *For any economy that without conflict imports good* 1 *and exports good* 2*, there exists an appropriation sector with technology* $A(L_A)$ *such that the economy with appropriation would export good* 1 *and import good* 2*. That is, there is an appropriation technology that would overturn the patterns of trade.*

Proof. Given homothetic preferences, the relative consumptions of goods $\frac{c_1(p_1,M)}{c_2(p_1,M)}$ depends only on the price p_1, and does not depend on income M. As such, in an open economy with a given price p_1, the existence of conflict will not affect the relative consumptions of both goods as domestic conflict does not affect international prices. Therefore, to show that conflict can change the patterns of trade from importing to exporting good 1, we must show that it is possible to have $\frac{q_1}{q_2} < \frac{c_1}{c_2}$ without conflict and $\frac{q_1}{q_2} > \frac{c_1}{c_2}$ with conflict.

From equations (3) and (4) we have that the relative production of goods 1 and 2 is:

$$\frac{q_1}{q_2} = \frac{a_{2L}\overline{K} - a_{2K}\left(\overline{L} - L_A\right)}{a_{1K}\left(\overline{L} - L_A\right) - a_{1L}\overline{K}}. \tag{8}$$

Then, if without conflict the country imports good 1, it must be the case that:

$$\frac{c_1}{c_2} > \frac{a_{2L}\overline{K} - a_{2K}\overline{L}}{a_{1K}\overline{L} - a_{1L}\overline{K}}. \tag{9}$$

For the country to export good 1 with conflict, it must be the case that:

$$\frac{c_1}{c_2} < \frac{a_{2L}\overline{K} - a_{2K}\left(\overline{L} - L_A\right)}{a_{1K}\left(\overline{L} - L_A\right) - a_{1L}\overline{K}}. \tag{10}$$

Rearranging equation (10), we have that for the flow of trade to change the amount of labor allocated to conflict must be large enough:

$$L_A > \frac{\frac{c_1}{c_2}\left(a_{1K}\overline{L} - a_{1L}\overline{K}\right) - \left(a_{2L}\overline{K} - a_{2K}\overline{L}\right)}{a_{2K} - \frac{c_1}{c_2}a_{1K}} \equiv \underline{L_A}. \tag{11}$$

Note that the numerator in condition (11) is positive by equation (9). In addition, it can be easily shown that the critical value of labor allocated to conflict, $\underline{L_A}$, in condition (11) is less than the total amount of labor in the economy, $\overline{L}$, and smaller than the amount of conflict that would result in productive specialization in good 1.

Therefore, for any conflict technology that results in an allocation of labor to conflict equal to $L_A^* > \underline{L_A}$, the existence of conflict would change the pattern of trade. It only remains to show that such a conflict technology exists. Existence can be shown with a simple example. Consider $A\left(L_A\right) = \frac{L_A}{\gamma + L_A}$ with $\gamma = \frac{r}{w}\overline{K} + \overline{L} - L_A^*$. ■

An important literature in trade has focused on the determinants of trade flows among countries (see for instance Deardorff 1984 for a survey of tests of trade theories and an overview of results on determinants of trade patterns). That literature, however, abstracts from the possible presence of conflict in each country.

The above result on the connection between conflict and trade was first established in Garfinkel, Skaperdas and Syropoulos (2008) in the context of a different model where the pattern of trade involving one unproduced good was emphasized. The notion that conflict seen as appropriation may alter the relative factor mixes available for production and hence

trade patterns resonates with other contributions emphasizing that the security of property rights, and institutional characteristics more broadly, may affect comparative advantage (e.g., Levchenko 2007, Nunn 2007, Vogel 2007).

2.4 Immiserizing growth

Bhagwati (1955) considered the effects of increasing a factor endowment on the welfare attainable in a *large* open economy (see Dixit and Norman 1980 for a modern treatment utilizing duality theory). When an economy receives an extra amount of the endowment which is intensively used in its exporting industry, the effect will be to augment the country's exports. If the country is large, such an increase will cause the terms of trade to deteriorate. Such deterioration may be large enough that the country attains a lower welfare level under the expanded factor endowment. As is well known, this result is intimately linked to Edgeworth's transfer paradox.

The presence of conflict does not bear an analogy to market power. However, in the presence of conflict immiserizing growth may obtain in a small open economy where terms of trade effects are absent.

Proposition 3 *In an economy with conflict an increase in endowments may reduce income. In other words, growth may be immiserizing.*

Proof. Consider an increase in the country's capital endowment. The country's income is given by $M = r\bar{K} + w\left(\bar{L} - L_A\right)$. The capital expansion will not affect international prices nor the rental price of factors. We can then write:

$$\frac{dM}{d\bar{K}} = r - w\frac{dL_A}{d\bar{K}}$$

Therefore, to prove that an increase in the endowment of capital may have a negative effect on income we only need to find a technology of appropriation such that in equilibrium $\frac{dL_A}{d\bar{K}} > \frac{r}{w}$ while making sure the solution is interior and no specialization occurs. Consider for instance the technology $A(L_A) = m + sL_A$, with $m, s > 0$. Using (5) we find that the equilibrium level of conflict is $L_A = \frac{m}{\frac{1}{(\frac{r}{w}\bar{K}+\bar{L})} - s}$. For an interior solution in L_A and $A < 1$ we respectively need (i) $s < \frac{1}{\frac{r}{w}\bar{K}+\bar{L}}$ and (ii) $m + sL_A < 1$. For no specialization we need L_A to be small enough so that $L_A < \bar{L} - \bar{K}\frac{a_{1L}}{a_{1K}}$ and $q_2 > 0$, which requires (iii) $m < \frac{(\bar{L}-\bar{K}\frac{a_{1L}}{a_{1K}})(1-s\left(\frac{r}{w}\bar{K}+\bar{L}\right))}{\left(\frac{r}{w}\bar{K}+\bar{L}\right)}$. It is easy to show that $\frac{dL_A}{d\bar{K}} > \frac{r}{w}$ if and only if (iv) $m > \left(1 - s\left(\frac{r}{w}\bar{K} + \bar{L}\right)\right)^2$. Straightforward algebra shows conditions (i)-(iv) are met for all values of (s, m) satisfying,

$$\begin{aligned} (1 - s\left(\frac{r}{w}\bar{K} + \bar{L}\right))^2 &< m < \frac{(\bar{L} - \bar{K}\frac{a_{1L}}{a_{1K}})(1 - s\left(\frac{r}{w}\bar{K} + \bar{L}\right))}{\left(\frac{r}{w}\bar{K} + \bar{L}\right)} \\ \frac{1}{\left(\frac{r}{w}\bar{K} + \bar{L}\right)} - \frac{(\bar{L} - \bar{K}\frac{a_{1L}}{a_{1K}})}{\left(\frac{r}{w}\bar{K} + \bar{L}\right)} &< s < \frac{1}{\left(\frac{r}{w}\bar{K} + \bar{L}\right)}. \end{aligned}$$

Note that the upper bounds are greater than the lower bounds, so for any productive economy it is possible to find values of (s, m) such that an increase in the capital endowment reduces income. ■

The possibility that a windfall may backfire appears in various models. In Tornell and Lane (1989), a terms of trade windfall increases rent-seeking from opposing groups, triggering a capital flight that lowers growth. In Hotte, Van Long and Tian (2000), the price effects of trade opening may cause a socially costly move from an open access regime for exploiting a common resource to an enclosures regime. The move is costly because under the enclosures regime resources are spent on the enforcement of exclusionary property rights. More generally, various papers have been written on the resource curse. We will not attempt to do them justice here. Our last proposition complements that literature by connecting

the classic immiserizing growth result with the effects of a conflict distortion in a canonical trade model. It is worth mentioning that the endowment that is increased in the proposition above is a productive one, rather than a stock that can only be disputed for direct sale or consumption.

2.5 The effect of trade opening when there is social conflict

Our model allows us to study when opening the economy to international trade will increase conflict. An important feature of the model is that it integrates the decision of workers between conflict vs productive activities into standard models of trade; this allows studying how opening the economy to international trade will modify the returns to factors and the incentives of workers to get into conflict activities in the context of otherwise well known mechanisms. In fact, the main proposition in our earlier paper, and its modified version below follow directly from two other results, the first of which is the famous Stolper-Samuelson theorem linking international prices with domestic factor prices.

Lemma 1 *(Stolper and Samuelson 1941) An increase in the price of the capital intensive good results in an increase in the rental price of capital and a decrease in the rental price of labor* ($\frac{dr}{dp_1} > 0$ *and* $\frac{dw}{dp_1} < 0$*).*

The second result on which the main proposition in this section will hinge relates to how conflict changes with changes in the rental price of factors.

Lemma 2 *An increase in the rental price of capital relative to labor results in an increase in conflict* ($\frac{dL_A}{d\frac{r}{w}} > 0$*).*

Proof. The equilibrium condition for the appropriation sector (5) can be written as $A(L_A) = \frac{L_A}{\frac{r}{w}\overline{K}+\overline{L}}$. The conditions for the implicit function theorem are satisfied, so we can write L_A as a function of $\frac{r}{w}$. Differentiating the previous equality with respect to $\frac{r}{w}$ we obtain: $\frac{dL_A}{d\frac{r}{w}} = -\frac{\frac{\overline{K}L_A}{(\frac{r}{w}\overline{K}+\overline{L})^2}}{[A'-\frac{1}{\frac{r}{w}\overline{K}+\overline{L}}]}$. Given the concavity of $A(L_A)$, and that in equilibrium $A(L_A) = \frac{L_A}{\frac{r}{w}\overline{K}+\overline{L}}$, it is the case that $A' - \frac{1}{\frac{r}{w}\overline{K}+\overline{L}} < 0$, and $\frac{dL_A}{d\frac{r}{w}} > 0$. ■

By the Stolper-Samuelson theorem (called lemma 1 in this chapter), an increase in the price of the capital intensive good increases the rental price of capital relative to labor, and, by lemma 2, we know that this will increase conflict. Therefore, any increase in the price of the capital intensive good will result in an increase in conflict as discussed in Dal Bó and Dal Bó (2004). In particular, this tells us when trade will increase conflict:

Proposition 4 *Opening to international trade will increase conflict if the international price of the capital intensive good is greater than its domestic price under autarky.*

The intuition for this result involves the balance of two forces. First, trade affects workers' wages, which affects the opportunity cost of conflict. Second, trade affects the wealth that can be targeted. As a result, trade affects both sides of the cost-benefit equation of appropriators (as captured in the right and left hand sides of equation (5), respectively). Interestingly, to understand the balance between these two forces we only need to understand how trade affects the relative prices of factors in the economy.

This proposition has welfare ramifications: it may be the case that the gains from trade are overshadowed by trade-spurred conflict, resulting in lower welfare. It has long been known that in the presence of distortions a move from autarky to free trade may (though it will not necessarily) be welfare decreasing. The debate can be traced back to the fifties

and sixties –see for instance Bhagwati and Ramaswami (1963). In the context of conflict, Garfinkel, Syropoulos and Skaperdas (2008) established a more precise result, namely that when international prices are close enough to autarky prices, trade opening will necessarily reduce welfare. Some research remains to be done in the context of conflict models to isolate the most general conditions under which free trade will necessarily decrease welfare over some range of prices, as well as to identify situations in which free trade must necessarily increase welfare. For example, it is easy to show that even in the presence of conflict free trade must be welfare increasing when preferences display an infinite elasticity of substitution.

Because in the presence of conflict trade could be welfare reducing, trade interventions may be welfare improving. However, as is well known in the trade literature, even if trade is welfare reducing it does not follow that trade intervention is the best policy. In section 3 we discuss the welfare ranking of possible interventions in an economy with conflict. But before we draw a parallel between our model and a simpler one that also captures the effects of trade on conflict economies.

2.6 Comparison with a simpler model

As anticipated in the introduction, it is possible to write simple models where restrictive assumptions pair specific shocks with a force affecting conflict. For instance, a shock to the price of one good could always affect the returns to conflict and nothing else, while another type of shock always affects the opportunity costs of conflict and nothing else. This approach introduces restrictive assumptions on the way the economy is portrayed, and it abstracts from general equilibrium considerations linking prices of goods on the one hand,

and prices of factors on the other.

In this subsection we exemplify that approach and establish a clear contrast with the general equilibrium effects present in the model used earlier in this chapter. The simpler model presented in this subsection, which can be obtained from the more general model presented earlier by imposing a number of restrictions, captures the forces usually studied in the conflict literature. Using this simpler model we provide a result regarding trade and conflict related to proposition 4.

As before we consider an economy with two goods, 1 and 2. Production is now 'simpler' in that a strict subset of factors is required: labor is the only production factor. Good 2 no longer requires capital to be produced, while good 1 no longer requires any factors of production. In other words, good 1 is not produced; rather, there is endowment or stock S of it available for consumption. The productive industry 2 is comprised of many profit maximizing firms utilizing an identical constant returns to scale technology. This technology uses labor with marginal productivity equal to α. We denote with w the rental price of labor. There is a fixed endowment of labor $\overline{L}$. As before, we denote with p_1 the price of the product from industry 1, and good 2 is the numeraire. In addition to the productive sectors, there exists an appropriation sector that can obtain a share $A(L_A)$ of the stock of good 1 by allocating units of labor to appropriation. This is another important simplification relative to the earlier model: we say that good 1 is the lootable resource, while good 2 (or the income generated by it) can no longer be targeted for appropriation at all. We also assume that all agents in the economy have the same homothetic preferences over bundles of the two goods. From the maximization of their utility given output prices (p_1) and income M we obtain

aggregate demand functions $c_1(p_1, M)$ and $c_2(p_1, M)$.

Four sets of conditions must be satisfied in a competitive equilibrium of this model. First, firms in the productive industry must earn zero profits:

$$w = \alpha. \tag{12}$$

Second, the market for factors must clear:

$$q_2 \frac{1}{\alpha} = \overline{L} - L_A. \tag{13}$$

Third, a no arbitrage condition must hold for the allocation of labor between the productive industry and appropriation:

$$\frac{A(L_A)}{L_A} p_1 S = w. \tag{14}$$

As before, this last condition merely says that the individual payoff from appropriation (in the left hand side, the value of appropriated goods per unit of labor deployed to expropriation), must equal the returns from work (in the right hand side). This equation determines the amount of labor allocated to appropriation given the equilibrium factor prices and the total endowment of factors. It is clear that the role of the different goods has now been separated. Good 2 relates to labor income and the opportunity cost of conflict only, while good 1 is connected to the 'revenue' side of conflict only (clearly this neat separation would be maintained if good 1 were produced by utilizing capital only).

Finally, the country may be open or closed to international trade. If the country is open to trade we assume that the country is small relative to the rest of the world and it cannot affect the international price of good 1:

$$p_1 = p_1^I. \tag{15}$$

In a closed economy output prices must clear the markets of goods. That is, we must add the following equilibrium condition to the system:

$$c_1(p_1, M) = S \tag{16}$$

We focus on equilibria with positive levels of appropriation. If $A(\overline{L})$ is sufficiently small and $A'(0)$ is sufficiently large, then there is an equilibrium with positive levels of conflict.

Proposition 5 *Opening to international trade will increase conflict if the international price of the lootable resource is greater than its price under autarky.*

Proof. We must show that conflict is increasing in p_1.

Note that from equations (12) and (14) we have that:

$$A(L_A) = \frac{\alpha L_A}{p_1 S} \tag{17}$$

Differentiating the previous equality with respect to p_1 we obtain: $\frac{dL_A}{dp_1} = -\frac{\frac{\alpha L_A S}{(p_1 S)^2}}{[A' - \frac{\alpha}{p_1 S}]}$. Given the concavity of $A(L_A)$, and equation (17), it is the case that $A' - \frac{\alpha}{p_1 S} < 0$, and $\frac{dL_A}{dp_1} > 0$. ■

The intuition for this result is simple: an increase in p_1 increases the value of lootable resources and the returns from conflict, while leaving unchanged wages and thus the opportunity costs of conflict. Hence, conflict can only go up. These type of results are present in much of the literature on conflict. An example is Collier and Hoeffler (1998) who consider a partial equilibrium model where it is possible to separately shift the returns and the costs to conflict. The incentives for rebellion are assumed to be linked to the taxable base of the economy, while the costs depend on wages, which are determined by the country's income per

capita, without allowing for a connection between income per capita and taxable base. While such pioneering steps in the literature have been valuable, the general equilibrium approach we presented in subsection 2.1 lifts restrictive assumptions to unveil less immediate and more robust insights. A comparison of Propositions 4 and 5 tells us that if we remain agnostic about what wealth is targettable by appropriators, and we allow for interrelation between the costs and benefits of conflict, then factor intensities become key to making predictions about conflict.

Much of the traditional literature on conflict poses an additional problem. A wide variety of models are available where the incentives to fight depend on varying formulations of what can be targeted for appropriation, and how productive effort translates into safe versus appropriable wealth. Moreover, the economic backdrop differs substantially across models, shaping in different ways the incentives to fight versus work. The different assumptions yield different results regarding the comparative statics of conflict as we change price or productivity parameters. In some cases (e.g. Hirshleifer 1991) the assumptions are such that increasing the value of production or the productivity of "legal" effort causes an exactly equal change in the returns and costs of fighting effort, which renders conflict unresponsive to price or productivity shocks. An ensuing question is whether the economics behind conflict models are general enough that we can trust their predictions.

A solution to the two limitations above –partial equilibrium approaches, and ad hoc economic settings– is to rely on canonical general equilibrium settings that are augmented with the presence of conflict. A broader and more realistic scope for a general equilibrium treatment of the problem requires letting factor prices and lootable wealth change simultaneously

with economic and policy shocks. The model laid out in section 2 offers such an approach and it provides the basis for the policy discussion in the following section.

3 Policy Analysis with a Social Constraint

In our earlier paper we focused on the fact that given the presence of conflict policymakers could sympathize with a variety of interventions that diminish conflict. We studied the ability of various interventions to reduce conflict, like tariffs, industrial policy, and tax and subsidies to factors, but we did not characterize their relative merits. In this section we rank these policies in terms of welfare and relate this exercise to results from traditional trade theory regarding policy rankings under the presence of distortions.[4]

Traditional work on policymaking under distortions in trade theory has recognized three main types of distortion: externalities in production, policy constraints on consumption (e.g. a need for a certain degree of "self-sufficiency" in the provision of some good), and distortions in factor markets. Each category produces a ranking of most to least desirable policies to deal with the distortion -see Table 1.[5]

We show here that conflict entails a type of distortion that does not exactly match any of the distortions typically analyzed in the literature on policymaking under distortions; however, the ranking of policies that results coincides with that obtained in the case of distortions in factor markets - see Table 1. That is, in an economy with conflict, the preferred

[4] An example of previous work analyzing responses to conflict is Grossman (1994). He studied the incentives of landowners to yield control over some land to prevent forceful redistribution. He also compared the relative attractiveness for landowners of using wage subsidies instead.

[5] See Bhagwati (1971) for a taxonomy of the different types of distortions and welfare consequences.

option is to impose taxes and subsidies in the factor markets. The next best option is to impose taxes and subsidies to production and the least preferred option is trade intervention. As will be clear from our analysis, an important difference with the case of factor distortions in the trade literature is that when conflict is present it may not be possible to reach the first best (the main reason being that society may not be able to tax the allocation of labor to appropriation). In other words we augment Bhagwati's (1971) taxonomy of policy rankings in the way shown by Table 1 below.

3.1 Ranking of policies in an economy with conflict

Before ranking policies we must describe the distortions entailed by conflict. To this end we must describe the production bundles that are possible with and without conflict and the equilibrium of production. As is traditional in economics we define the production possibility frontier as the production bundles that maximize production. In Figure 1 we show one such frontier (PPF) when there is no conflict.[6] Each point in the frontier represents the maximum possible production of good 2 given a production level of good 1. The production possibility frontier can also be thought to represent equilibrium bundles given prices: each bundle corresponds to an equilibrium production bundle for a given price p_1.[7] Given that without conflict the economy achieves the first best, the equilibrium production bundles maximize the revenue of the economy. This means that the slope of the PPF must be equal to the price p_1 that the economy faces - see point A in Figure 1.[8]

[6] For Figure 1 we consider an economy with $\overline{K} = \overline{L} = 100$, $q_1 = L^{\frac{1}{3}}K^{\frac{2}{3}}$ and $q_2 = L^{\frac{2}{3}}K^{\frac{1}{3}}$.

[7] Remember that we have normalized $p_2 = 1$ as good 2 is the numeraire.

[8] All equilibrium points are calculated assuming $p_1 = 0.8$.

With positive levels of conflict, the productive economy loses labor and the production possibility frontier PPF_C must be closer to the origin than the frontier without conflict PPF. It is useful to think of the production possibility frontier with conflict PPF_C as the set of equilibrium production bundles. Figure 1 shows the PPF_C under one particular technology of appropriation.[9] As it could be expected, one distortion generated by conflict is a reduction in resources available for production, contracting the production possibility frontier.

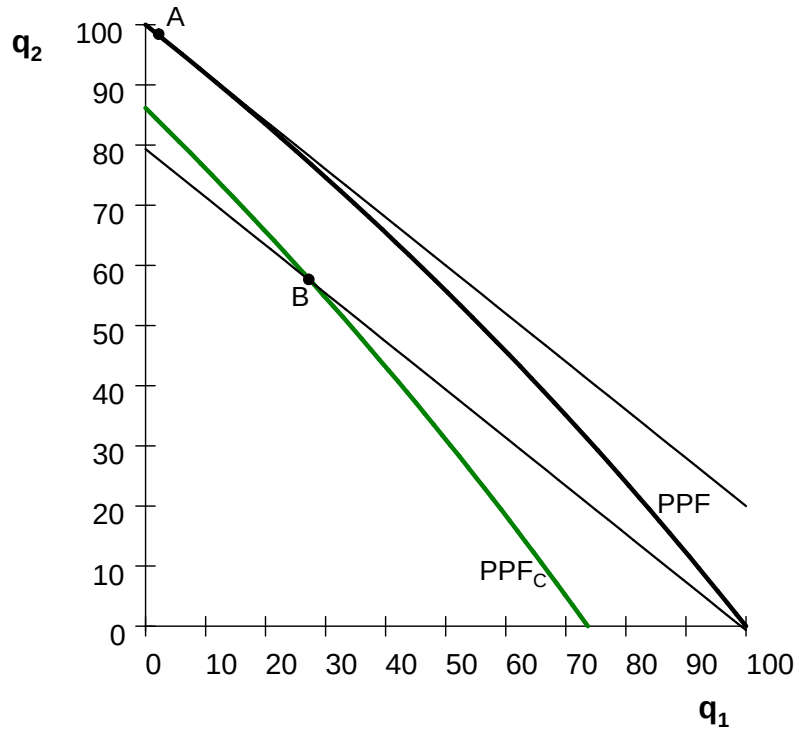

Figure 1: Production frontiers and equilibria with and without conflict

In addition, conflict may distort the production bundle towards one that does not maximize the revenues of the economy among those available in the production frontier with

[9] We assume $A(L_A) = \frac{L_A}{120+L_A}$.

conflict PPF_C. Figure 1 shows that the slope of the budget line through the equilibrium point B is not tangent to the production frontier.

This is not particular to the chosen example but a general result. The reason for this lack of tangency is as follows. If the amount of labor allocated to appropriation were constant, the slope of the production possibility frontier in point B would coincide with the slope of the budget line at that point (that is p_1) as this economy would be equivalent to an economy without conflict but with less labor and the first welfare theorem would imply a production bundle that maximizes the revenue of the economy. However, in the conflict economy, the labor available for production is not constant. A decrease in the production of good 1 would reduce the amount of labor allocated to conflict (remember that by Rybczynski's theorem q_1 and L_A are positively related) allowing for a greater expansion in the production of good 2 than with constant labor. Therefore, with conflict, the budget line corresponding to the equilibrium production bundle for a given price must cross the production possibility frontier from below. This implies that given the price p_1, the production bundle does not maximize the revenues for the economy.

In summary, the allocation of labor to appropriation generates two types of distortions in an economy with conflict. First, it shrinks the production possibility frontier, and second, it results in an equilibrium production bundle that does not maximize the revenue for the economy.

These two types of distortions suggest that two policy instruments may be needed to improve welfare: 1) production taxes and subsidies to improve the choice of production bundle given the production possibility frontier, and 2) factor taxes and subsidies to reallocate

labor out of conflict moving the production possibility frontier towards the first best one. However, as we will see, there is no need for both types of intervention, as intervention in factor markets dominates intervention in product markets. Before showing this, we explain why we can abstract from a third policy instrument, namely tariffs.

Tariffs can be readily shown to be dominated by taxes and subsidies to production by appealing to the existing literature on trade under distortions. The positive effects of any trade intervention that affects producer prices can be reproduced by taxes and subsidies to production while avoiding the consumption distortions. In conclusion, trade interventions will always be ranked below production interventions in our model.

Back to the comparison of tax/subsidy schemes on products vs. factors, let us start analyzing the former. Given that under conflict there is too much production of good 1, the optimal tax/subsidy scheme on production should lower the price earned by producers of good 1. In the case depicted in Figure 1, such a policy should move production from point B to point C such as to maximize the revenues for the economy given the production possibility frontier with conflict PPF_C. Note, however, that this policy does not allow the economy to reach the first best. The reason is that at point C conflict is still present and therefore the economy is producing less than it is technically possible.[10] In fact, it can be easily shown in general that product policies cannot restore the first best in an economy with conflict.

Proposition 6 *For an economy with conflict such that at international prices there is a*

[10] While we focus on the case of production diversification, the results are robust to considering specialization. Note that once the economy is fully specialized in one product, changes in the price of the produced good will not change the relative prices of inputs and cannot affect conflict. As such, once the economy specializes, it is not longer possible to affect conflict with product taxes and subsidies.

positive amount of appropriation, taxes and subsidies to production cannot restore the first best.

Proof. Consider first the case in which the production possibility frontier with conflict is always closer to the origin relative to the production possibility frontier without conflict. This means that for every possible price p_1, the equilibrium level of labor allocated to appropriation (L_A) is positive. As production taxes and subsidies will affect producer prices, but there is no price that would eliminate conflict, it follows that these interventions cannot yield the first best.

Consider now the case in which the production possibility frontier with conflict PPF_C partially overlaps with the production possibility frontier without conflict PPF (that is, there exist a set of prices p_1 such that $L_A = 0$). Since we are assuming that there is a positive amount of appropriation in equilibrium, it must be the case that the price p_1 is such that the equilibrium production bundle belongs to the conflict frontier PPF_C when this does not overlap with the conflict-free frontier PPF. By the same logic the equilibrium production bundle without conflict belongs to the PPF when it does not overlap with the PPF_C. Therefore, it is not possible for the taxes and subsidies on products to move the production bundle towards the first best one, as this one does not belong to the PPF_C. ■

Can factor taxes and subsidies do better than product policies? The answer is yes. Consider the effects of a subsidy to wage earners (in the productive economy) coupled with a tax on capital returns so as to keep a balanced budget.

Figure 2 shows the case in which sufficiently taxing the return to capital and subsidizing productive labor results in a complete elimination of conflict and allows the economy to reach

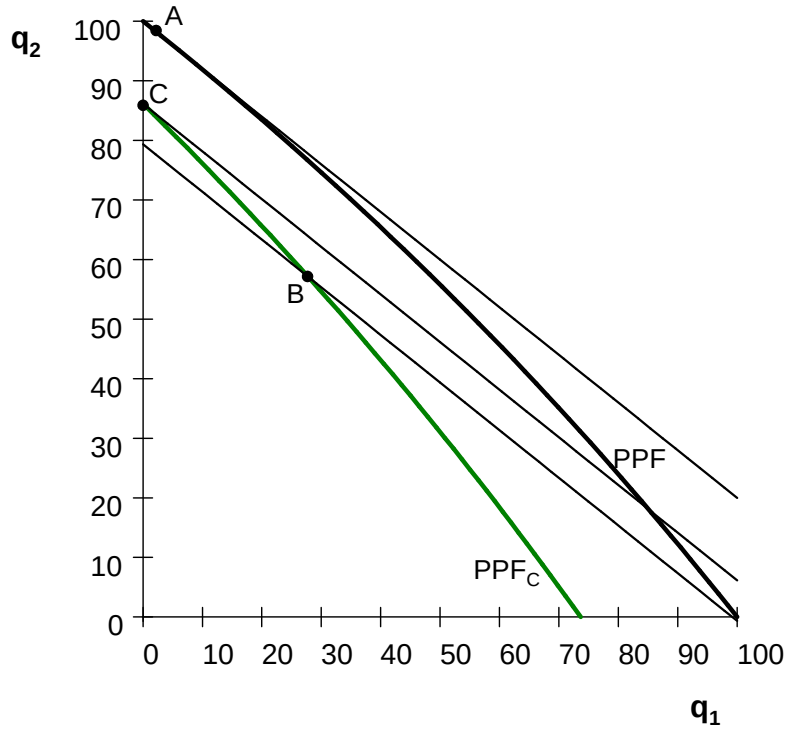

Figure 2: Equilibrium with best production taxes and subsidies

the first best (we do not graph the production possibility frontier after this intervention as it coincides with PPF). In that case, the equilibrium production bundle with sufficiently large taxes to capital and subsidies to productive labor would be the point A in Figure 2. This point maximizes the revenue of the economy and, as prices paid by consumers are not distorted, it maximizes welfare.

The next proposition gives a condition for this to be possible.

Proposition 7 *In our model, taxes to capital and subsidies to productive labor can bring the economy to the first best if and only if* $A(0) = 0$ *and* $A'(0) < \frac{1}{L}$.

Proof. Remember that the equilibrium condition for the appropriation sector can be written as:

$$A\left(L_A\right) = \frac{L_A}{\frac{r}{w}\overline{K} + \overline{L}}. \tag{18}$$

The "if" part of the proposition follows directly then from the fact that $A\left(L_A\right)$ is a concave function and if $A(0) = 0$ and $A'(0) < \frac{1}{\overline{L}}$ there cannot be a solution to equation (18) with a positive level of conflict. To prove the "only if" part first note that if $A(0) > 0$ there will always be an equilibrium with positive level of conflict. Second, if $A'(0) > \frac{1}{\overline{L}}$, even after capital has been fully taxed, there must also be a solution with $L_A > 0$. ■

Figure 3 shows a case in which the condition in proposition 7 does not hold and a factor market intervention cannot restore the first best.[11] The equilibrium production bundle with conflict (point B) results in lower revenues than the first best bundle (point A). Product taxes and subsidies increase the revenues of the economy by moving the production bundle to point C from point B across the production possibility frontier with conflict PPF_C. However, fully taxing capital to subsidize productive labor expands the production possibility frontier to PPF_{LM} , which is closer to the first best frontier and results in a production bundle D with revenues greater than those from point C obtained with product market interventions.

Note that at the equilibrium production bundle under maximal factor market intervention, the budget line is tangent to the production possibility frontier PPF_{LM}. The reason is that if even under maximal factor market intervention conflict cannot be eliminated, the minimum level of conflict is obtained by fully taxing capital. In this case the equilibrium

[11] Figure 3 is drawn for an economy as that in Figures 1 and 2 but with a different appropriation technology: $A(L_A) = \frac{L_A}{80+L_A}$.

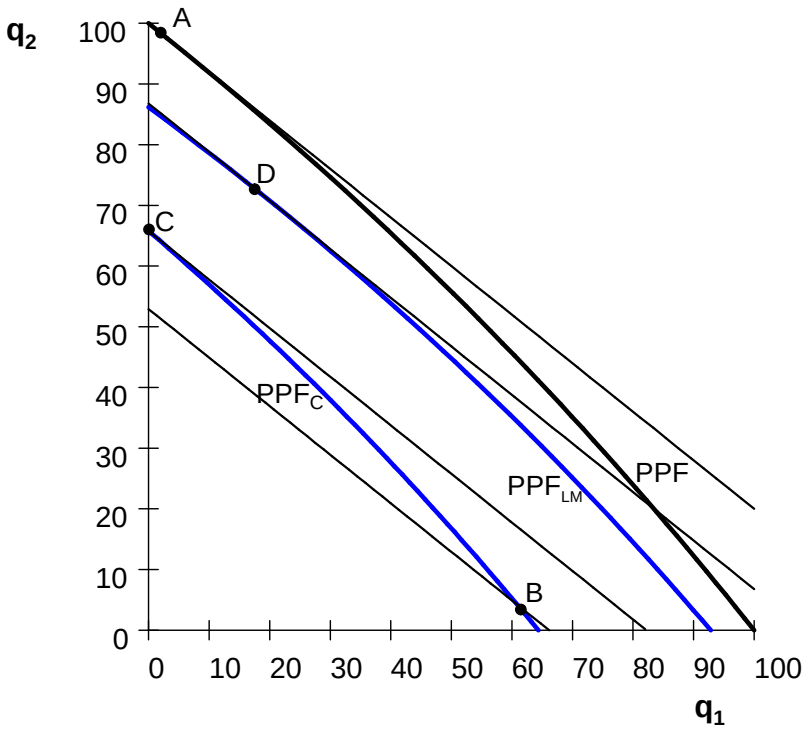

Figure 3: Economy in which conflict cannot be eliminated

allocation of labor to conflict solves:

$$A\left(L_A\right) = \frac{L_A}{\overline{L}}, \tag{19}$$

which does not depend on factor prices. Then, given this policy, the equilibrium level of appropriation does not depend on prices implying that the production possibility frontier should be tangent to the budget line at the equilibrium point.[12] This tangency implies that after fully taxing capital the equilibrium production bundle maximizes revenue and,

[12] As discussed above, if the amount of labor allocated to appropriation is constant, the economy is be equivalent to an economy without conflict but with less labor and the first welfare theorem imples a production bundle that maximizes the revenue of the economy.

therefore, *product taxes and subsidies would not help.* Our discussion in this section leads to the following theorem:

Proposition 8 *In an economy with conflict, taxes and subsidies to factors are ranked first, taxes and subsidies to production are ranked second and trade interventions (tariffs and export subsidies) are ranked last.*

3.2 Differences between conflict and other distortions in terms of policy implications

Traditional work on policymaking under distortions in trade theory has recognized three main types of distortion: externalities in production, policy constraints on consumption (e.g., a need for a degree of "self-sufficiency"), and distortions in factor markets. We discuss here some of the differences between these distortions and those generated by conflict.

It is immediate that conflict is different from the self-sufficiency story. Conflict involves externalities (appropriation hurts its victims) and a factor misallocation (some factors are used not to produce but to redirect wealth). One could ask whether conflict is similar to one of the other distortions.

The conflict case seems, at first, to map neatly into the externality case. The economy is operating in a frontier that is a second best case relative to one where the externality (or conflict) does not exist, and production occurs at a point of non-tangency. This would imply we can resort to well known results in the theory of policy under distortions and conclude that the first best policy is a tax on good 1 and a subsidy to good 2, and that any trade intervention would be strictly worse because it would distort consumption patterns.

As we have shown above, the latter is right but the former is wrong. Trade interventions will do worse than product interventions as they generate a welfare loss due to consumption distortions. And the former is wrong as taxes and subsidies to factors can expand the production possibility frontier and thus do better than product interventions. Moreover, when factor market interventions fail to restore the first best, product market interventions cannot provide additional help.

Given international prices, the effect of taxes on capital and subsidies to productive labor, as shown in Dal Bó and Dal Bó (2004), is to expand the production frontier. This is exactly the effect such intervention would have when there are distortions in factor markets. The classic literature on policymaking under distortions (e.g., Bhagwati 1971) deals with factor market distortions that create a wedge in the wages that must be paid in different sectors. A typical example is one where labor in industry must be paid a wage premium relative to labor involved in agriculture. Given this wedge, the value of marginal productivity is not equalized across sectors, leading the economy to operate on a second best production possibility frontier. In that situation, a clear welfare ranking of policies is possible. A suitable tax cum subsidy intervention in the factor markets will expand the frontier to its first best version and maximize welfare. A tax cum subsidy intervention on production will be second best, followed by a tariff intervention.

One obvious way in which conflict is not exactly the same as the factor market distortions that have attracted attention in the trade literature is that in the conflict economy there is no wage differential nor is industry too capital intensive. In the conflict economy firms are using the correct factor mixes. This implies that the main counterindication for an

intervention on producer prices in the case of factor market distortions, namely that even after the intervention industry will be too capital intensive, is not present in the case of the conflict economy. The problem is that labor is siphoned off by appropriation. The one common aspect between the conflict and the factor market distortions is that subsidizing labor and taxing capital can expand the frontier. A less obvious difference is that under conflict it may not be possible to totally eliminate the distortion: fully taxing capital to subsidize productive labor may not eliminate conflict. However, we have shown that if this is the case there is no more room left for other policies to improve matters, as the resulting production bundle would be optimal given the conflict production possibility frontier.

4 Conclusion

In this chapter we revisited a framework introduced by Dal Bó and Dal Bó (2004) to study the general equilibrium implications of economic shocks for conflict. After exploring more fully the implications of that setup and drawing a contrast with simpler partial equilibrium approaches, we explored the welfare consequences of various policy interventions. Special attention was paid to whether we could fall back on the traditional trade literature on policymaking under distortions to derive a ranking of policy performance. If the distortion posed by conflict fell neatly into one of the distortion categories studied in that classic literature, we could easily obtain a welfare ranking for policy interventions by reference to that literature.

We argued that conflict poses a distortion with key similarities to externalities in production and factor market imperfections. This similarity indicates that classic results of

trade theory with distortions (such as the possibility that free trade and growth may destroy welfare) could extend to conflict economies. However, conflict poses a distortion with idiosyncratic properties that prevent an automatic derivation of the optimal policy response. We find that the policy ranking in a conflict economy is identical to that in a conflict-free economy with distortions in factor markets, although the best available policy (tax-cum-subsidy schemes in the factor markets) may not restore the first best.

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Table 1: Ranking of polices under distortions

Type of distortion			
Production Externalities	Consumption Constraints	Factor Distortions	Conflict
Production Tax+Subsidy	Consumption Tax+Subsidy	Factor Tax+Subsidy	Factor Tax+Subsidy
Trade or Factor Tax+Subsidy	Trade Tax+Subsidy	Production Tax+Subsidy	Production Tax+Subsidy
	Production or Factor Tax+Subsidy	Trade Tax+Subsidy	Trade Tax+Subsidy

Note: In the case where two policies cannot be ranked relative to each other in general, they are included together in the table, as in the case of Trade and Factor tax-cum-subsidy schemes as a response to production externalities.