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Abstract

Although a major contribution to trade theory, Krugman's 1979 demonstration that 'trade can arise and lead to mutual gains even when countries are similar' fails to make explicit the economic mechanisms that lead up to this result.

The current paper attempts to fill this gap by addressing several questions that are implicit in Krugman's demonstration but which he does not explicitly analyze:

- What is the effect of trade upon the demand curve faced by the typical firm in each nation?
- How do firms react to the change in the demand curves they face, and what is the short-term outcome of their behaviour?
- Why do some firms fail?
- What is the role of the failure of firms in the adjustment to the final free trade equilibrium?

Key words: Krugman, intra-industry trade, economies of scale, monopolistic competition

JEL: F12

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1. Introduction

According to traditional trade theory, trade could only arise, and lead to mutual gains, if countries differed in their technologies (David Ricardo) or in their resources (Heckscher-Ohlin). Moreover, trade would consist only of exchanges of goods in different product categories (inter-industry trade).

One of the main contributions of Paul Krugman to economics was to show that this is not true: trade can also arise, and lead to mutual gains, if countries are similar; and this trade will consist of two-way exchanges of goods within standard industrial classifications (intra-industry trade).

Krugman's 1979 explanation of intra-industry trade between similar countries is based on the operation of economies of scale under monopolistic competition. His contribution could not be more relevant. First, the major part of world trade takes place between developed countries – which are similar, not different, in their technologies and resources. And, second, their trade is primarily of the intra-industry type.

Having said this, we believe that Krugman's explanation of trade based on economies of scale under monopolistic competition fails to make explicit the crucial economic mechanisms that lead up to his results (i. e. that trade can arise and lead to mutual gains even if countries are similar). Furthermore, the main textbooks on trade theory - including Krugman and Obstfeld (2006), henceforth KO (2006) – generally follow Krugman's original article, and are also silent on the economic mechanisms behind his model.¹

This paper is an attempt to fill this gap. Section 2 summarizes KO's 2006 presentation of Krugman's model. In section 3, we present an alternative explanation of that model. Section 4 concludes.

2. A summary of Krugman's presentation of his model

Krugman proceeds in two steps. First, he characterizes the autarkic equilibrium in a monopolistic competitive industry. Afterwards, he analyses the effect of trade on that equilibrium.

¹ This can be said about the following influential textbooks: Caves et. al. (2007) and Appleyard et. al. (2008).

A. Autarkic equilibrium in a monopolistic competitive industry

In the standard model of monopolistic competition, all firms are assumed to be symmetric – that is, “the demand function and cost function are identical for all firms (even though they are producing and selling somewhat differentiated products).” (KO, 2006, p. 117)

The costs of the typical firm

Krugman assumes the following linear cost function for the typical firm:

$$C = F + c \cdot Q \quad (3)$$

where F is a fixed cost, Q is the level of output, and c the firm’s marginal cost (MC, *constant* by assumption). This implies economies of scale, because the larger the firm’s output, the less is the fixed cost per unit. Specifically, the firm’s average cost (AC) is:

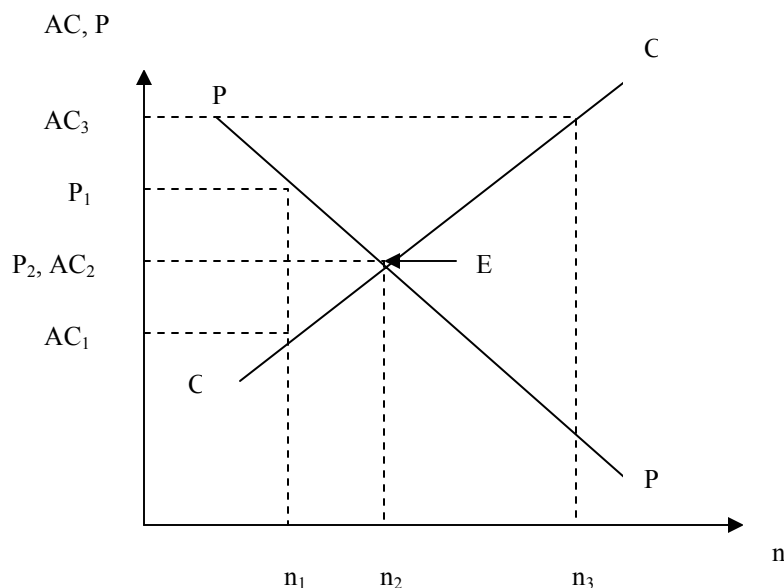
$$AC = C/Q = F/Q + c \quad (4)$$

The average cost declines as Q increases because the fixed cost is spread over a larger output.

One implication of this equation is that, *given the size of the industry’s market (S)*, the more firms there are in the industry, the higher the AC of each firm. Indeed, if the number of firms increases ($\uparrow n$), each firm will sell and produce less ($\downarrow Q = S/n$) and, therefore, will have an higher average cost ($\uparrow AC$). Schematically:

$$\uparrow n \Rightarrow (\text{given } S) \downarrow Q (= S/n) \Rightarrow \uparrow AC$$

This relationship between n and AC is represented by the CC curve in the following figure (reproduced from KO, 2006, p. 119):



The demand faced by the typical firm

In a monopolistic competitive industry, the demand directed to the product of the typical firm (Q) decreases with its own price (P) and the number of firms in the industry (n), and increases with the size of the total demand for the industry's product (S) and the average price charged by the firm's rivals (P^*):

$$Q = f(n, P, S, P^*) \quad (1)$$

(-)(-)(+)(+)

In a model "in which consumers have different preferences and firms produce varieties tailored to particular segments of the market" (KO, 2006, p. 117), it is possible to obtain the following specification for equation 1:

$$Q = S.[1/n - b.(P-P^*)] \quad (2)$$

where b is a constant term representing the responsiveness of a firm's sales to its own price, P , and the average price charged by its competitors, P^* . This equation can be given the following intuitive explanation: "if all firms charge the same price, each will have a market share $1/n$. A firm charging more than the average of the other firms [$P > P^*$] will have a smaller market share, a firm charging less [$P < P^*$] a larger share." (KO, 2006, p. 117)

Krugman assumes furthermore that "the total industry sales S are unaffected by the average price charged by the firms in the industry. That is ... firms can gain customers only at each other's expense. This is an unrealistic assumption but simplifies the analysis and helps focus on the competition among firms." (KO, 2006, p. 118)

A crucial implication of equation (2) is that, *given the size of the industry's market (S)*, the more firms there are, the lower the (profit-maximizing) price each firm will charge.

Why? Because "the more firms there are, the more intense will be the competition among them and hence the lower the price. This turns out to be true in this model but proving it takes a moment." (KO, 2006, p. 118)

Krugman is aware that an explanation for 'lower prices as a result of more intense competition' is insufficient and, for that reason, makes a mathematical demonstration of his point. Firstly, he obtains the marginal revenue (MR) function from the demand curve facing the typical firm (equation 2). Afterwards, he equalizes the MR to the MC (c). Finally, he solves the resulting equation to obtain a relationship between P (the profit-maximizing price) and n (the number of firms): $P = c + 1/(b.n)$

This equation says that the more firms there are in the industry ($\uparrow n$), the lower the price each firm will charge ($\downarrow P$). It is represented by the downward sloping PP curve in figure 1.

Industry equilibrium

Given free entry and exit, the industry equilibrium is given by $P = AC$ (the zero-profit condition). *This equilibrium is defined by the number of firms and the average price they charge.* It corresponds to point E in figure 1, where there are n_2 firms in the industry and where their profit maximizing price (P_2 , given by the PP curve) is exactly equal to their average cost (AC_2 , given by the CC curve).

Point $E = (n_2, P_2)$ is a stable equilibrium: If the number of firms is $n_1 < n_2$, their profit maximizing price P_1 is higher than their average cost AC_1 . Thus, established firms are making above-normal profits and, as a result, new firms enter the market. This drives the price down and the average cost up until they are equal at point E. (If the number of firms is $n_3 > n_2$, the opposite happens).

Finally, note that the *equilibrium of each individual firm* corresponding to the aggregate industry equilibrium (point E) is given, in the figure that follows, by the point of tangency between the demand curve (D) and the average cost curve (AC) of the firm:

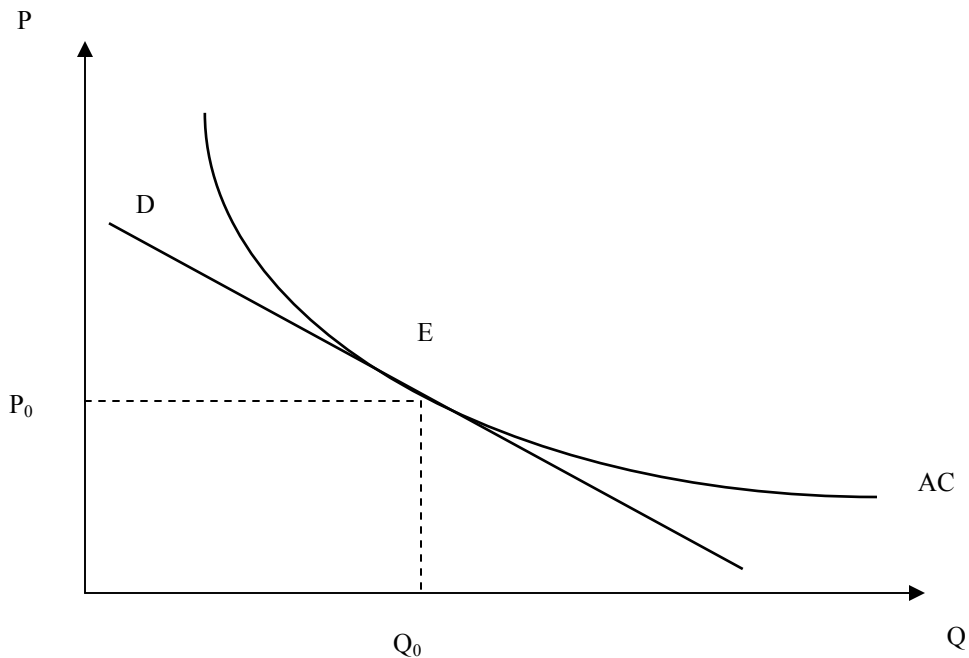


Figure 2

B. The effect of trade on the industry equilibrium

Krugman's explanation

The key contribution of Krugman is to show that trade, by creating a combined market larger than any of the national markets that comprise it, allows *more varieties* of each good to be produced, at *lower average costs*, than in any national market alone. Krugman's demonstration is based on the following figure (reproduced from KO, 2006, p. 122):

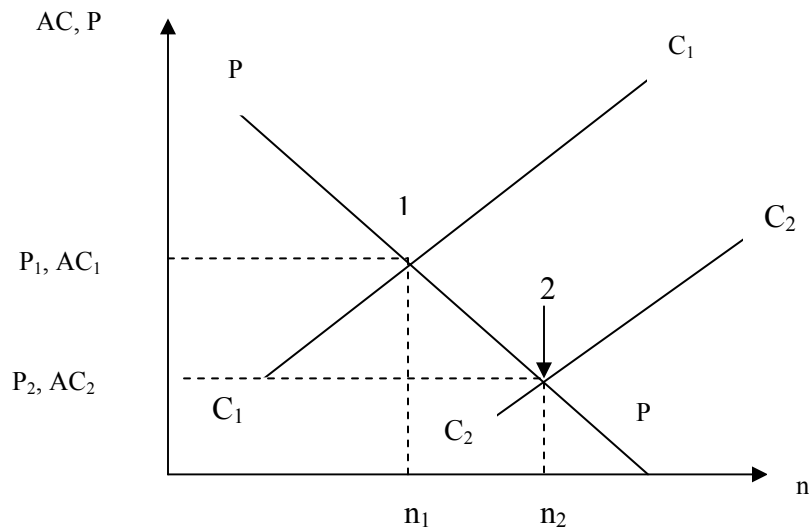


Figure 3

In autarky, the industry equilibrium in each country is at point 1, with a price P_1 and a number of firms n_1 . When trade starts, the market size of the industry increases ($\uparrow S$) and, *given the number of firms* (n), the sales of each firm rise ($\uparrow Q = S/n$). As a result, the AC of each firm falls for any given n – that is, the CC curve shifts down to C_2C_2 . Schematically:

Trade $\Rightarrow \uparrow S \Rightarrow$ (for any given n) $\uparrow Q (=S/n) \Rightarrow \downarrow AC$ (for any given n)

By contrast, trade and the ensuing increase in the size of the market do *not* have any effect on the PP curve (which relates the profit-maximizing price with the number of firms). Why? Because the “size of the market does not enter into [the equation that defines the PP curve, $P = 1 + 1/(b \cdot n)$]” (KO, 2006, p. 122).

Conclusion: the industry equilibrium shifts from point 1 to point 2, which means that the number of firms increases from n_1 to n_2 while the price falls from P_1 to P_2 . “Clearly, consumers would prefer to be part of a large market than a small one. At point 2, a greater variety of products is available at a lower price than at point 1.” (KO, 2006, p. 123)

This is all that Krugman has to say. We hope that the reader is by now bewildered and wondering about the economic mechanisms that lead up to the conclusion that ‘trade lowers the price and increases the varieties available to consumers.’ This paper is an attempt to shed light on this issue.

3. An alternative explanation of Krugman’s model

A. A critique of Krugman’s explanation

In our view, Krugman’s geometrical demonstration fails to address the following questions:

1. What is the effect of trade upon the demand curve faced by the typical firm? The answer to this question is indispensable if we are to understand *what motivates* firms to cut their prices.

2. What happens to the level of sales of the typical firm when it lowers its price? Does it rise, fall or remain constant?

3. At the end of the adjustment process (point 2 in figure 3), the output of the typical firm increases (we know this because its average cost falls). Since the output of the industry is constant by assumption, this can only happen as a result of the failure of some firms. Hence the question: *Why do some firms fail?*

(Oddly enough, Krugman does not even mention that some of the initial firms must inevitably fail during the adjustment process).

4. What is the role of the failure of firms in the adjustment to the final free trade equilibrium?

B. A clarification of Krugman’s question

Imagine two symmetric “countries”, the US and the European Union (EU), whose autarkic national markets of autos share exactly the same characteristics: In each country, there are 10 firms facing the same cost and demand curves. Each firm produces 100 thousand autos per year, and thus 1 million autos are produced and bought annually in each nation. Finally, both auto industries are in long run equilibrium ($P = AC$, point E in figure 1).

What happens when the two countries start trading with each other and form an integrated market of 2 million autos?

At first, it seems that the integration of the markets will *not* have any effect on the demand directed to the typical US or EU firm. Consider, for example, the case of EU firms. In fact, some American consumers will buy European autos instead of American autos. However, this will be exactly offset by a symmetric deviation of demand of some European consumers towards American autos. Therefore, the demand directed to the typical EU firm will remain unchanged.

Hence, the sales and the output of each US and EU firm in the *unified* market will apparently remain constant at the initial autarkic levels. And, as a result, it seems that the unification of both markets will *not* have any effect on the average cost and on the price of autos.² Well, the key insight of Krugman's model is to show that this is *not* true: the unification of both markets will have an effect on the average cost and on the price of autos – both will fall as a result of trade.

In the rest of the paper, we make a detailed description of the economic mechanisms that lead up to this result.

C. The effect of trade on the demand curve faced by the typical firm

What happens to the demand curve faced by the typical firm as a result of trade? Before trade, in each country there are 10 firms catering for separate national markets of 1 million autos each. Trade unifies the two markets and *instantly* doubles the number of firms (up to 20) and the level of sales (up to two million autos). Therefore, the demand directed to the product of each firm remains unchanged *at the initial prices*: in figure 4, the equilibrium point (E_0) in the initial demand curve of the typical firm (D_0) does not move.

However, as a result of trade there are now 19 instead of 9 close substitutes for the product sold by each firm. Therefore, an increase in the price of any one firm leads now to a greater reduction in its sales than before. This means that the demand curve facing the typical firm becomes less steep for any $P > P_0$.

On the other hand, as a result of trade the potential market for each firm has now doubled from 1 million to 2 million autos. Hence, a price cut by any one firm leads now to a greater increase in its sales than before. This means that the demand curve facing the typical firm becomes less steep for any $P < P_0$.

In short, in geometrical terms trade leads to a rotation of the demand curve faced by the typical firm towards a more horizontal position ($D_0 \rightarrow D_1$):

² The only apparent difference is that now there will be 20 firms catering for a unified market of 2 million autos, instead of 10 firms in each country selling for separate markets of 1 million autos each. Hence, the only apparent benefit received by consumers is that now they will choose from 20 instead of just 10 varieties of autos.

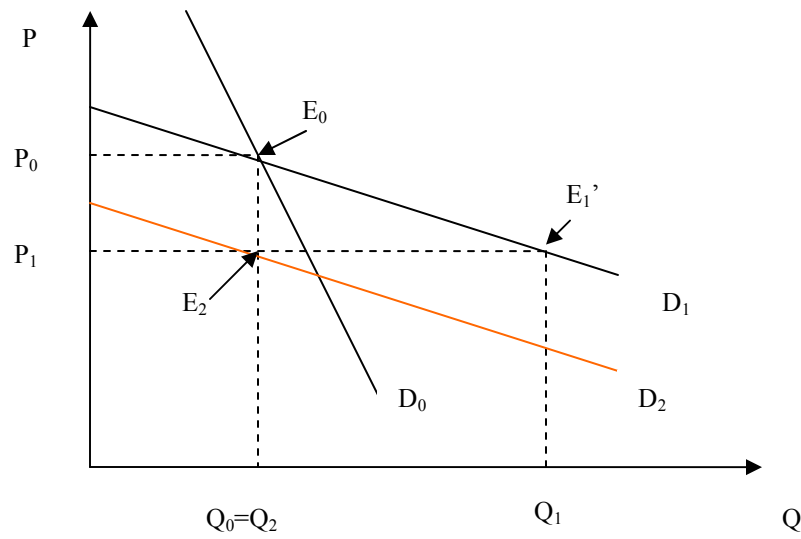


Figure 4

D. The failure of firms

What motivates the typical firm to cut its price? What is the effect of that price cut on its level of sales? Does it rise, fall or remain constant? Why do some firms fail?

Faced with a more elastic demand curve, the typical firm reacts by lowering its price (say, from P_0 to P_1) in order to boost its sales (from Q_0 to Q_1). But the firm does not succeed in this objective: its sales remain constant. Indeed, all firms are *simultaneously* cutting their prices by the same extent (from P_0 to P_1) and, therefore, the relative price of the typical firm does not change. Hence, the reduction in the *absolute* price of the typical firm fails to expand its level of sales.

These ideas are illustrated in figure 4. In this figure, the demand curve faced by the typical firm D_1 is drawn *on the assumption that the average price of the other firms is constant at P_0* . On this assumption, a price cut by the typical firm from P_0 to P_1 would boost its sales from Q_0 to Q_1 . However, trade leads all firms to cut their prices down to P_1 , and this fact shifts the demand curve faced by the typical firm from D_1 to D_2 . As a result, the price reduction by the typical firm from P_0 to P_1 does not have any effect whatsoever on its sales and output, which remain constant at Q_0 . A consequence of this unchanged output is that *the average cost of the typical firm does not fall*.

In sum: trade lowers the price but leaves the output and the average cost of the typical firm unchanged. Moreover, this fact has the following crucial implication: prices become lower than average costs and, therefore, profits turn negative and some firms exit the industry.

E. Firms' failures and the final equilibrium

The exit of some firms expands the sales of the firms that remain in the industry. As a result, the outputs of these firms rise and, due to economies of scale, their average costs fall towards the lower price.

These ideas are illustrated in figure 5. In this figure, the exit of some firms shifts up the demand curve faced by the typical surviving firm from D_2 to D_3 , and the final equilibrium is reached at point E_3 . In this free trade equilibrium, the output of the typical firm, Q_3 , is greater than in the previous autarkic equilibrium, Q_0 . Hence, the free trade average cost, AC_3 , is lower than the previous autarkic average cost, AC_0 .

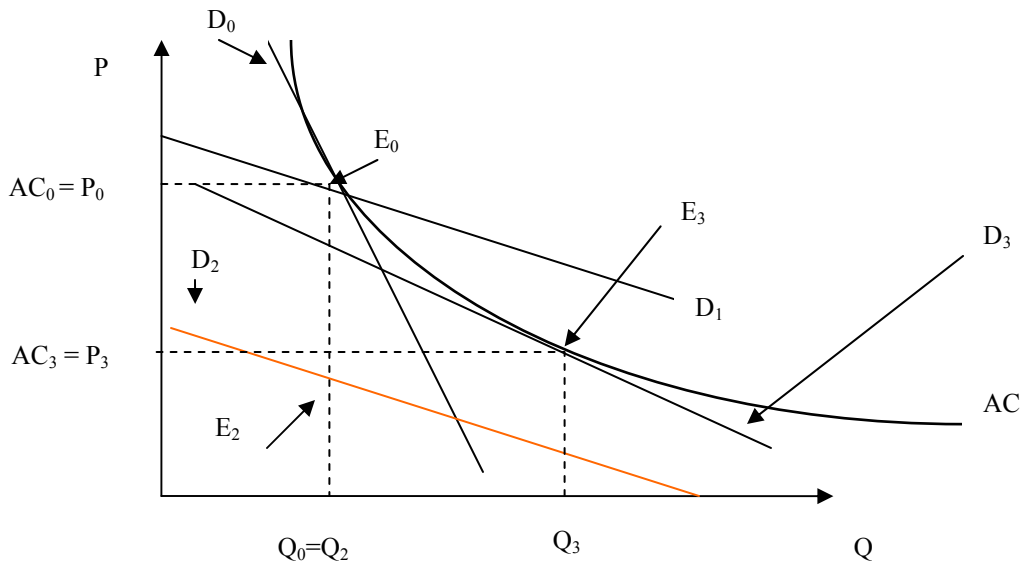


Figure 5

Notice that the whole process of adjustment from the autarkic equilibrium to the free trade equilibrium involves three successive shifts of the demand curve perceived by the typical firm ($D_0 \rightarrow D_1 \rightarrow D_2 \rightarrow D_3$) which, in turn, lead to a movement between three equilibrium points ($E_0 \rightarrow E_2 \rightarrow E_3$). It is clear that

Krugman's explanation, based simply on the previous figure 3, overlooks various subtleties of the adjustment process between the initial autarkic equilibrium and the final free trade equilibrium.

F. The increase in welfare

As a result of trade, consumers in each country pay lower prices and benefit from a greater variety of available products. For example, in the final free trade equilibrium (E_3) there may only be 12 firms in the unified market, instead of the initial 20 firms, catering for the same 2 million consumers. This means that free trade increases the output of the typical surviving firm (from 100.000 up to 166.666 autos), and hence reduces its average cost and the price paid by consumers.

4. Conclusion

Although a major contribution to trade theory, Krugman's 1979 demonstration that 'trade can arise and lead to mutual gains even when countries are similar' fails to make explicit the economic mechanisms that lead up to this result.

The current paper has been an attempt to shed some light on this issue. In particular, we have argued that the process through which trade 'lowers the price and increases the varieties available to consumers' involves the following mechanisms:

- By unifying previously separated markets, trade increases competition and the level of potential sales, and therefore raises the elasticity of the demand curves faced by monopolistic competitive firms.

- Faced with more elastic demand curves, firms react by lowering prices in order to boost their sales. But, since all firms cut their prices at the same time, they do not succeed in their objective: their sales and output remain constant. One consequence of this unchanged output is that the average costs of firms do not fall.

- Since trade lowers prices but leaves average costs constant, profits turn negative and some firms exit the industry.

- The exit of some firms expands the sales and the output of the firms that remain in the industry. Due to economies of scale, average costs fall.

- In the final free trade equilibrium, there are fewer firms in each country producing at a larger scale and at a lower average cost than in autarky - and therefore charging a lower price. Yet, by buying from other countries varieties that its own firms do not produce, each country can simultaneously increase the varieties available to its consumers.

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