DISCUSSION PAPER SERIES

A Win-Win-Win Tariff-Tax Reform under Imperfect Competition

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February 17, 2012

Abstract

Taking into account non-constant marginal costs, this paper considers the effects of a tariff cut combined with a consumption tax increase on welfare, government revenue, and market access. We show that welfare, government revenue, and market access can all improve with this policy reform under decreasing marginal costs. This result may provide a theoretical rationale for the above policy reform, which is guided by the IMF and the World Bank.

1 Introduction

A tariff reduction is one of the most important driving forces behind rapid growth of world trade. In an influential work, Baier and Bergstrand (2001, p. 22) report evidence suggesting that 'tariff reductions still explain almost three times as much trade growth as transport-cost declines.' As the traditional trade theory claims, growth of world trade is potentially gainful for not only an individual country but also the world. Nevertheless, a number of developing countries have a concern over trade liberalization for fear that it induces government revenue losses. In order to compensate for them, several countries have introduced another tax, e.g., a consumption tax or a value-added tax (VAT).[1] However, Baunsgaard and Keen (2010, p. 571) empirically find that 'for low income countries, implying no impact on the extent of revenue recovery.'

Given these growing interests in the empirical literature, there is a theoretical literature that examines the effects of tariff-tax reforms. While this paper is along this line of research, we focus on one specific tariff-tax reform, which is increasingly recognized in the literature, in a context of imperfect competition. The policy reform we study consists of one unit of tariff reduction and the same unit of consumption tax increase. This policy reform, which is first addressed by Hatzipanayotou et al. (1994), is welfare-improving for a competitive small open economy. Keen and Ligthart (2002) generalize this result, but the same authors (Keen and Ligthart (2005)) show that the same no longer survives imperfect competition. Concretely, assuming a duopoly served by a domestic and a foreign duopolists, and linear demand and marginal costs, Keen and Ligthart (2005) demonstrate that the point-by-point reform necessarily reduces welfare.

The finding of Keen and Ligthart (2005) is striking, but it deserves further investigations since it rests on many simplifying assumptions.[2] This paper revisits their result by paying special attention to the role of non-constant marginal costs. As is first illustrated by Krugman (1984), non-constant marginal costs allow a policy change to have a secondary (spillover)

effect through a change in each firm's marginal cost. We show that the point-by-point policy reform can improve welfare under decreasing marginal cost whereas Keen and Ligthart's (2005) result is valid under increasing marginal costs.

Another purpose of this paper is to look at the effect of the tariff-tax reform on market access, which is defined by a value of import volumes at the world price. The reason for considering the market access effect is that market access issues have an increasing importance in the real world. In a model of a competitive small open economy, Kreickemeier and Raimondos-Møller (2008) prove that the point-by-point policy reform may fail to increase market access although it does raise welfare and government revenue. To our knowledge, there is no previous work that addresses the market access aspect of the tariff-tax reform under imperfect competition. This paper fulfills this gap.

Apart from the tariff-tax literature, there is another strand of literature on trade policies that incorporates non-constant marginal costs. Although the assumption of constant marginal cost is analytically convenient and frequently made in literature, it is not surprisingly natural that marginal costs are non-constant. For example, in many manufacturing industries, decreasing marginal costs through R&D, learning-by-doing and developments of communication networks are profoundly observed.[3] In this sense, it is an important task to explore whether the policy outcomes under the assumption of constant marginal cost are survives the more realistic assumption of non-constant marginal costs. To our knowledge, Krugman (1984) is the first to seek this objective in the trade policy literature. While Krugman's (1984) argument is mainly based on a diagrammatic approach, Uekawa (1994) examines welfare effects of multiple trade policies with a rigorously mathematical model. Developing a formal model, Zhang and Zhang (1998) mathematically formalize Krugman's (1984) argument. In a monopoly model, Ishikawa (2004), Ishikawa and Kuroda (2007), and Ishikawa and Mukunoki (2008a, 2008b) also demonstrate that the effects of trade policies including trade liberaliza-

tion crucially depend on whether marginal costs are increasing, constant, or decreasing, as well as demand behavior.

This paper is planned as follows. Section 2 presents a model. Section 3 seeks welfare effects of the point-by-point tariff-tax reform suggested above, and Section 4 turns to its effects on government revenue and market access. Section 5 concludes. Appendix presents the detailed derivation of key equations in the main text.

2   A Model

Consider a market of a country, say Home, in which a Home firm and a Foreign firm play a Cournot-Nash game. Denoting by $p(x + y)$ the inverse demand function of the Home consumer, where x and y are the output of the Home and Foreign firms, respectively, and $p(\cdot)$ is strictly decreasing, i.e., $p'(\cdot) < 0$. Both firms have a production cost $c(x)$ and $c_*(y)$, the marginal cost of which is either increasing, constant, or decreasing.[4]

The government levies a specific import tariff $t \geq 0$ and a consumption tax $\tau \geq 0$.[5] Given these assumptions, the profit of each firm is defined by

$$\text{Home firm} \quad : \quad p(x + y)x - c(x) - \tau x$$
$$\text{Foreign firm} \quad : \quad p(x + y)y - c_*(y) - \tau y - ty,$$

by noting that the world market price of the duopolized good is $p - \tau - t$ since p is the price at which the Home consumer purchases, i.e., it is the world price plus the consumption tax and tariff.

The Cournot-Nash equilibrium outputs are determined by the system of the first-order conditions for profit maximization:

$$xp'(x + y) + p(x + y) - c'(x) - \tau = 0 \tag{1}$$
$$yp'(x + y) + p(x + y) - c_*'(y) - \tau - t = 0, \tag{2}$$

and the second-order conditions:[6]

$$xp'' + 2p' - c''(x) < 0, \quad yp'' + 2p' - c_*''(y) < 0.$$

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Totally differentiating (1) and (2), we have

$$\begin{bmatrix} xp'' + 2p' - c''(x) & xp'' + p' \\ yp'' + p' & yp'' + 2p' - c''_*(y) \end{bmatrix} \begin{bmatrix} dx \\ dy \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \end{bmatrix} d\tau + \begin{bmatrix} 0 \\ 1 \end{bmatrix} dt,$$

from which the comparative static outcomes are[7]

$$\frac{\partial x}{\partial \tau} = \frac{-(x-y)p'' + p' - c''_*(y)}{\Delta}, \quad \frac{\partial y}{\partial \tau} = \frac{(x-y)p'' + p' - c''(x)}{\Delta} \quad (3)$$

$$\frac{\partial x}{\partial t} = \frac{-(xp'' + p')}{\Delta}, \quad \frac{\partial y}{\partial t} = \frac{xp'' + 2p' - c''(x)}{\Delta}, \quad (4)$$

where Δ is the determinant of the coefficient matrix:

$$\Delta = [xp'' + 2p' - c''(x)][yp'' + 2p' - c''_*(y)] - (xp'' + p')(yp'' + p'),$$

which is assumed to be positive from the stability of the Cournot-Nash equilibrium.[8]

3 Welfare Effects

Welfare of the Home country W consists of consumer surplus CS, the Home firm's profit π, consumption tax revenue, and tariff revenue:

$$W(\tau, t) = CS + \pi + \text{consumption tax revenue} + \text{tariff revenue}, \quad (5)$$

where

$$CS = \int_0^{x+y} p(X)dX - (x+y)p(x+y) \quad (6)$$

$$\pi = p(x+y)x - c(x) - \tau x \quad (7)$$

$$\text{consumption tax revenue} = \tau(x+y) \quad (8)$$

$$\text{tariff revenue} = ty, \quad (9)$$

and x and y are the function of τ and t from (1) and (2). Using (6)-(9) and differentiating (5) with respect to τ and t, we obtain

$$\frac{\partial W(\tau, t)}{\partial \tau} = y + [-(x+y)p' + \tau]\frac{\partial x}{\partial \tau} + (-yp' + \tau + t)\frac{\partial y}{\partial \tau} \quad (10)$$

$$\frac{\partial W(\tau, t)}{\partial t} = y + [-(x+y)p' + \tau]\frac{\partial x}{\partial t} + (-yp' + \tau + t)\frac{\partial y}{\partial t}. \quad (11)$$

The policy reform suggested by Keen and Ligthart (2005) is defined by $d\tau = -dt > 0$, namely one unit of tariff reduction is accompanied by one unit of consumption tax increase. Its welfare effect is calculated by subtracting (11) from (10):[9]

$$\frac{\partial W(\tau, t)}{\partial \tau} - \frac{\partial W(\tau, t)}{\partial t}$$
$$= \frac{-c_*''(y)\left[-(x+y)p' + \tau\right] - y\left(xp' + t\right)p'' + \left[-(x+y)p' + p - c'(x) - t\right]p'}{\Delta}.$$
(12)

Eq. (12) allows us to find that the sign of $\partial W / \partial \tau - \partial W / \partial t$ crucially depends on that of the Foreign firm's marginal cost. Formally, we can establish:

Proposition 1. *The welfare effects of the point-by-point tariff-tax reform are summarized as:*

(1) If demand is linear and $c_*''(y) \geq 0$, it reduces welfare.

(2) If $c'(x) = c_*'(y)$ and both firms' marginal cost is non-decreasing, it reduces welfare.

(3) If demand is linear and $c_*''(y) < 0$, it can improve welfare.

Proof. See Appendix. ‖

(Figures 1 and 2 around here)

Let us seek intuitions behind Proposition 1 by the help of Figures 1 and 2. Suppose that the pre-reform Cournot-Nash equilibrium is given by N in the figures. One unit of tariff reduction accompanied with the same unit of consumption tax increase shifts only the Home firm's reaction curve inward to the dotted locus without affecting the Foreign firm's reaction curve. As

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a result, the Home firm's output decreases, and the Foreign firm's output increases. As Keen and Ligthart (2005) argue, this profit-shifting into the Foreign country is the key for their result that this policy reform reduces welfare.

In contrast, the same is no longer the case under non-constant marginal costs since a change in outputs has a secondary effect on the reaction curves through a change in marginal costs. Under increasing marginal costs, a decrease in the Home firm's output lowers its marginal cost, and the opposite holds for the Foreign firm. Therefore, the Home firm's reaction curve shifts outward to the dashed locus while the Foreign firm's reaction curve shrinks. Hence, the post-reform Cournot-Nash equilibrium becomes N' at which the profit-shifting effect is partially offset since N'' would be the new equilibrium where marginal costs were constant. The Home firm's output expansion that occurs as a secondary effect raises its cost and hence price, which is another reason for a welfare loss. To sum, under increasing marginal costs, welfare is likely to deteriorate than the constant marginal costs case.

On the other hand, the first effect on outputs shifts the Home firm's reaction curve inward further, and the Foreign firm's reaction curve outward further (see Figure 2). At the resulting equilibrium N', the profit-shifting is larger than the constant marginal costs case. Nevertheless, it is possible for welfare to improve because it allows both the marginal cost of the Foreign firm and the price to fall, which benefits the Home consumer. Consequently, there is a possibility of a welfare improvement in the case of decreasing marginal costs.

Remark 1. Simple examples may make sense for Proposition 1. The most frequently adopted example of increasing marginal costs is a quadratic cost function $c(x) = cx^2/2$ and $c(y) = cy^2/2$, where c is a positive constant. Then, if c is large enough, the above policy reform proves to welfare-reducing.

An example exhibiting decreasing marginal costs is $c(x) = 1 - \exp(-bx)$ and $c(y) = 1 - \exp(-by)$, where b is a positive constant, and measures the

concavity (the degree of decreasing marginal cost). With sufficiently high b, the policy reform can be gainful.[10]

Remark 2. While the foregoing arguments focus on the Home welfare, we briefly address the effect on Foreign welfare, which is measured by the profit of the Foreign firm. Letting $\pi^*(\tau, t)$ denote the Foreign firm's profit in the Cournot-Nash equilibrium, the tariff-tax reform we are considering affects $\pi^*(\tau, t)$ as follows.

$$
\begin{aligned}
\frac{\partial \pi^*(\tau, t)}{\partial \tau} - \frac{\partial \pi^*(\tau, t)}{\partial t} &= [yp' + p - c'_*(y) - \tau - t]\left(\frac{\partial y}{\partial \tau} - \frac{\partial y}{\partial t}\right) + \left(\frac{\partial x}{\partial \tau} - \frac{\partial x}{\partial t}\right)yp' \\
&= \frac{[yp'' + 2p' - c''_*(y)]yp'}{\Delta} > 0,
\end{aligned}
$$

where the second equation uses the first-order condition for the Foreign firm's profit maximization (2), and the comparative statics results (3) and (4). The positivity follows from the second-order condition for profit-maximization $yp'' + 2p' - c''_*(y) < 0$. Consequently, Foreign will agree to the point-by-point tariff-tax reform suggested in the sense that the reform improves the Foreign welfare irrespective of the sign of $c''_*(y)$.

4 Effects on Government Revenue and Market Access

While the last section has focused on the welfare effect of the policy reform, this section turns to the other effects of it. Throughout this section, we exclusively focus on the linear demand case. The first is the effect on government revenue, and the second is the effect on market access.

4.1 Government Revenue Effect

The government revenue T is the sum of the consumption tax revenue and the tariff revenue, and given by

$$
T(\tau, t) \equiv \tau(x + y) + ty.
$$

A change in the consumption tax and tariff is

$$\frac{\partial T(\tau, t)}{\partial \tau} = x + y + \tau \frac{\partial(x+y)}{\partial \tau} + t \frac{\partial y}{\partial \tau}$$

$$\frac{\partial T(\tau, t)}{\partial t} = y + \tau \frac{\partial(x+y)}{\partial t} + t \frac{\partial y}{\partial t}.$$

Thus, the effect of one unit of tariff reduction accompanied by one unit consumption tax increase is[11]

$$\frac{\partial T(\tau, t)}{\partial \tau} - \frac{\partial T(\tau, t)}{\partial t} = x + \frac{-\tau c_*''(y) + (\tau - t)p'}{\Delta}. \qquad (13)$$

While the sign of (13) is generally ambiguous, Eq. (13) has an important implication, which is:

Proposition 2. *Suppose $\tau < t$. Then, under either constant or decreasing marginal costs, the point-by-point policy reform increases the government revenue. If, on the other hand, marginal costs are sufficiently strongly increasing, the government revenue can decrease.*[12]

Proof. Straightforward from (13). ||

The ambiguous result on the government revenue effect is parallel with the finding of Keen and Ligthart (2005). However, what is worth noting is that the positive effect is more likely under decreasing marginal costs than constant marginal costs. This is because a large increase in the Foreign firm's output favorably affects both the consumption tax revenue and tariff revenue. From the opposite reason, the government can lose from the reform under increasing marginal costs since the output expansion of the Foreign firm is mitigated as compared to the constant marginal costs case (see Figure 1 once again).

4.2 Market Access Effect

The last effect we are interested in is the market access effect. As is introduced in Introduction, this criterion of policy reform has an increasing

importance, but it is not addressed in a context of imperfect competition. This subsection fulfills this gap by using the present generalized model of Keen and Ligthart (2005). Following Kreickemeier and Raimondos-Møller (2008, p. 87), we define the market access M as 'the value of imports at the world market prices.'

$$M(\tau, t) \equiv [p(x + y) - \tau - t]y.$$

Then, a change in τ and t affects M as follows.

$$\frac{\partial M(\tau, t)}{\partial \tau} = \left[p' \frac{\partial(x + y)}{\partial \tau} - 1 \right] y + (p - \tau - t) \frac{\partial y}{\partial \tau}$$

$$\frac{\partial M(\tau, t)}{\partial t} = \left[p' \frac{\partial(x + y)}{\partial t} - 1 \right] y + (p - \tau - t) \frac{\partial y}{\partial t}.$$

Subtracting the latter from the former, and substituting (3) and (4) into the resulting expression, we have[13]

$$\frac{\partial M(\tau, t)}{\partial \tau} - \frac{\partial M(\tau, t)}{\partial t} = \frac{\{y[2p' - c''_*(y)] - c'_*(y)\} p'}{\Delta}, \tag{14}$$

which is definitely positive. Therefore, we have arrived at:

Proposition 3. *The point-by-point policy reform necessarily improves market access whether marginal costs are constant or non-constant.*

Proposition 3 gives a good feature of the suggested policy reform. Kreickemeier and Raimondos-Møller (2008) prove that the same policy reform does not necessarily improve market access in a competitive small open economy whereas it is welfare- and revenue-improving.[14] In contrast, Proposition 3 suggests that the above skepticism no longer survives imperfect competition. In this sense, Proposition 3 has a certain importance in considering the market access effect of the reform.

One of the most important implications obtained in our analysis is that the point-by-point policy reform is not only easy to implement but also it can involve a win-win-win outcome, i.e., it can enhance all of welfare, government revenue, and market access particularly under decreasing marginal costs.

5 Concluding Remarks

Incorporating non-constant marginal costs into a model of Keen and Ligthart (2005), we have examined the effect of a tariff cut combined with a consumption tax increase on welfare, government revenue, and market access. It is shown that all of these can improve as a result of the suggested policy reform under decreasing marginal costs.

Despite the above novelty, our analysis needs more elaboration. For instance, we have considered no inherent dynamic interaction between marginal costs and outputs by simply assuming decreasing marginal costs which are called *static* economies of scale. Alternatively, it is possible to build a dynamic game model of economies of scale as in Spence (1981). It is our future research agenda to reconsider the robustness of our result in a richer setting.

Appendix

Derivation of (12) and Proof of Proposition 1

Subtracting (10) from (11), we have

$$\frac{\partial W(\tau,t)}{\partial \tau} - \frac{\partial W(\tau,t)}{\partial t} = [-(x+y)p' + \tau]\left(\frac{\partial x}{\partial \tau} - \frac{\partial x}{\partial t}\right) + (-yp' + \tau + t)\left(\frac{\partial y}{\partial \tau} - \frac{\partial y}{\partial t}\right).$$

Substituting (3) and (4) into this yields

$$
\begin{aligned}
& \frac{\partial W(\tau,t)}{\partial \tau} - \frac{\partial W(\tau,t)}{\partial t} \\
= {} & \frac{-c_*''(y)\left[-(x+y)p' + \tau\right] - y\left(xp' + t\right)p'' + \left[-(2x+y)p' + \tau - t\right]p'}{\Delta} \\
= {} & \frac{-c_*''(y)\left[-(x+y)p' + \tau\right] - y\left(xp' + t\right)p'' + \left[-(x+y)p' + p - c'(x) - t\right]p'}{\Delta},
\end{aligned}
$$

where the last equation uses the first-order condition for the Home firm's profit maximization (1).

Making use of (12), statements (1) and (3) in Proposition 1 straightforwardly follow since the numerator of (12) with linear demand ($p'' = 0$) becomes $-c_*''(y)\left[-(x+y)p' + \tau\right] + \left[-(x+y)p' + p - c'(x) - t\right]p' < 0$ when

$c_*''(y) \geq 0$, and can be positive when the degree of $c_*''(y) < 0$ is sufficiently strong.

To prove statement (2), let us set $c'(x) = c_*'(y)$. Then, the numerator of (12) is rewritten as

$$
\begin{aligned}
&-c_*''(y)\left[-(x+y)p' + \tau\right] - y\left(xp' + t\right)p'' + \left[-(x+y)p' + p - c'(x) - t\right]p' \\
=\ & \left[-(x+y)p' + \tau\right]\left[yp'' + 2p' - c_*''(y)\right] - \left(-yp' + \tau + t\right)\left(yp'' + p'\right) \\
=\ & \left[-(x+y)p' + xp' + p - c'(x)\right]\left[yp'' + 2p' - c_*''(y)\right] - \left[-yp' + yp' + p - c_*'(y)\right]\left(yp'' + p'\right) \\
=\ & \left[p - c'(x) - yp'\right]\left[yp'' + 2p' - c_*''(y)\right] - \left[p - c'(x)\right]\left(yp'' + p'\right) \\
=\ & -y\left[yp'' + 2p' - c_*''(y)\right]p' + \left[p - c'(x)\right]\left[p' - c_*''(y)\right],
\end{aligned}
$$

where the second line eliminates τ and t from the two first-order conditions (1) and (2), and the third line uses $c'(x) = c_*'(y)$. Taking into account the second-order condition for the Foreign firm's profit maximization, and $c_*''(y) \geq 0$, the above equation becomes negative, and hence we have arrived at statement (2).

Derivation of (13)

The effect of the reform on government revenue is

$$
\begin{aligned}
\frac{\partial T(\tau, t)}{\partial \tau} - \frac{\partial T(\tau, t)}{\partial t} &= x + \tau\left[\frac{\partial(x+y)}{\partial \tau} - \frac{\partial(x+y)}{\partial t}\right] + t\left(\frac{\partial y}{\partial \tau} - \frac{\partial y}{\partial t}\right) \\
&= x + \tau\frac{p' - c_*''(y)}{\Delta} + t\frac{-yp'' - p'}{\Delta} \\
&= x + \frac{\tau\left[p' - c_*''(y)\right] - tp'}{\Delta} \\
&= x + \frac{-\tau c_*''(y) + (\tau - t)p'}{\Delta},
\end{aligned}
$$

where the second equation uses (3) and (4), and the third equation follows from the assumption of linear demand.

Derivation of (14)

The effect of the reform on market access is

$$
\frac{\partial M(\tau, t)}{\partial \tau} - \frac{\partial M(\tau, t)}{\partial t}
$$

$$
\begin{aligned}
&= yp' \left[\frac{\partial(x+y)}{\partial \tau} - \frac{\partial(x+y)}{\partial t} \right] + (p - \tau - t) \left(\frac{\partial y}{\partial \tau} - \frac{\partial y}{\partial t} \right) \\
&= yp' \frac{p' - c_*''(y)}{\Delta} + (p - \tau - t) \frac{-yp'' - p'}{\Delta} \\
&= \frac{yp'[p' - c_*''(y)] - (p - \tau - t)p'}{\Delta} \tag{15} \\
&= \frac{\{y[p' - c_*''(y)] - [p - yp' - p + c_*'(y)]\} p'}{\Delta} \tag{16} \\
&= \frac{\{y[2p' - c_*''(y)] - c_*'(y)\} p'}{\Delta} > 0,
\end{aligned}
$$

where Eq. (15) comes from linear demand, and Eq. (16) uses (2), i.e., $\tau + t = yp' + p - c_*'(y)$. The positivity of (14) follows from the second-order condition for the Foreign firm's profit maximization, $2p' - c_*''(y) < 0$.

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Notes

1. Aizenman and Jinjarak (2009) provide an empirical assessment of the effect of the change in tax base on government revenue.

2. To our knowledge, Naito and Abe (2008) are the only previous work that revisits Keen and Ligthart's (2005) result by using a vertically related model of imperfect competition.

3. Dick (1994), Yan et al. (2008) and Thompson (2010) are an example of an empirical study of R&D and learning-by-doing.

4. While it is interesting to allow for the case where one firm's marginal cost is non-constant, and the other firm's marginal cost is constant, such a possibility complicates the analysis so drastically that we assume away it. Okuguchi and Serizawa (1996) address the above possibility in a context of

strategic trade policies.

5. This paper assumes specific taxes because (i) we want to make the model as close to Keen and Ligthart's (2005) as possible, and (ii) ad valorem taxes make the analysis too complicated to obtain definite results.

6. In what follows, we employ simpler notations p' and p'' to denote $p'(x+y)$ and $p''(x + y)$.

7. Throughout this paper, it is presupposed that both firms are active in equilibrium.

8. For the details of stability of the Cournot-Nash equilibrium, see Zhang and Zhang (1998).

9. The detailed derivation of this equation is left in Appendix.

10. Of course, b can not be too large due to the second-order condition for profit maximization. Although it is possible to make a parallel example of a linearly decreasing marginal cost $c(x) = ex - fx^2/2$ and $c(y) = ey - fy^2/2$, where e and f are both positive, this example can not ensure a welfare improvement.

11. The derivation of (13) is left in Appendix.

12. The assumption that $\tau < t$ is empirically plausible and applicable to many countries, particularly developing countries.

13. Eq. (14) is derived in details in Appendix.

14. See also Hatzipanayotou et al. (1994) and Keen and Ligthart (2002) for the effects on welfare and government revenue.
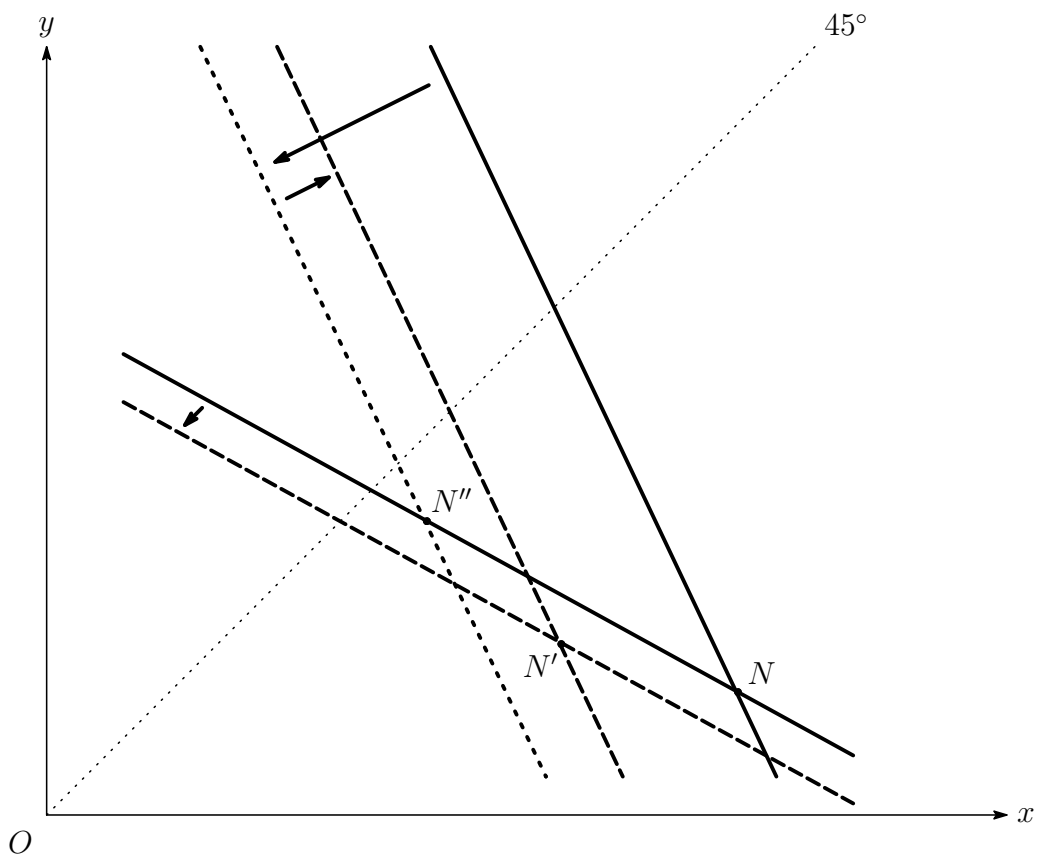
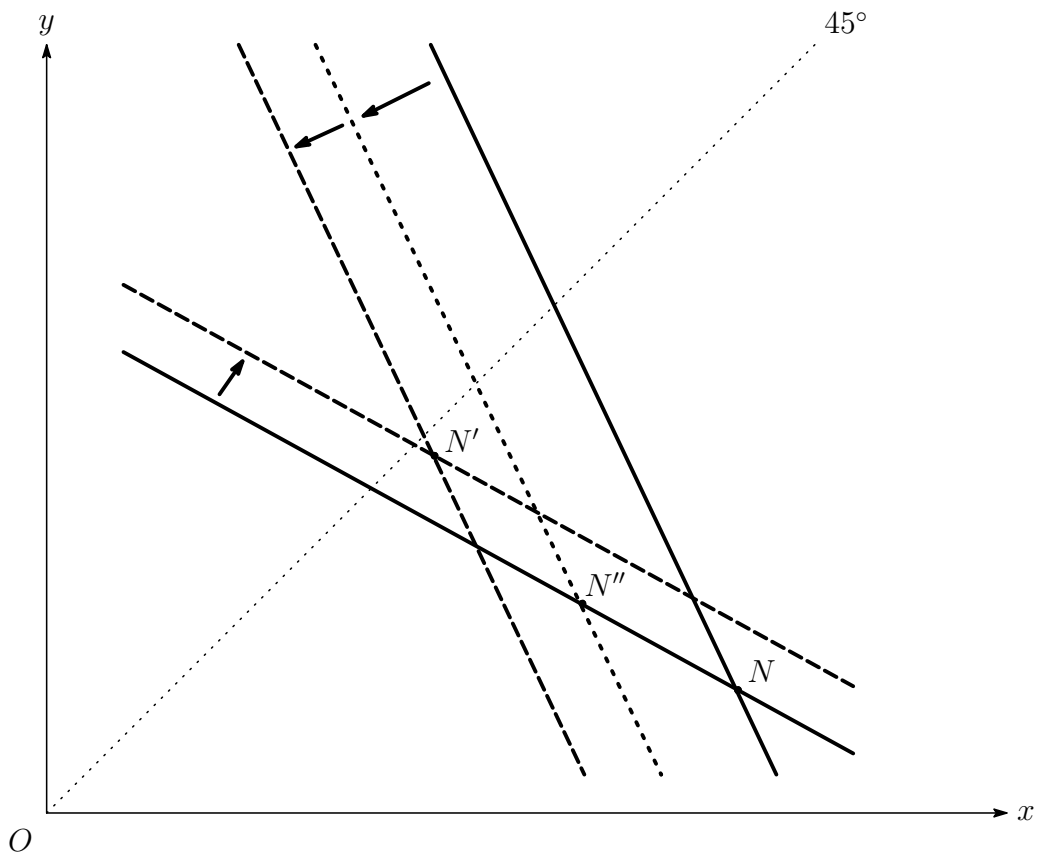Figure 1: The effect of the policy reform: increasing marginal costs

Figure 2: The effect of the policy reform: decreasing marginal costs