Vanek-Reinert Effect as a Corollary of Ricardo's Comparative "Advantage": a Simple Numerical Illustration

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Abstract

Proponents of free trade contend that trade liberalization benefits all participants, regardless of whether the country is advanced or developing. There is another benefit to free trade, some economists argue, specifically for the developing nations. According to these economists, the trade-liberalizing developing country will benefit from technology transfer from advanced countries. Here we aim to provide a simple illustration that both these arguments are in direct contradiction with a basic economic optimization principle – and the canonical foundation of international trade – specialization by Ricardo's comparative advantage.

Introduction

Consider two disconnected worlds. One world operates under highly efficient market economy, the other world – under less efficient planned one. The worlds don't trade with each other.

The first world is highly technologically advanced. While some or possibly substantial amount of manual labor is still required in manufacturing of most goods, a very large part of manufacturing is highly mechanized.

The second world is just as highly educated, on average, and is capable of producing the same nomenclature of high-technology products. However, due to a less efficient planned economy, a smaller share of manufacturing is mechanized and larger amount of manual labor is required in industry.

The central dogma of most economics teachings is that upon economic liberalization in the planned-economy world and establishment of free trade regime knowledge will flow from technologically advanced world to the former planned-economy world and convergence in economic well-being will take place.

However, this has not occurred in practice. The economic convergence has either been slow at best or the opposite has occurred.[1] [2]

But from pure mathematics or optimization perspective this outcome is not unexpected. The reason is that the technology is relatively more advanced in the industrial nations. By Ricardo's comparative advantage principle,[3] the world will benefit if each of its parts specializes in areas where it's relatively more efficient. Therefore, the industrial world will specialize in high-technology mechanized areas while the developing world, due to its comparative advantage in manual labor, would be expected to specialize in labor-intensive lower-added-value activities.

The same outcome follows from pure optimization standpoint. Given limited resources, the business will naturally reallocate resources to the most productive use. And if engineering or high added-value resources are relatively more productive in the industrial world, the developing world will mostly get investment in areas that are relatively more costly in the industrial world, that is in manual labor.

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One could also argue that Ricardo's comparative advantage principle is essentially an example of constrained optimization – the most efficient allocation of resources and maximization of output given natural constraints in labor and capital. In this paper we will provide a simple illustration how upon trade liberalization, following the comparative advantage or resource optimization principles, the world resources shift to benefit the industrial countries at the expense of developing ones. We will also demonstrate the equivalence of Ricardo's comparative advantage and constrained optimization – the maximization of total output given limited capital and labor resources – with a simple numerical example in automotive industry.

Results

Consider a hypothetical model involving two car manufacturers, Volkswagen of Germany and Skoda of Czechia, making 5000 cars each, priced at 20,000 euros, in a given period of time. For illustration purposes, suppose that car manufacturing consists of only two main sets of operations. One is production of key components, for example engines and transmissions. The other is final assembly.

Suppose, further, the following number of personnel are required to produce the 5000 engines/transmissions and to assemble the 5000 vehicles at each manufacturer:

	Volkswagen workers	Volkswagen output	Skoda workers	Skoda output
Engines+Transmissions	800	5000	1500	5000
Final assembly	1000	5000	1200	5000

The total number of employees is 1800 for Volkswagen and 2700 for Skoda.

Even though Volkswagen is more efficient both in producing components and in final assembly, Skoda has comparative advantage in the latter. In Ricardo's terms, there is basis for "trade." If the two automakers are to merge operations, the maximum production will be achieved if each division specializes on operations where it has comparative advantage. Namely, assume that workers and engineers can be moved freely between operations within either Volkswagen or Skoda, either Volkswagen or Skoda engine or transmission can be fit into both makes, and the engine/transmission and assembly personnel can equally well work on either VW or Skoda product. Then the Volkswagen division would specialize in engines and transmissions, and the Skoda division should specialize in final assembly.

Under "free trade" (merging operations and optimizing production resources) the output of the combined entity will be as follows:

	Volkswagen workers	Volkswagen output	Skoda workers	Skoda output
Engines+Transmissions	1800	11,250	0	0
Final assembly	0	0	2700	11,250

Thus, Ricardian specialization through a more efficient use of existing resources brings multiple benefits to the combined entity. The total output increases from 10,000 to 11,250 vehicles per year. The revenue increases from 100 million euros to 112.5 million. Revenue per employee increases from just over 22,000 euros to 25,000. Classic!

Differentiated value of labor

But now we need to take into account the following consideration. The first set of operations (engines and transmissions) is highly mechanized, while the second requires a substantial amount of manual labor. Correspondingly, the added value per designer/engineer/worker in the mechanized part of car production is much higher than in the labor-intensive one. In monetary terms assume that engine plus transmission cost 12,000 euros, while the final assembly constitutes 8,000 euros of the value of the car, and the car is priced at 20,000 euros.

Before specialization, both companies' revenues are 100 million euros, with the following distribution by specialization:

	Volkswagen workers	Volkswagen output, euros	Skoda workers	Skoda output, euros
Engines+Transmissions	800	60,000,000	1500	60,000,000
Final assembly	1000	40,000,000	1200	40,000,000
Total	1800	100,000,000	2700	100,000,000
Revenue per employee	55,555		37,037	

After specialization, the total output increases to 11,250 vehicles or 225 million euros, with the following distribution by division:

	Volkswagen workers	Volkswagen output, euros	Skoda workers	Skoda output, euros
Engines+Transmissions	1800	135,000,000	0	0
Final assembly	0	0	2700	90,000,000
Total	1800	135,000,000	2700	90,000,000
Revenue per employee	75,000		33,333	

Thus, Ricardian specialization leads to a disproportionate increase in output (or "welfare") at the more advanced company at the expense of the less advanced company. The less advanced company loses the expertise in producing high-technology components and switches to specialization in relatively primitive manual assembly operations.

Partial specialization

The case of complete specialization in the previous section assumes that all the workers can be moved between production activities in a short period of time. In reality, of course, this may not be the case. However, the complete specialization does not have to happen overnight. We can demonstrate that any incremental shift of workers from one activity to another within both Volkswagen and Skoda leads to the same conclusions – increasing specialization on high-technology work within the more advanced part of the firm/economy and increasing specialization on labor-intensive work within the less advanced part of the firm.

Consider an incremental change in the allocation of workers. Namely, start with the original table – before specialization

	Volkswagen workers	Volkswagen output	Skoda workers	Skoda output
Engines+Transmissions	800	5000	1500	5000
Final assembly	1000	5000	1200	5000

Consider the situation where a relatively small number – 100 workers – can be shifted from labor-intensive final assembly operations to more advanced engines+transmissions operations within Volkswagen. Respectively, 150 Skoda workers need to be shifted from engines+transmissions to final assembly to compensate for the change in Volkswagen output.

The output of combined entity is now as follows:

	Volkswagen workers	Volkswagen output	Skoda workers	Skoda output
Engines+Transmissions	900	5625	1350	4500
Final assembly	900	4500	1350	5625

Total vehicle output for combined entity due to this small change increases from 10,000 with no specialization to 10,125 with incremental specialization.

Further, consider the change in output per worker in euro terms. Before specialization:

	Volkswagen workers	Volkswagen output, euros	Skoda workers	Skoda output, euros
Engines+Transmissions	800	60,000,000	1500	60,000,000
Final assembly	1000	40,000,000	1200	40,000,000
Total	1800	100,000,000	2700	100,000,000
Revenue per employee	55,555		37,037	

After partial specialization:

	Volkswagen workers	Volkswagen output, euros	Skoda workers	Skoda output, euros
Engines+Transmissions	900	67,500,000	1350	54,000,000
Final assembly	900	36,000,000	1350	45,000,000
Total	1800	103,500,000	2700	99,000,000
Revenue per employee	57,500		36,667	

The conclusions of this partial specialization example are the same – increased specialization in more advanced (capital-intensive, high added-value) activities for the more advanced “economy” and loss of high-technology jobs and high-technology output (primitivization) of the less advanced “economy.” And disproportionate increase in welfare of the more advanced economy at the expense of the less advanced one.

Equivalence to constrained optimization

The above partial specialization illustration is a trivial case of constrained optimization.[4] Essentially, this is how constrained optimization works. Starting with the initial condition and given constrained resources (fixed amount of labor and capital), the optimization procedure finds a gradient (incremental resource reallocation) which maximizes output increase. This gradient corresponds to incremental production optimization. In our example, the gradient corresponds to gradual shifting of workers toward more advanced operations withing Volkswagen with the simultaneous gradual shifting of workers toward more labor-intensive operations within Skoda. The complete specialization represents the only stable equilibrium point of this optimization.

A note on global value chain

In real-world industry it is sometimes said that a vehicle or a final product is manufactured in one country, and typically this assumes the country of final assembly. In our simple one-industry two-country example one could say that production of vehicles is shifted to Czechia. This would not the be fair, however. The cars, in our simple example, are still produced in two countries. There is a global value chain, which in this simple case consists of just two parts – high-tech components and labor-intensive assembly operations. The Vanek-Reinert principle, the Ricardian comparative advantage specialization, and constrained optimization given limited labor resources are one and the same. The result is that upon liberalization of trade, given differentiated value of labor, the more advanced economy is benefiting from specialization in high-added-value activities, while less-advanced economy undergoes primitivization of production activities, shift down the global value chain, and falling incomes.[5]

Discussion

We have considered a simple illustration which demonstrates the Vanek-Reinert effect in an industry. The Vanek-Reinert effect if this example is a corollary of Ricardo's comparative advantage principle. The comparative advantage is, in turn, equivalent to constrained optimization – maximization of production given limited engineering and manufacturing resources.

In our example there is a single optimizing force – the firm, which ensures that the optimization gradient leads both entities in the direction of their comparative advantage. We did not need, therefore, to consider currency exchange rate – everything could be demonstrated essentially in real terms. The euros that we use for both countries is just a measure of the amount of goods exchanged and the relative value of technologically advanced inputs versus labor-intensive ones, that is a measure of labor value differentiation by economic activity.

Our illustration shows that even with constant returns the case for specialization is compelling. Increasing returns would only make the case stronger. Also, while the returns are increasing in both Skoda and Volkswagen engine/transmission manufacturing, Volkswagen is relatively more efficient. Therefore, Volkswagen can supply more engines/transmissions at the same expense, or relatively more reliable product for the same price (which is an equivalent concept), or a combination of both, regardless of whether the returns are constant or increasing.

Vanek-Reinert effect equally applies when two trading parties are not bound by a single optimizing business entity. In the classical two-country two-commodity example[6] there is an optimum in overall production and consumption, but when considering real commodities there is no force that would cause the less developed nation abandon its most advanced industry. In this case to provide a numerical illustration of Vanek-Reinert effect one needs to consider two different currencies and a varying exchange rate. The

mechanism is the following. Upon trade liberalization the developed world has absolute advantage in both high-tech and manual labor. This results in currency depreciation in the developing world. This in turn may lead to absolute advantage in both high-tech and manual labor for the developing world, due to extremely cheap prices of both manual and engineering labor and, respectively finished products. However, this situation is unsustainable either and the developing world's currency starts appreciating. This appreciation continues up to the point where the developing world loses absolute advantage in its more advanced industries but still maintains absolute advantage in labor-intensive low-added-value ones. It is at this point that the gradient leading to extinction of the most advanced industries in the less-developed nation kicks in. This topic is the subject of a follow-up study.

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[1] It has been observed that upon trade liberalization the most efficient industries in the less developed countries are the first to become extinct. This is known as Vanek-Reinert effect.
https://www.un.org/en/ecosoc/meetings/2005/docs/Reinert.pdf, Page 9

[2] Ricardo Hausmann and Dani Rodrik, https://drodrik.scholar.harvard.edu/files/dani-rodrik/files/doomed-to-choose.pdf, Page 3.

[3] Ricardo, David (1817), On the Principles of Political Economy and Taxation (1 ed.), London: John Murray, ISBN 9783487409290.

[4] One of the best books on optimization is Bertsekas, Dimitri P. (1982). Constrained Optimization and Lagrange Multiplier Methods. New York: Academic Press. ISBN 0-12-093480-9.

[5] Eric Reinert https://mpra.ub.uni-muenchen.de/47909/1/MPRA_paper_47909.pdf. Section 3.2 *Quality of Industrial Change* shows that international competitiveness and quality of industrial structure in new EU members from Central and Eastern Europe deteriorated from 1980 to 2000.

[6] In our previous paper https://mpra.ub.uni-muenchen.de/107780/1/MPRA_paper_107780.pdf we gave a simple illustration that given differentiated value of labor the overall production and consumption optimum also corresponds to the more advanced economy benefiting disproportionately at the expense of the less-advanced one. That illustration was a static equilibrium rather than a dynamic process.