Exporting growth: how recycling changes the distributive effects of international trade

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Abstract:

This paper examines the effects on the global income distribution from a shift to a materially closed world economy. It argues that in such a setting export (import) of finished goods implies export (import) of the resources of which these goods exist. Trade thus affects the resource endowments and future production capacity of countries. It is shown that trade entails a voluntary sacrifice of future production capacity for resource-exporting countries. In this way, the combination of recycling and international trade negatively affects the development prospects of resource abundant (developing) economies.

Keywords: resource economics, recycling, international trade, development, inequality

JEL codes: O13, Q27, Q56, F11, F18.

1. Introduction

Today there is little doubt that resource depletion is a growing problem potentially affecting future global welfare and growth. As a way to achieve environmental sustainability, various authors have proposed a shift towards materially closed systems, reducing the need for virgin material input by stimulating recycling, re-manufacturing, and other forms of re-use (e.g. Ayres 1997; King et al 2005; Korhonen and Niutanen 2003; McEvoy et al 2004). Such notions have been translated in policies such as the WEEE Directive on Waste and Electrical and Electronic Equipment (EU 2003). Most of the literature on re-use has focused on the technological and economic challenges of initiating such changes, and on the environmental benefits. The social-economic effects of a shift towards a materially closed economy have rarely been addressed, however.

Yet this is an area well worth studying. Recycling fundamentally alters the relation between production factors and consumption in the economy. Not only does consumption capacity depend on the available production factors, future production capacity also depends on present consumption, which is the source of resources available for the future. This has far-reaching implications for economic theory about the distribution of production and income around the world.

This paper looks at the distributive effects of international trade in a materially closed global economy. We develop a simple, two-factor HO-model, in which consumer goods are the source of the physical inputs for future production. We show that the export and import of goods embodying resources has repercussions on the growth prospects of a country, because it determines the amount of physical production factors available in the future. Trading resource-intensive goods implies indirectly trading recyclable resources,

so that the global stock of resources available for future production shifts away from resource-abundant (developing) economies to labor- or capital-abundant (industrialized) economies. Trade thereby negatively affects future consumption in countries specializing in resource-intensive production. It positively affects future consumption in labor- and capital-abundant countries.

These insights are important for the discussion about a shift to a materially closed economy. While desirable from an environmental point of view such a shift, if effected, has implications for the distribution of income and growth globally. Such unintended consequences may be considered less desirable in their own right while also being a potential source of resistance to a re-use focused economy in the future. For these reasons, understanding the distributive implications of a shift to a materially closed global economy is vital. The paper also contributes to the long-standing debate between advocates of free trade, arguing that trade increases general welfare, and opponents arguing that it 'robs' developing countries of their resources. The paper suggests they may both be right: as the effects discussed in this paper are occurring in a Heckscher-Ohlin framework without any market failures, the insight that trade is welfare enhancing is maintained. Although trade harms development prospects of resource exporting countries, they are compensated for this loss by positive gains of trade-effects in the present. In this sense, one could say that trade hurts developing economies in an optimal way.

The remainder of the paper is organized as follows. Section 2 discusses the main literature about international trade, resources and recycling. In section 3, we present our

model, analyzing trade with recyclable resources. Section 4 offers a discussion of the main results. Section 5 presents our conclusions.

2. Theoretical background

One of the most persistent insights in modern economics is that international trade leads to the factor price equalization (Ohlin 1933; Samuelson 1948, 1949) and is beneficial to countries engaging in it. One popular way of explaining factor-price equalization is by pointing out that international trade can be interpreted as the indirect exchange of production factors (e.g. Krugman and Obstfeld 1996; Leamer 1995, pp. 18). The export of labor intensive goods can be understood as an indirect way of exporting labor, while the import of capital intensive goods can be seen as the indirect import of capital. If production factors are thus allowed to move freely, they will flow to where their marginal returns are highest, increasing overall welfare and causing convergence of factor prices.

The consequences of trade have been argued to be more complex when natural resources are taken into consideration. The relation between trade and natural resources has been on the agenda of international economics for a long time. Papers by Singer (1950), Kemp and Ohyama (1978) and Proops (2004) analyze terms of trade and asymmetries in the gains of trade between resource-rich and resource-poor countries. Other segments of the literature focus on exhaustible resources, analyzing the effects of trade on resource depletion (Djajić 1984; Elbers and Withagen 1984; Lopez 1994; McRae 1978; Ferreira 2007) or renewable resources, analyzing the interaction effects of trade and market failures on management of such resources (Brander and Taylor 1997, 1998; Bulte and Barbier 2005; Jinji 2007).

Recycling and other forms of re-use have been extensively discussed in a separate literature. This literature has largely focused on the potential environmental benefits of recycling and the effects on the markets for resources. Many authors are fairly positive about the effects of shifting to materially closed systems (e.g. Ayres 1997; King et al 2005; McEvoy et al 2004). Others take a more critical attitude. A large literature exists investigating the effects of re-use and the challenges in efficient management of recycled inputs (e.g. Anderson and Spiegelman 1977; Eichner and Pethig 2001; Fleckinger and Glachant; Jenkins et al 2003; Korhonen and Niutanen 2003; O'Neill 1983; Pethig 2006; Walls and Palmer 2001). Classic papers by Baumol (1977) and Schulze (1974) go further and question the environmental and economic sense of recycling directly.

The attention to trade and resources on the one hand and recycling on the other notwithstanding, the relation between recycling and trade has not been extensively discussed in the literature. An exception is a paper by Grace et al. (1978a), which instigated a brief debate about secondary material use and trade (Yohe 1978; Grace et al 1978b). Like most of the literature about recycling, this discussion focused on the environmental and resource-prices effects. Little attention has been devoted to the social-economic implications of recycling and trade such as the consequences for income distribution and development. This is all the more strange since definitions of sustainability usually include both environmental and social objectives (e.g. WCED 1987). It therefore is important to know more about the social justice effects of a potential shift to a materially closed world economy.

This paper seeks to fill this gap, by theoretically analyzing the welfare distribution effects of North-South trade in a setting where resources are recyclable. It argues that for one

class of production factors, the interpretation of trade as indirect exchange of production factors is more than simply a well-working metaphor. Production factors can be classified into factors whose services are used in the production process, and factors that are physically embodied in the produced goods. Put differently, products are not only made by production factors (labor, capital), but also exist of them (resources). The resources of which commodities are made genuinely change hands when commodities are traded. That means that by exporting finished goods, one also exports the resources of which they exist. Since these resources are the inputs for new rounds of production, this implies that future production and consumption is limited[1]. To show this in a more rigorous way, Section 3 provides an analytical model of trade when resources are recyclable.

3. Analysis

The assumptions behind the analytical model are analogous to Samuelson (1949). We assume two countries, Home and Foreign, producing two commodities, A and B. Each commodity is produced with resources and labor, which are both employed fully. Resources are physically embodied in produced goods, whereas only the services of labor are embodied in goods[2]. As a consequence, resources reenter the economy at the location of consumption, while labor reenters the economy at the location of production of goods[3]. The production function of each commodity shows constant returns to scale, so that an increase in both inputs results in a proportionate increase in output. Production is subject

[1] Some debate exists on the compatibility of physical constraints with micro-economic models. Krysiak et al (2003) show that abstract models (i.e. without specified production and utility functions) are not invalidated by introducing physical constraints. Since the Heckscher-Ohlin model is such an abstract model, the ensuing analysis is warranted.

[2] For labor, we could also read capital or any other production factor that is not physically incorporated in traded goods.

[3] For simplicity, we assume that recycling is complete and costless. Obviously, this assumption is not very realistic. However, in our analysis global resources are fully employed so that in future rounds both countries have to derive their resources from recycled final goods. There is therefore no difference between them in the cost rates of preparing resources for production. Since our focus is on distributive effects of recycling, we can ignore the costs of recycling.

to diminishing marginal productivity, so that an increase of one input relative to the other causes a decrease in this factor's marginal productivity. There are no barriers or costs to trade in final goods, so that commodity prices are equalized. Production factors are not mobile (except as embodied in final goods). Finally, we assume technologies, qualities of inputs, and preferences to be the same in the two countries.

We can write the production side of our model as follows, following Leamer (1995). Let p denote a vector of final goods prices, v denote a vector of resource supplies, w denote a vector of factor prices, and q denote a vector of outputs, with $w = f(p,v); q = g(p,v)$. A is the input-output matrix, so that

$$A = A(w) \ , \tag{1}$$

$A(w)$ being the cost-minimizing choice of input intensities using the technologies available. Equilibrium in the market for factor goods requires:

$$q^h = \frac{v^h}{A} \ , \tag{2}$$

with the superscript h denoting Home. The zero-profit condition in the final goods market requires final goods prices (p) to be equal to production costs, implying:

$$w^h = \frac{p^h}{A'} \ . \tag{3}$$

By assuming identical homothetic tastes and an absence of all barriers of trade the demand side of the model is neutralized. The fact that the resources embodied in consumption are the inputs for future production gives a boost to demand for resource intensive goods relative to labor intensive goods, depending on the time preference of consumers. However, because we are assuming identical preferences (tastes and time preferences), this does not affect the point that factor prices and, hence, consumption proportions are equal in both countries. Thus,

$$c^h = s^h c^w = s^h \frac{v^w}{A} \ , \tag{4}$$

in which s^h denotes the consumption share of country H, c^w gives the vector of world consumption, and v^w the vector of world resource supplies. On basis of this, we can write the vector of trade flows as

$$T = q^h - c^h = \frac{v^h - s^h v^w}{A} \ . \tag{5}$$

The factors not indirectly consumed in the country itself are exported, and the factors indirectly consumed in excess of domestic availability are imported. In other words, in the two-factor case, (5) implies that:

$$L^h_{traded} = L^h - s^h L^w \ , \tag{6}$$

$$R^h_{traded} = R^h - s^h R^w \ , \tag{7}$$

with L denoting labor, R denoting resources, and L^h_{traded}, R^h_{traded} being the labor and resources respectively embodied in traded goods. For Foreign, all equations are the same. Upon trade, the relatively labor abundant country consumes less labor than it owns ($L - sL^w > 0$) and exports its excess labor in the form of labor intensive goods. Likewise, the relatively resource abundant country consumes more labor than it owns ($L - sL^w < 0$), and has to export resources in the form of resource intensive goods in order to cover excess labor consumption. As a result of these imports and exports both countries are better off; they can make use of each other's relative abundances, and are able to consume more when trading with each other than they were able to in autarky.

This is not the end of the story, however. The indirect import and export of resources brings about a change in factor endowments in both countries. Production in the next period in each country is a function of the resources embodied in the goods that have been consumed and the country's labor endowments, so that

$$q^h_{t+1} = g(R^h_{t+1}, L^h) = g(s^h_t R^w, L^h) . \tag{8}$$

The country exporting resource-intensive goods has become less resource abundant as a result of trade, the country importing them less labor abundant. As countries thus become more alike, trade falls. This process goes on until in the long-run equilibrium factor endowment ratios are exactly the same in both countries and trade stops altogether:

$$\frac{R^w}{L^w} = \frac{R^h_{equilibrium}}{L^h} = \frac{R^f_{equilibrium}}{L^f} \quad . \tag{9}$$

This long-run equilibrium is caused by the indirect transfer of resources from the resource abundant country to the labor abundant country until factor endowment ratios are equal. If Home was the resource abundant country and Foreign the labor abundant country initially, this means that $R^h - R^h_{equilibrium} > 0$ and $R^f - R^f_{equilibrium} < 0$, implying that $q^h_{equilibrium} < q^h$ while $q^f_{equilibrium} > q^f$. Production and consumption in the initially resource abundant country has fallen due to trade, since it has exported part of its production factors. Production and consumption in the initially labor abundant country has been boosted by the import of extra production factors[4]. The resource-abundant country only gains from trade in the short run. The labor abundant country gains in the long run as well.

4. Discussion

The model analyses the effects of trade on factor endowments when resources are recyclable. It starts out from the idea that trade in finished goods literally implies an exchange in production factors. When goods are traded, resources are traded indirectly, affecting the factor endowments of the economy. The analysis shows that while trade is welfare improving, it negatively affects future production and consumption of resource

[4] A informative way of writing (9) is $\frac{L^h}{L^f} = \frac{R^h_{equilibrium}}{R^f_{equilibrium}}$, emphasizing the fact that in the eventual distribution of ownership of resources follows the distribution of ownership of labor.

abundant countries. By contrast, trade increases the production capacity of resource importing countries.

In absence of market failures, we can expect individuals in both countries to take these long-run effects on production capacity into account when deciding to engage in trade. This implies that the relative price of resources will be higher as a result of the production capacity effect than in the Heckscher-Ohlin set-up without recycling. This price premium is a consequence of the fact that resource prices not only reflect the value attached to the goods that can be made out of them in the current period, but also the value of goods that can be made out of them in the future. The size of this price premium and the extent to which consumers are prepared to trade in future consumption for present welfare is dependent on the time preference of consumers. With increases in the importance attached to future consumption, consumers in both countries value the consumption of resource-intensive goods more, resulting in higher resource prices.

The fact that individuals take future production capacity effects into account when engaging in trade does not affect the standard results of trade theory. One of the characteristics of the Heckscher-Ohlin model is that the demand side is neutralized because preferences are assumed to be homogenous. The extra value attached to resources due to future production capacity effects therefore does not alter the main insights of the theory. Trade is still driven by differences between factor endowments, countries export their abundant factors, and trade is beneficial to all countries. Although the resource-abundant country's real income and consumption eventually falls due to trade, the degree to which it does so is chosen by individual consumers making a trade-

off between present and future consumption. Production capacity falls in the resource exporting country, but in the absence of market failures, it does so in an optimal way.

At the same time, the analysis lends some support to the popular view that trade tends to impoverish resource exporting countries. The fact that trade affects factor endowments, and thereby possibilities for future production, implies that trade is more of a zero-sum game than conventional trade theory portrays it to be, albeit only in the very long run. There is a limited amount of resources on Earth. Through trade, these resources are shifted from one place to the other. The increase in resources of one is the loss of the other. Resource abundant countries export resource intensive goods, depleting their resource base and harming future production possibilities. Labor abundant economies import resource intensive goods, adding to their resource base and boosting future production possibilities.

5. Conclusion

This paper looked at the effects of trade in a world harboring a fixed amount of recyclable resources. It shows that trade implies a transfer of resources from resource-rich to resource-poor economies, thereby causing a structural drop in consumption in the former. However, as long as agents involved in trade take these long-run production effects into account, the resource exporting country is compensated for its loss of production capacity by a higher immediate price for its resources. In absence of market failures, the depletion of the resource-abundant country's resources occurs in an optimal way.

Since resource abundant countries are often unindustrialized, developing countries, these results indicate that there may be a trade off between environmental and social dimensions of sustainable development. Whereas recycling probably brings environmental benefits, it may come at the price of aggravating the inequality in the distribution of resources and production capacity in the world. Since sustainable development has often been defined as covering both environmental and social-economic principles, there is a need to study the distributive consequences of environmental strategies such as a shift to recycling in more detail.

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