

## Chapter 10

### DISTORTIONS AND EXTERNALITIES AS DETERMINANTS OF TRADE

#### 10.1 Departures from our stylized world

Chapters 7, 8, and 9 discussed in some detail two of the five determinants of trade described in Chapter 6, namely, production function (technology) differences, and endowment differences. In this chapter we will discuss domestic distortions as a determinant of trade. The term distortion refers to departures from our highly stylized world which is characterized by (1) all agents are perfectly competitive and have no market power, which in turn generally implies that firms have constant returns to scale as we will discuss in the next chapter; (2) prices and quantities are freely determined by the forces of supply and demand; and (3) all interactions are through markets, meaning that there are no externalities. An externality in turn is an effect one agent (firm or consumer) has on another which is not priced through a market. Pollution is a classic example of a negative externalities, also called a spillover, in which the actions of one agent harm another and the latter is not compensated for this. A knowledge spillover in which the innovation of one firm is copied by other firms without the former being compensated is a classic example of a positive externality. Externalities, spillovers and other distortions are also often called “market failures”.

The principal focus of the chapter is to understand how distortions and externalities by themselves can be causes of trade and whether or not that distortion-induced trade leads to gains from trade. The chapter retains the focus on the positive theory of trade and does not focus on normative issues such as what is optimal government policy in the presence of market failures; some of that will be considered later in the book. Words like distortion and market failure inevitably sound like bad things and they are relative to a best possible outcome. But keep in mind that the terms refer both to failures in which too much of something is produced such as pollution and in which too little of something is produced, such as knowledge.

There are two distinct parts of the chapter. The first part focuses on taxes and subsidies. The examination of taxes and subsidies is intended as an example of the effects that a wide range of government policies can have on trade. For example, environmental policies and regulations impact on firms costs, and hence have effects on outputs and trade similar to those produced by taxes. We are not asserting that commodity and factor taxes rank with factor endowments as a cause of trade, but we do believe that collectively, government policies have a much more profound impact on trade than is suggested in most international trade textbooks. One theme of the chapter is that government policies can generate trade, but it not necessarily beneficial trade.

As before, the approach will be to neutralize other factors so that a clear understanding of the specific effects of each can be obtained. Thus throughout the tax analysis, we will assume that either (A) we have a single country facing fixed world prices, or (B) there are two countries that are identical in all respects. They have identical technologies, identical factor endowments, identical homogeneous utility functions, and constant returns and perfect competition in production. In the absence of the distortions that we introduce, the two countries would have no incentive to trade, or alternatively, the free trade equilibrium would be identical to autarky.

#### 10.2 Distinguishing among consumer, producer and world prices

When we introduce taxes and subsidies into the analysis, it becomes important to distinguish prices paid by consumers from prices received by producers. Once we introduce trade, consumer and producer prices must be distinguished from world prices, the prices at which the country can trade. Throughout this Chapter, we will use the notation  $q$  to represent consumer prices,  $p$  to represent producer prices, and  $p^*$  to represent world prices. This notation will also be used in later Chapters, such as the

## Chapter on tariffs.

In order to focus on trade issues, we will also make the assumption throughout the Chapter that there is no government sector per se; the government returns all tax collections to consumers in lump-sum fashion and/or raises all subsidies by lump-sum taxation. We implicitly assume a very large number of consumers, with each consumer getting a check or a bill which gives to (or takes from) the consumer his or her share of taxes (subsidies). Each consumer regards their bill or check as being unaffected by their own purchases. For examples, if a consumer pays \$1 in sales tax, the consumer gets a refund of only \$1/N of that amount where N is the number of consumers (consider the refund if there are 100 million consumers). Thus each consumer does indeed regard the tax as raising prices, even though the tax is return to all consumers collectively. Similar comments apply to subsidies.

We will specify taxes and subsidies in an ad valorem (percentage of value) form throughout the Chapter rather than in specific form.  $t$  will denote a tax and  $s$  a subsidy. *Ad valorem* taxes are quoted as rates. A sales tax of 5%, for example, would mean a tax rate of  $t = .05$  in this context. (*Specific* taxes, on the other hand, are quoted in monetary units per unit of the good: the US gasoline tax is quoted in cents per gallon.) Thus the relationship between consumer and producer prices with a tax or subsidy is given as follows.

$$\begin{aligned} q &= p(1 + t) > p && \textit{tax} \\ q &= p(1 - s) < p && \textit{subsidy} \end{aligned} \tag{10.1}$$

A tax raises the consumer price above the producer price while a subsidy lowers the consumer price below the producer price. A tax rate  $t = .05$  raises the consumer price 5% above the producer price:  $q = p(1.05)$ . When there are only two goods, the effects of a tax on one good are equivalent to a subsidy on the other good. In order to see this, consider the commodity price ratios resulting from a tax on  $X_1$  versus a subsidy to  $X_2$ .

$$\begin{aligned} \frac{q_1}{q_2} &= \frac{p_1(1 + t)}{p_2} > \frac{p_1}{p_2} && \textit{tax on } X_1 \\ \frac{q_1}{q_2} &= \frac{p_1}{p_2(1 - s)} > \frac{p_1}{p_2} && \textit{subsidy on } X_2 \end{aligned} \tag{10.2}$$

We see from (10.2) that a subsidy to  $X_2$  and a tax on  $X_1$  induce the same "wedge" between the consumer and producer price ratios.

Figure 10.1 gives autarky equilibrium at point E when there is *either* a tax on  $X_1$  or a subsidy on  $X_2$ . In order to focus on the distortions per se, we will assume throughout this Chapter that the tax revenue is redistributed lump sum and the subsidy is raised by a lump sum tax. These latter assumptions are reflected in the fact the consumption and production bundles are the same even though, in the case of a tax, for example, the consumption bundle costs more than the value of those goods at producer prices. The consumers pay more than the producers receive because of the tax, but then they receive an income in excess of the value of production due to the fact that they receive the tax refund. Let  $D$  denote consumption (demand) and  $X$  denote production quantities. For a tax on  $X_1$ ,

$$q_1 D_1 + q_2 D_2 = p_1(1 + t)X_1 + p_2 X_2 = [p_1 X_1 + p_2 X_2] + [p_1 t X_1] \tag{10.3}$$

The left-hand side of (10.3) is consumer expenditure at consumer prices. The first bracketed term on the right-hand side is income received from production (payments to factors of production), while the second term on the right-hand side is redistributed tax revenue. Thus consumer expenditure equals consumer income. A similar analysis of a subsidy simply requires us to change the sign of  $t$ .

### Figure 10.1

Figure 10.1 illustrates the distortionary effect of the tax on  $X_1$  or subsidy on  $X_2$ . Welfare is lower at E than at the undistorted competitive equilibrium at A. The producer price ratio  $p$  is tangent to the production frontier TT' while the consumer price ratio  $q$  is tangent to the indifference curve through E. The tax causes the consumers to perceive  $Y$  as more costly than it actual is to produce, or a subsidy to  $X$  causes consumers to perceive  $X$  as relatively cheaper than what it actually costs to produce.

The previous paragraph should not be taken to suggest that all taxes or subsidies are bad. First, governments usually raise revenues in order to provide public goods that are not or cannot be provided by markets. No account is taken of public goods in this analysis. Second, not all taxes are distortionary or as distortionary as the commodity tax shown here. For example, in the present model, an equal ad valorem tax on both goods would leave the relative consumer and producer prices equal. Such a *set* of taxes is non-distortionary.

Finally, some government policies are imposed to correct an *existing* distortion in the economy, such as an environmental externality. In such a situation, Figure 10.1 might accurately depict the effects of a pollution tax (on  $X_1$ ) on production and trade, but the indifference curves no longer indicate welfare change. Welfare may be improving due to lower pollution (i.e., there is actually a third good, environmental quality, not shown in the diagram). More will be said about taxes in the presence of existing distortions later in the book.

## 10.3 Taxes and subsidies as determinants of trade: a small open economy

Suppose that the home country faces fixed world prices. Assume also that these prices just happen to be equal to home's autarky price ratio such that home does not choose to trade at these prices. This is completely unlikely, but we are simply following the strategy outlined in Chapter 6: "neutralize" all causes of trade except the one which we wish to examine. The situation is shown in Figures 10.2 where the autarky equilibrium A is also the free-trade equilibrium at price ratio  $p^*$ .

Once we introduce trade, we not only have to keep track of consumer and producer prices, but world prices as well. This in turn means that we have to specify whether a tax or subsidy is assessed on consumption or production. In the closed economy, it does not matter since production and consumption of each good are equal. But with trade, consumption and production are in general not equal, so it matters which one we are taxing. In this section, we will limit ourselves to looking only at production taxes and subsidies. These are not necessarily more common than consumption taxes, but space constraints limit the range of distortions we can deal with here. It is also true that focusing on production taxes helps build some intuition for the analysis of imperfect competition which begins in the next Chapter.

Consider a tax on the *production* of  $X_1$  or a subsidy on the production of  $X_2$ . In this case, consumers face world prices, not producers. Consumer prices and world prices will be equal to one another, but not to world prices. The relationships among the three price ratios are given by

$$\frac{p_1(1+t)}{p_2} = \frac{q_1}{q_2} = \frac{p_1^*}{p_2^*} > \frac{p_1}{p_2} \quad (10.4)$$

The relationships in (10.4) are shown in Figure 10.2. The producer price ratio is now greater than the

consumer and world price ratios, so production is shown as taking place at point  $X'$  in Figure 10.2. Consumption must take place along the world price ratio through  $X'$ , and consumers now face world prices. Thus the consumption point is given by the tangency between an indifference curve and the price line  $p^*$  through point  $X'$ . We show the consumption point as  $D'$  in Figure 10.3. The production tax discourages production of  $X^1$  and leads to a substitution in production toward good  $X^2$ .

### Figure 10.2

Several important results are shown in Figure 10.2. First, it clearly demonstrates that government policies such as taxes and subsidies can generate trade. However, it shows equally clearly that *trade induced by the introduction of distortions is not beneficial trade*. In Figure 10.2, the country receives a welfare loss as a consequence of distortion-induced trade. Point  $X^*$  in Figure 10.2 would be the undistorted equilibrium yielding a utility level of  $U^*$ . The distorted equilibrium yields a utility level of  $U'$ .

This is a very important results insofar as governments sometimes decide that it would be a good thing if the country produced and exported more of a certain good (e.g., "high tech" goods). We could think of Figure 10.2 as a situation generated by a government deciding that it must be good to produce and export  $X_2$ . By putting on a subsidy to the production of  $X_2$  we do indeed get exports of  $X_2$  and the government congratulates itself on the success of its project. However, exports generated by distortions are welfare reducing (put differently, the initial level of exports, zero, is optimal).

Welfare is reduced by this distortion, because producers make *privately* efficient choices given the prices they face, but they do not make efficient *social* choices when they do not face the true costs of producing the commodities. But again, we should separate this welfare result from the results concerning consumption and trade, since not all commodity taxes need be welfare reducing. Most countries have gasoline (petrol) taxes, for example, which have the beneficial effects of reducing pollution and traffic congestion.

## 10.4 Taxes and subsidies as determinants of trade: two identical countries.

Now we introduce a second country and explicitly return to our concept of the two-country, no-trade model. Suppose that we have two identical countries, both with production frontiers as in Figure 10.1, such that the point A in Figure 10.1 represents both the free-trade and autarky equilibria for both of the countries. Now country h imposes a production tax on  $X_1$  or a production subsidy  $X_2$ . At the initial free-trade price ratio  $p^*$ , country f will wish to continue to produce and consume at A in Figure 10.3 (the same as A in Figure 10.1) while country h will wish to shift production away from  $X_1$  toward  $X_2$ .

This cannot be an equilibrium because there will be excess demand for  $X_1$  and excess supply of  $X_2$  at the initial prices. The price ratio  $p^*$  must rise, giving us a new equilibrium as shown in Figure 10.3. The fall in  $p^*$  induces country h to export  $X_2$  and import  $X_1$ , producing at  $X^h$  and consuming at  $D^h$  in Figure 10.3. Country f produces at  $X^f$  and consumes at  $D^f$ . We see that a production tax on  $X_1$  or subsidy on  $X_2$  can indeed generate exports of  $X_2$ , but this is not welfare improving trade. Country h creates trade by its tax or subsidy, but it is not beneficial trade.

The interesting additional result that we get from Figure 10.3 is that *country f is made better off* by h's tax or subsidy. Recall from Chapter 5 that the ability of a country to trade at any prices other than its autarky prices can make it better off (and *will* make it better off if it has no distortions). The institution of the tax or subsidy in country h now allows country f an opportunity to trade at prices different than its autarky prices. This might also help us understand why country h has to be worse off. With the countries absolutely identical, there are no opportunities for mutual gains from trade. If the distortion makes country f better off, it must make country h worse off.

### Figure 10.3

The implication here is that country f should be happy when it's trading partner subsidizes its exports to h. Intuitively, the subsidizing country h is selling for less than the cost of production to the benefit of the passive country f. Happiness in f is rarely the reaction in practice however to a trading partner's subsidy. In some cases, a government may simply misunderstand this gift. But our result here is not general. In a Heckscher-Ohlin world of multiple factors of production, someone in country f is surely worse off and will understandably make a political fuss. Second, suppose that there are three countries, two of which export  $X_2$  to the third. Then the first two, call them h and f are competitors, and a subsidy to  $X_2$  by country h is going to drive down the price of  $X_2$  for both countries, making country f worse off as well.

Again, we will not provide a detailed normative discussion of this here. Our purpose is simply to show that a distortion can serve as a basis for trade but also that trade generated by a distortion is not necessarily good trade.

## 10.5 Production externalities

As noted above, externalities are another source of "market failure" yet at the same time can imply an additional source of gains from trade. Such externalities come up in quite a number of contexts, ranging from pollution to intellectual property. In this section, we will look at positive production externalities among firms in an industry. As suggested earlier, this could result from knowledge spillovers in which the innovations of one firm are quickly copied by other firms without compensating the innovating firm. Many other cases are discussed in the literature, including the increases in the range of intermediate goods as an industry or country grows, an idea going back to Adam Smith's "the division of labor is limited by the extent of the market". One interpretation of division of labor is increases in the number of specialized intermediate goods, a topic we will return to in Chapter 12.

Suppose that there is just a single factor of production labor,  $L$ , which is in fixed supply. Good  $X_2$  is produced with constant returns to scale by a competitive industry. Good  $X_1$  is produced by competitive firms who perceive themselves as having constant to scale, but the productivity of their labor inputs is positively related to the overall output of the industry. These competitive firms view total industry output as constant, much as we assume that competitive firms view the industry price as constant and unaffected by their own decisions. Let  $X_{1i}$  denote the output of an individual firm in industry 1 and let  $X_1$  denote total industry output, the sum over all  $i$  firms. The production side of our economy is given as follows:

$$X_{1i} = (X_1^\alpha)L_{1i} \quad X_2 = L_2 \quad \bar{L} = \sum_i L_{1i} + L_2 \quad (10.5)$$

where  $0 \leq \alpha < 1$  is an externality parameter:  $\alpha = 0$  is the special case of no externality, in which case the model reduces to the Ricardian model of Chapter 7. As just noted, each individual firm  $i$  in industry  $X_1$  views total industry output as constant. In competitive equilibrium, each firm equate the value of the marginal product of labor to the wage rate, denoted  $w$  as in the Ricardian model. Competitive equilibrium is then described by

$$p_1 X_1^\alpha = w \quad p_2 = w \quad \frac{p_1}{p_2} = \frac{1}{X_1^\alpha} \quad (10.6)$$

Total industry output in  $X_1$  is given by summing the first equation in (10.5) over all  $i$  firms. We do this and then rearrange the equation to given total industry output  $X_1$  as follows.

$$\sum_i X_{1i} = X_1 = X_1^\alpha \sum_i L_{1i} = X_1^\alpha L_1 \quad X_1^{1-\alpha} = L_1 \quad X_1 = L_1^{\frac{1}{1-\alpha}} \quad (10.7)$$

Since  $\alpha < 1$ , the exponent on the right-hand equation of (10.7) is greater than one: total industry output exhibits increasing returns to scale in its total labor input. Differentiate the middle equation in (10.7) along with the equation for  $X_2$  output, making use of the total labor supply constraint.

$$(1 - \alpha)X_1^{-\alpha}dX_1 = dL_1 \quad dX_2 = dL_2 = -dL_1 \quad (10.8)$$

Divide the first equation of (10.8) by the second and rearrange.

$$-\frac{dX_2}{dX_1} = (1 - \alpha)\frac{1}{X_1^\alpha} \quad (10.9)$$

which is the slope of the production frontier, the marginal rate of transformation. As we noted back in Chapter 2, the production frontier is a convex function (the production set is non-convex) reflecting the increasing returns to scale in  $X_1$ : the denominator of (10.9) gets smaller as  $X_1$  gets larger. The production frontier for our economy is shown as  $\bar{X}_2\bar{X}_1$  in Figure 10.4.

**Figure 10.4**

Now combine (10.9) with the competitive pricing condition in (10.6). This gives us a relationship between the marginal rate of transformation and the equilibrium price ratio.

$$-\frac{dX_2}{dX_1} = (1 - \alpha)\frac{p_1}{p_2} < \frac{p_1}{p_2} \quad (10.10)$$

Now we discover a second issue, in addition to the convexity issue, connected with a positive production externality. The competitive-equilibrium price ratio is not tangent to the production frontier, but rather cuts it as shown in Figure 10.4. The intuition behind this result is the fact that when an individual firm expands output a little, it confers a positive productivity effect on all other firms taken together. Thus the true or “social” marginal product of an additional worker hired is greater than the “private” marginal product of an individual firm. Or to put it the other way around, the private cost of an addition worker hired is more than the true social cost. The slope of the production frontier depends on the true social cost and so it is flatter than the price ratio, equal to private marginal cost. Competitive equilibrium is at a point like A in Figure 10.4, giving a welfare level of  $U^a$ .

While we don’t want to get into a detailed normative analysis here, we should note that this is a case where an offsetting distortion could increase welfare. The first-best outcome in Figure 10.4 is at point S yielding welfare  $U^s$ . This could be achieved by a subsidy to  $X_1$  in effect compensating for or “internalizing” the externality. If the externality is due to imperfect protection of intellectual property (the innovating firms is not compensated for benefits conferred on other firms), then added intellectual property protection will act to offset the distortion and move the country toward point S in Figure 10.4. This is an application of what is known as the theorem of the second best:

Theorem of the second best: in the presence of one distortion, the imposition of an additional and offsetting distortion can improve welfare.

We will return to this idea later in the book.

## 10.6 Trade and gains from trade in the presence of production externalities

Let us abstract from the issue of the price line cutting the production frontier by assuming that there are positive externalities in both  $X_1$  and  $X_2$  and in the same degree  $\alpha$ . Then there will be a term  $(1 - \alpha)$  in both the numerator and denominator of (10.10) and these will cancel out, leaving the marginal rate of transformation equal to the price ratio. In this special case, we will have an autarky equilibrium at point  $X^a = D^a$  in Figure 10.5, giving an autarky welfare level of  $U^a$ .

### Figure 10.5

Now assume that there are two absolutely identical economies and let them trade. It is beyond the scope of this chapter to give a detailed analysis of the adjustment process but in short, the outcome shown in Figure 10.5 at  $X^a$  continues to be an equilibrium but it is *unstable*. A small perturbation can send the two countries off to corners, each specializing in only one of the two goods. One country could specialize in good  $X_2$  and the other in  $X_1$  and they could each trade half of their output for half of the other country's good, leading both countries to share a common consumption point at  $D^*$  in Figure 10.5. Here is our first instance of how there can exist gains from trade even between identical countries arising from increasing returns to scale.

The outcome shown in Figure 10.5 in which the equilibrium price ratio is exactly the cord connecting the two endpoints of the production frontier is a special case requiring strong symmetry assumptions. Suppose at this price ratio, the countries do not demand  $X_1$  and  $X_2$  in the proportions produced, but each country wants to consume a lot of  $X_1$  and not so much  $X_2$ . Then at the price ratio shown in Figure 10.5, there will be excess demand for  $X_1$  and excess supply of  $X_2$ . The outcome is going to have to be as shown in Figure 10.6: the relative price of  $X_1$  will rise to clear the market. The country specializing in  $X_2$ , call that country h, consumes at  $D^h$  and country f specializing in  $X_1$  consumes at  $D^f$  in Figure 10.6.

### Figure 10.6

Note that the outcome shown in Figure 10.6 is not the only possible one. Reversing which country is which is also an equilibrium. Thus situations in which there are production externalities can be characterized by multiple equilibria. In such a situation, we want to note that this phenomenon has many implications, for development economics in particular. In the presence of multiple equilibria, a country doesn't want to end up in the "wrong" outcome: it wants to be country f in Figure 10.6, not country h. A more detailed analysis is beyond the scope of this chapter. But in closing, refer back to Figure 10.4. Suppose one country has a free market and the other one "internalizes" the externality via intellectual property protection for example. The former country is at A while the latter one is at S in Figure 10.4. If trade opens up, the country at S has a lower price for  $X_1$  and hence will tend to end up specializing in  $X_1$ : this country will be country f shown in Figure 10.6. Internalizing positive production externalities can give a country an advantage in a situation of multiple equilibria.

## 10.7 Summary: what you should know

This chapter has turned our attention away from underlying production differences between countries, principally differences in technologies and in factor endowments. Instead, we neutralize these differences by assuming that technologies, factor endowments and also demand are identical across two countries. This continues the methodology outlined in Chapter 6. Here we look at distortions and externalities (which are themselves a class of distortions) to see how asymmetries in distortions across countries can generate trade and may or may not generate gains from trade for each of two countries.

One class of distortions is represented here by simple production taxes and subsidies. In such a situation, it is important to keep track of different sets of prices, in particular consumer, producer, and world prices. The principal result of this analysis is that production taxes or subsidies can generate trade between otherwise identical countries, but it is a welfare-worsening trade for the taxing/subsidizing country. This carries a very important lesson for policy makers, which is that exports should never be

confused with welfare. A production subsidy to a favored sector may indeed generate exports from that sector, but these exports are being sold abroad for less than the cost of production and hence are welfare worsening.

The second class of distortions addressed here are positive production externalities or spillovers, arising due to some failure on the part of firms to be able to capture returns for benefits they confer on rival firms. Examples include the lack of protection for intellectual property and innovations, and increases in productivity arising from the finer “division of labor” in a larger market. These issues will arise again in this book.

These positive production externalities imply aggregate increasing returns to scale even though individual firms have constant returns technologies. As discussed back in Chapter 2, this can imply that the production frontier is convex (the production set non-convex) or “bowed in”. This in turn can imply positive gains from trade for each of two identical countries: with each country specializing in only one sector, productivity rises and then can exist mutual gains from trade. The situation is not simple however, and we touch briefly on issues like the existence of multiple equilibria, with the alternative equilibria having very different welfare implications for the trading partners.

The next two chapters continue to look at similar, even identical economies, and analyze how imperfect competition and increasing returns to scale offer added sources of gains beyond those arising from comparative advantage linked to differences between countries.

**REFERENCES**

- Bhagwati, J. and T.N. Srinivasan (1983), *Lectures on International Trade*, Cambridge: MIT Press, Chapters 20-23.
- Grossman, Gene M. and Estaban Rossi-Hansberg (2009), "External economies and international trade redux", Princeton University working paper.
- Ethier, Wilfred J. (1979), "Internationally decreasing costs and world trade", *Journal of International Economics* 9, 1-24.
- Kemp, Murray C. (1969), *The pure theory of international trade and investment*, New Jersey: Prentice Hall.
- Markusen, James R. (1900), "Micro-Foundations of External Economies", *Canadian Journal of Economics* 23, 495-508.
- Markusen, James R. and James R. Melvin (1981), "Trade, Factor Prices, and the Gains from Trade with Increasing Returns to Scale," *Canadian Journal of Economics* 14, 450-469.
- Melvin, J. R. (1970). "Commodity Taxation as a Determinant of Trade." *Canadian Journal of Economics* 3, 62-78.
- Melvin, J. R. (1969). "Increasing Returns to Scale as a Determinant of Trade", *Canadian Journal of Economics* 2, 389-402.

Figure 10.1

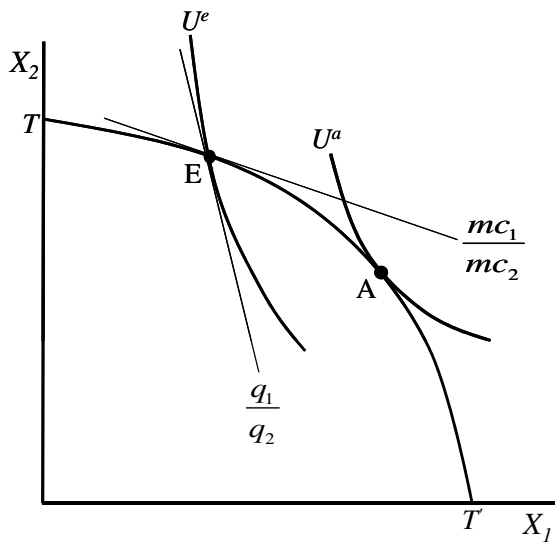


Figure 10.2

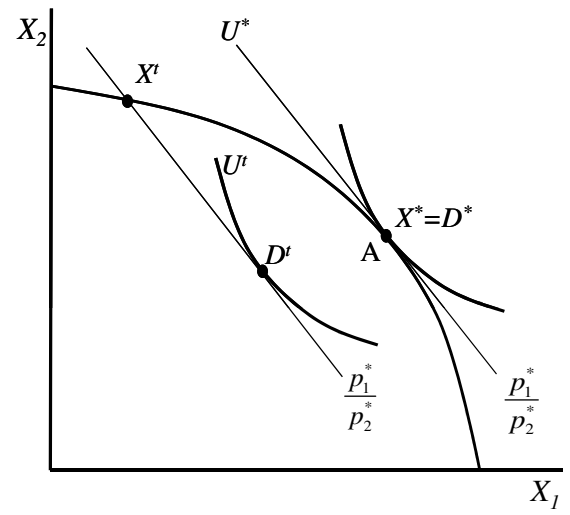


Figure 10.3

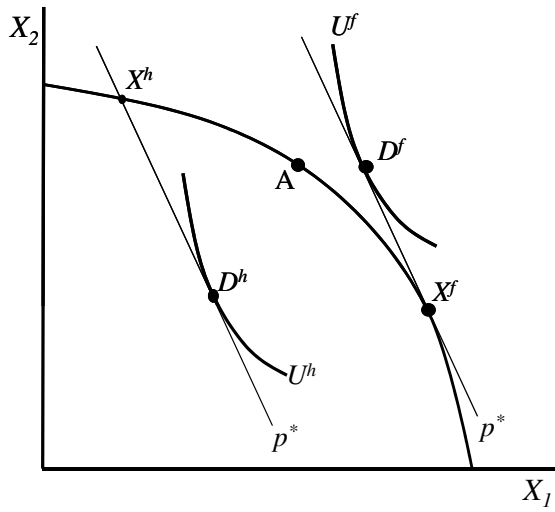


Figure 10.4

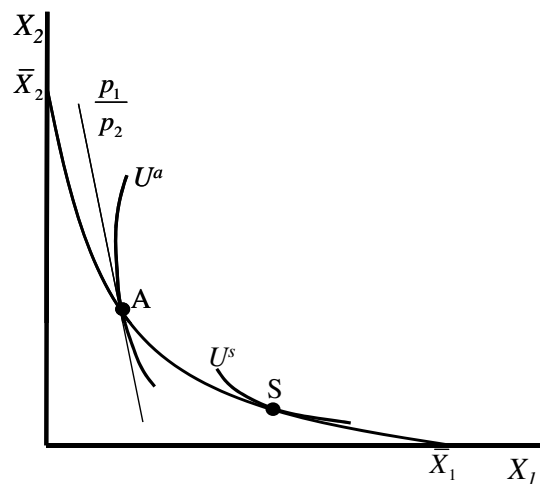


Figure 10.5

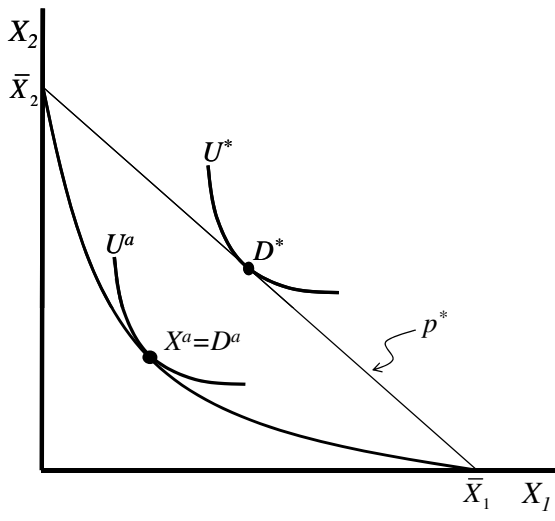


Figure 10.6

