UNITED NATIONS UNIVERSITY
UNU-WIDER
World Institute for Development Economics Research

Working Paper No. 2011/78

Global Supply Chains in Chinese Industrialization

Impact on Waste Scavenging in Developing Countries

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November 2011

Abstract

China has undergone remarkable economic growth spearheaded by industrialization. Chinese industry demands a wide variety of raw materials in increasing amounts in order to manufacture all kinds of products. Industrial demand exceeds domestic supply for several materials. Thus, China needs to import raw materials. In order to satisfy its needs, China has developed global supply chains, which link two apparently separate worlds: its industry and millions of scavengers that recover recyclable materials from waste in developing countries. This paper examines this new phenomenon and argues that it has been mostly beneficial to the poor in developing countries.

Keywords: China, industrialization, recycling, scavenging

JEL classification: L11, L13

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This study has been prepared within a joint project of UNU-MERIT, UNU-WIDER, and UNIDO on Pathways to Industrialization in the 21st Century: New Challenges and Emerging Paradigms.

UNU-WIDER gratefully acknowledges the financial contributions to the project by the Finnish Ministry for Foreign Affairs, and the financial contributions to the research programme by the governments of Denmark (Ministry of Foreign Affairs), Finland (Finnish Ministry for Foreign Affairs), Sweden (Swedish International Development Cooperation Agency—Sida) and the United Kingdom (Department for International Development).

ISSN 1798-7237 ISBN 978-92-9230-445-4

Tables and figures appear at the end of the paper.

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Typescript prepared by Lisa Winkler at UNU-WIDER

1 Introduction

Recycling in developing countries relies on the activities carried out informally by scavengers or waste pickers. These activities have existed for centuries, supplying raw materials that industry recycles (Medina 2007). But over the past two decades, globalization has encouraged the development of global supply chains that link scavengers in many developing countries with industrial activities in China and India. These new supply chains have received scant attention from researchers. This paper intends to fill some knowledge gaps about these supply chains.

Over the past two decades China, and, to a lesser extent India, has undergone a remarkable economic transformation. This transformation has been spearheaded by industrialization. Between 2003 and 2007, the increase of China's industrial production grew at an annual rate of 11.5–12.8 per cent. In 2006, the added value of industrial activities accounted for 43.1 per cent of the national economy.

Industrial activities require a wide variety of inputs, such as energy, water, metals, plastics, wood, textiles, glass, and so on. China is now an important global player in the international commodities markets. The country is a significant producer and consumer of commodities and other industrial inputs.

China now tops the world in the production of steel, coal, cement, TVs, and cotton fabric, and ranks second in power generation, third in sugar output, and fifth in crude oil output. But the country is not self-sufficient in a number of raw materials, such as crude oil, coke, paper, metals, and plastics. In order to close the gap between demand and domestic production, China must import large amounts of raw materials, and this encouraged the development of global supply chains and the world's largest recycling efforts. Some of the industrial inputs are recyclable materials recovered from waste in many countries. It can be argued that Chinese industrialization has been fuelled by waste from the USA and other countries. China is the world's largest consumer and largest importer of recyclable materials. In 2008, the USA sold China over US$7.7 billion in recyclable materials.

China's recycling supply chains are more global than those of other countries. Waste pickers also play an important role in the domestic supply chains in many developing countries. In Brazil, for instance, about 90 per cent of the materials recycled by industry are recovered by Brazilian scavengers (Medina 2010).

These supply chains have received little attention from researchers and thus our knowledge of them is incomplete.

2 Why industry in emerging countries recycles

Industry in developing countries shows a strong demand for recyclable materials due to their low cost. The main factors that account for the lower prices of secondary materials are the following. First, materials recovered from waste often include impurities. Even when materials are segregated at the source, extraneous items can be found, such as tags, traces of glue, and moisture. Virgin materials are thus more homogeneous than secondary materials. Second, most developed countries have created recycling programmes that produce large amounts of secondary materials. But supply of these

materials usually exceeds domestic demand, so a large percentage of materials must be exported and sold in international markets. Third, many materials can be easily recycled and transformed into new products. But there are constraints in recycling some materials, such as paper. Paper is made from vegetable fibres, most commonly wood. Each time paper is recycled the fibres break and get increasingly shorter. As a result, paper and cardboard can only be recycled two to four times before the fibres get too short. A ton of wood pulp has more fibre than a ton of recovered paper. Fourth, recycling requires less energy and water than processing virgin materials (see Table 1), thus lowering industry's operating costs. Fifth, the recovery of materials in developing countries relies on a large numbers of scavengers, who lack the organization and power to have an impact on prices (Bartone 1988; Medina 2007).

These factors translate into lower prices for recyclable materials. For example, in Mexico the price per ton of wood pulp imported from the USA is seven times more expensive than recovered waste paper. And in China, in 2008 the price of scrap copper was 8 per cent lower than virgin copper. In May 2009, the price of virgin polyethylene terephthalate (PET) was US$0.87/lb while secondary PET was US$0.65 (25 per cent lower).

Recycling can render social, economic, and environmental benefits. It provides an income to scavengers who recover recyclable materials. Factories that consume recyclable materials can be built for a fraction of the cost of building plants that consume virgin materials. Recycling lowers industry's operating costs and reduces the amount of wastes that need to be collected, transported, and be disposed of, thus extending the life of disposal facilities. This translates into savings to municipalities (Vogler 1984). Recycling can result in a more competitive economy and a cleaner environment, and can contribute to a more sustainable development.

3 The development of global supply chains for raw materials

The current supply chains for China, India, and other developing countries, differ in important respects from those in the developed world today and when they underwent industrialization. Chinese industrial supply chains show a more circular pattern, with a more intensive recycling of materials:

Obviously, these loops are not completely closed. Chinese production and consumption activities generate large amounts of wastes of all kinds that do not enter these recycling loops. In fact, in 2005, China surpassed the USA as the world's largest generator of solid wastes. No other country in history had generated as much waste in such a short period as China. Chinese industrial activities have created serious environmental problems in terms of air, water, and land pollution (Yardley 2005).

China's use of coal and lack of pollution prevention measures translates into highly polluted air. The country has become the worst atmospheric polluter in the world in terms of sulphur dioxide (SO_2) and nitrogen oxides (NO_x). But the recycling of materials is widespread throughout the Chinese economy. And the Chinese demand has encouraged the development of global supply chains to provide recycled materials to its industry, and in the process it encouraged the development of perhaps the largest recycling effort in the history of the world. These new supply chains span the globe and their underlying cause is economics (Branigan 2009).

Chinese industry discovered that the use of recycled raw materials is much cheaper than the use of virgin materials. Historically, the prices of materials recovered from waste (also known as 'recyclables' and 'secondary materials') are lower than their virgin counterparts. But the prices of secondary materials usually move in tandem with the prices of raw materials.

The prices of commodities in international markets are determined by the interplay of factors that affect global demand and supply, such as economic growth, interest rates, currency exchange rates, natural disasters, labour strikes or political crises in important producing regions, exploitation of new mines, and so forth (Medina 2007).

Periods of strong economic growth tend to push the demand for commodities up, as well as their prices. Over the past ten years, the economies of China and India have grown at a fast pace, which in turn have put upward pressure on commodities. The price of copper, for instance, tripled between 2002 and 2007, the price of zinc doubled, and wheat and soybean rose 70 per cent in 2007. Futures prices of crude oil, gold, silver, lead, uranium, cattle, cocoa, and corn were all at or near record levels at the end of 2008. The biggest single factor increasing commodity prices is China's rush to construct factories, other buildings, and roads to satisfy a growing, increasingly middle-class urban population with a taste for cars and other consumer goods.

China today has over 7,000 steel factories, double the number in 2002. Every new factory needs electricity, which means that power plants must be built. More diesel-powered trains are required to get the coal to the power plants, and more trucks and expanded ports are needed to move the steel to market.

China's industrial revolution caused an increase in crude oil consumption from 5.5 million barrels in 2003 to 8 million in 2008, according to the International Energy Agency, representing 31 per cent of the total rise in global demand (Anon. 2011). Over the same period, China was responsible for 64 per cent of the increased global demand for copper, 70 per cent of that for aluminium, and 82 per cent for zinc (Fagone 2011).

The relatively recent globalization of the supply chain has a greater impact on international trade than it used to. According to some estimates, in the 1960s and 1970s, if global GDP increased (or decreased) by 1 per cent, trade would grow (or shrink) by about 2 per cent, but in the 1990s, the change in trade was 3.4 per cent.

A globalized supply chain has a direct impact on the prices that scavengers throughout the developing world get paid for the recyclables they recover. During the boom years of 2006–08, the high prices of recyclables encouraged the development of an active international trade. High prices translated into higher incomes for millions of scavengers worldwide, and probably allowed many to escape poverty.

China is now a major global player in the commodities markets, as well as in the international trade of recyclables. The greater impact of a globalized supply chain encouraged international trade in recyclables. In 2001 China became the world's largest importer of scrap metal. Most of China's imports of recyclable materials originally comes from developed countries. But about 15 per cent came from developing countries, which arguably has benefitted millions of scavengers worldwide (Pollack and Bradsher 2004). Recovery of recyclables within China is intensive, and has led to the

development of the world's largest informal recycling sector, with as many as 6 million scavengers (Medina 2008).

But in 2008 the international economic crisis that began in the USA had a dramatic impact on those same scavengers that Chinese demand had benefitted in past years. Lower demand for all kinds of products in the USA and other countries reduced the demand for commodities and recyclables, depressing their prices (see Figure 1). Prices of recyclables dropped by more than 50 per cent, reducing scavengers' incomes, thus forcing many of them back into poverty.

China's demand for recyclables is well-documented, as well as its imports from various countries. What is not well-documented is how much the informal sector in developing countries accounts for in Chinese imports of recyclables. Newspaper articles have presented evidence that scavengers from many developing countries contribute significantly to China's imports (see for instance, Branigan 2009; Pollack and Bradsher 2004; Brooke 2004). In field work I have conducted in Africa, Asia, Latin America, and the Middle East they all report that some of the materials recovered by local scavengers are exported to China. Current import and export statistics of recyclable materials do not distinguish whether the materials were recovered by scavengers or not. Research in this area is necessary to quantify scavengers' contribution to the international trade in recyclables.

In early 2009, prices of recyclables started to rebound due to economic recovery in several Asian countries, as Figure 1 illustrates.

3 Features of the global supply chains for secondary materials

Recycling activities in developing countries rely largely on the informal recovery of materials from waste carried out by scavengers. It has been estimated that in African, Asian, and Latin American cities about 1 per cent of the urban population survives by scavenging. This translates into a potential scavenger population of about 15 million worldwide. Scavengers recover materials to sell for reuse or recycling, as well as diverse items for their own consumption. These individuals are generally known as 'scavengers' 'waste pickers', or 'rag pickers' in English-speaking areas, but they also receive different names, depending on the local language, on the place they work, and on the material(s) they collect. In Mexico, for example, dumpsite scavengers are known as *pepenadores*, in Brazil they are known as *catadores*, while the term *cartoneros* applies to the cardboard collectors, *buscabotes* to the aluminum can collectors, and *traperos* to rag collectors. And Colombians use the generic term *basuriegos*, while scrap metal collectors are known as *chatarreros*, glass bottle collectors as *frasqueros*, and so on (Medina 2007).

The underlying factors that created the current recycling system are fundamentally economic. The developing world is becoming more urban, which translates into a concentration of generation of large amounts of waste materials. Depending on the composition of industrial activities, industry demands inexpensive raw materials recovered from waste. Given the widespread poverty prevalent in developing countries, the inability of the economy to generate enough jobs, and the lack of a safety net for the poor, many people are forced into scavenging.

Most studies report that scavengers constitute disadvantaged and vulnerable segments of the population. Scavengers face multiple hazards and problems. Due to their daily contact with garbage, scavengers are usually associated with dirt, disease, squalor, and perceived as a nuisance, a symbol of backwardness, and even as criminals. They survive in a hostile physical and social environment (see Abad 1991; Castillo 1990; Chapin 1995; Fundacion Social 1990, 1991; Furedy 1984, 1991).

Figure 2 shows the typical flow of recyclable materials in the informal recycling sector. Because industry demands large volumes of materials that are processed—sorted, baled, crushed, or granulated—it does not buy directly from individual waste pickers. Instead, middlemen purchase recyclables recovered by waste pickers, then sell the materials—after some sorting, cleaning, and processing—to scrap dealers, who in turn sell to industry. In these circumstances, middlemen often earn large profits, while waste pickers are paid much too little to escape poverty. The existence of middlemen allows the possibility of exploitation and/or political control of scavengers (see Figure 2).

Scavengers usually specialize in recovering one or a few types of materials from waste. This depends on their availability of a vehicle to transport materials. For example, anyone with a sack or plastic bag can recover aluminium cans on the streets, but some kind of vehicle is necessary to carry cardboard, which is bulky and heavy. Upper-income neighbourhoods, as well as hotels, business and commercial districts are the most desirable areas for scavengers because they generate more recyclables.

3.1 Scavenger characteristics

Based on a review of studies, both academic and policy-oriented, as well as on anecdotal evidence, it is possible to enumerate the following generalizations about scavengers:

1. Scavenger individuals tend to be poor, relative to the rest of society. Many studies have found that scavenger earnings fall below the minimum wage. When scavenging activities are supported or at least tolerated, however, scavengers can earn decent incomes.
2. Due to their daily contact with wastes, their low incomes, and their often ragged appearance, society ascribes a low status to scavengers. Their scavenging activities frequently face a hostile, and sometimes violent, environment.
3. Immigrants, often from rural areas, comprise an important percentage of scavenger populations.
4. Scavenging epitomizes the informal sector: it constitutes a labour-intensive, low-technology, low-paid, unrecorded, and unregulated activity.
5. Scavenging can render economic and environmental benefits, such as work for unemployed individuals, supplies raw materials for industry, reduces the demand for collection, transport and disposal equipment and facilities. Further, recycling has a lower environmental impact compared to the use of virgin resources.
6. Scavenging not only generates benefits to society, it may also have social costs, such as scattering wastes on the streets.
7. Scavenging represents an adaptive response to chronic poverty prevalent in developing countries. However, scavenging also appears during particularly stressful situations that beget extraordinary circumstances and scarcity, such

as war and severe economic crises. In the aftermath of the collapse of the Soviet Union in 1989, and the ensuing economic crisis and unemployment, street and dumpsite scavenging became widespread in Hungary, Russia, Ukraine, Yugoslavia, and Romania.

8. Depending on the degree of industrialization of a country, scavenging supplies raw materials largely to either artisans or to industry. In regions where industrialization is relatively more advanced, such as in China, Latin America, and South East Asia, the materials recovered by scavengers are consumed by industry. Various studies have documented industrial use and demand for inexpensive materials recovered by scavengers. On the other hand, in regions where use of industrial consumer products is not widespread, such as in Africa and the non-oil producing countries of the Middle East, scavengers supply artisans with materials. In these countries, artisans manufacture a wide variety of consumer goods from materials collected by scavengers, such as sandals and water bags from old tires, oil lamps that use burnt out light bulbs as fuel reservoirs, children's toys, musical instruments, and household utensils made from metal scrap (Medina 2007, 1997).

3.2 Recovery patterns

The recovery of materials from waste by scavengers in developing countries takes place in a wide variety of settings. Although the circumstances under which materials are recovered in a particular place may be unique, scavenging patterns do exist. According to where they occur along the waste management system, scavenging activities can be classified into the following:

Source separation: Individuals at homes, small businesses, and offices recover materials, such as food leftovers and aluminium cans. These materials are then reused, sold or given away (Medina 1993).

Sorting of recyclables by collection crews while on their collection routes: This activity is common in Mexican, Colombian, Thai, and Philippine localities. Collection crews later sell the materials on their way to transfer or disposal facilities, and divide the proceeds among them. Sorting of recyclables by collection crews can double their salaries, providing a strong incentive to engage in it (Medina 1997).

Recovery of recyclables by informal refuse collectors: The *zabbaleen* of Cairo constitute an effective refuse collection and recycling system. A pair of *zabbaleen* working with a pickup truck can collect garbage from 350 households in a day. After sorting the garbage, the collectors feed the edible portion to pigs, sell pig droppings and human excrement to farmers as fertilizer, and scrap metal, glass, paper, and plastics to middlemen, who then sell the materials to craftsmen or to industry for recycling. They can reuse or recycle 80 per cent of the wastes they collect. Thus, only the residual 20 per cent needs final disposal. This high diversion rate from landfills renders social, economic, and environmental benefits (CID 2001).

Itinerant buyers purchase recyclables from residents: In many cities, itinerant buyers purchase from residents various types of items for reuse and recycling, such as cans, bottles, paper, old appliances, and old mattresses. They use pushcarts, animal-drawn carts and pick-up trucks to transport these items.

Scavengers salvage materials from dumpsters: Scavengers consider refuse from high-income neighbourhoods, hotels, and stores as particularly valuable, since wealthy individuals tend to discard more recyclables and items that can be repaired or reused. They can often be seen near dumpsters, looking for items and materials they can salvage.

Scavenging on the streets or public spaces: Scavengers pick up recyclables from litter, such as in Pune, India, where the approximately 10,000 'rag pickers' in the city recover materials from garbage thrown into the streets. This type of recovery activity is perhaps the most common in the world, because virtually anyone equipped with a bag or sack can do it (Chapin 1995).

Recovery in canals and rivers that cross urban areas: Canals and rivers that run through urban areas in developing countries often transport waste materials thrown in by residents or litter carried by runoff water. This type of scavenging activity is usual in cities such as Manila and Bangkok, where canals and rivers run through their cities. Scavengers generally recover recyclables from small boats, which they also use to transport the materials for sale. Recyclables present in canals and rivers tend to be more abundant during the rainy season, as runoff water carries materials littered on the streets.

Recovery at composting plants: Recovery of recyclables also exists at composting plants, such as the one in Monterrey, Mexico, which allows scavenging activities in its premises. This does not interfere with composting operations and reduces the presence of inorganic materials in the compost. Inorganic materials are contaminants if present in the compost, and thus scavenging improves the quality of the final product.

Recovery at municipal open dumps: Large scavenging communities have developed around open dumps in many developing country cities. As many as 20,000 scavengers live and work in Calcutta's municipal dumps, 12,000 in Manila, and 15,000 in Mexico City. By settling around the dumps, scavengers minimize their transportation costs, occupy land that may be undesirable to others, have access to discarded materials that can be used as construction materials for their homes—usually shacks—and thus save on housing costs. Living around a dump allows entire families to recover materials there by simply claiming an area and salvaging materials while mothers keep an eye on their children. Street scavenging, on the other hand, requires walking several miles a day searching for materials, making it harder for families with small children to recover materials. Settling around a dump also enables families to raise pigs by feeding them discarded organic materials found at the dumps.

Recovery at landfills: Prior to the compaction and burial of wastes, scavengers recover materials at landfills where these activities are allowed, such as in Mexico City. At these sites, scavenging activities have been integrated into the normal operation of the landfills. As soon as the refuse is dumped on the ground, scavengers pick over the piles of mixed wastes, searching for any items that can be reused or recycled. Later during the day, bulldozers compact the refuse and cover it with a layer of dirt (Medina 1997).

3.3 Formalization of scavenging

Scavengers are not always the poorest of the poor. In fact, scavengers sometimes earn more than factory workers. When scavengers organize themselves in micro-enterprises, scavenger cooperatives, or form public-private partnerships with municipalities, they can achieve a decent standard of living, and improve their working conditions, resulting in grassroots development. In African, Asian, and Latin American cities a growing number of successful micro-enterprises, scavenger cooperatives and public-private partnerships that provide low-cost waste management services to municipalities.

The structural causes of scavenging are under-development, poverty, unemployment, the lack of a safety net for the poor, as well as industrial demand for inexpensive raw materials. These factors are likely to continue to exist. Therefore, a public policy that supports scavenging activities would be humane, as well as make social, economic, and environmental sense.

Figure 4 presents estimates of the number of scavengers in selected countries.

A growing number of experiences in Africa, Asia, and Latin America demonstrate that formalization of scavenging can promote grassroots development, empowerment, poverty reduction, as well as protect the environment and improve industrial competitiveness. The most common models are:

1. Scavenger cooperatives: By getting organized, waste pickers become empowered. They can strengthen their bargaining position with industry and government, become actors in the development process, and overcome poverty through grassroots development. Working together, they can gain stability, higher incomes, and legalization of their activities. They can obtain better prices by circumventing middlemen and adding value to materials sold. And organized into cooperatives, they can enter into contracts with industry or grant agreements with donors. In South America alone, there are about 1,000 scavenger cooperatives, mostly in Argentina, Brazil, and Colombia.
2. Micro-enterprises: Scavengers can also create their own micro-enterprises to perform waste collection, recycling, and various manufacturing activities that use waste as raw materials.
3. Public-private partnerships: Public-private partnerships can combine the energy, creativity and low-operating costs of scavengers in the waste management sector. Public-private partnerships for collecting waste and recyclables can be beneficial to waste picker groups as well as to the broader society. In partnerships in several Colombian cities, the municipality provides infrastructure and equipment while waste pickers provide labour. In Bogotá a partnership has been formed to operate a recycling plant, managed by the Bogotá Association of Waste Pickers, to which the municipality takes recyclables separated at source.

As Figure 5 illustrates, cooperatives that have access to source-separated materials, such as the one in Juarez, Mexico, can earn ten times the country's poverty line income. Cairo micro-entrepreneurs that collect wastes, sell recyclables, and manufacture products from recyclable materials earn nearly eight times the poverty line income, and therefore have been able to escape poverty (Medina 2008).

3.4 Economic and environmental impact of scavenging

Scavenging renders economic and environmental benefits, such as providing an income to unemployed individuals, supplies inexpensive raw materials to industry, reduces the demand for collection, transport, and disposal equipment and facilities. Further, recycling has a lower environmental impact compared to the use of virgin resources.

Despite the lack of reliable data at the national level, various studies have highlighted the economic importance of scavenging activities. In Bangkok, Jakarta, Kanpur, Karachi, and Manila, scavenging saves each city at least US$23 million a year in lower imports of raw materials, and reduced need for collection, transport and disposal equipment, personnel and facilities. In Mumbai the economic impact of recycling activities has been estimated at nearly US$1 billion a year in the recovery of materials and the manufacture of products from them. According to some estimates, Indonesian scavengers reduce the amount of wastes that need final disposal by one third, which has significant environmental and economic benefits. In the city of Nuevo Laredo, on the USA-Mexican border, the economic impact of scavenging activities has been estimated at nearly half a million dollars a month. Table 2 shows estimates on the economic impact of several cities.

3.5 Scavenging and climate change

When organic waste—mostly food leftovers, kitchen and garden waste—is sent to open dumps and landfills it gets buried under layers of waste or dirt. Eventually, all oxygen is consumed and organic matter decomposes in anaerobic conditions. Anaerobic decomposition generates methane, a greenhouse gas that is 20 times more potent than CO_2 in trapping the sun's heat. Garbage dumps and landfills generate about 11 per cent of anthropogenic emissions of greenhouse gases.

Diverting organic waste from dumps and landfills can prevent the generation of methane and reduce greenhouse emissions. There are two ways to accomplish this: composting and pig farming. Composting is the biological decomposition of organic matter in aerobic conditions, which generates little or no methane. The resulting compost can be used in landscaping, horticulture, and as a soil conditioner in agriculture. Organic waste, such as food leftovers can be recovered as used to feed pigs. Composting and pig farming can also create jobs and reduce poverty for the scavengers who recover those materials. In southern Bali, Indonesia, 50 pig farms generate enough demand for organic waste to provide income opportunities for hundreds of scavengers. This practice, however, requires additional research to make sure it does not pose risks to public health from consuming the meat from these farms.

The recovery and recycling of inorganic materials by scavengers saves energy. Power generation is one of the largest sources of greenhouse gases. Assuming that everything else remains the same, recycling also reduces the emissions of greenhouse gases.

4 Public policy issues that need to be addressed

The informal recycling sector and the international trade of recyclables can benefit millions of low-income and vulnerable individuals worldwide, as well as contributing to a more competitive economy and environmental protection. It can be argued that

scavenging can be a perfect example of sustainable development. Only supportive efforts can unlock their development potential. But there are several important issues that need to be addressed:

(1) Public-policy: authorities in developing countries display a wide variety of policies that deal with scavengers. Those policies can be classified into the following:

a. Repression
   The dominant view of scavenging, which still prevails in many developing countries, sees scavenging as inhuman, a symbol of backwardness, and a source of embarrassment and shame for the city or country. Based on this, scavenging has been declared illegal and punished in many cities of Asia and Latin America.
b. Neglect
   In other cases, authorities simply ignore scavengers and their operations, leaving them alone, without persecuting or helping them. African cities such as Dakar, (Senegal), Bamako (Mali), and Cotonou (Benin), illustrate the policy of neglect towards scavengers.
c. Collusion
   Government officials sometimes develop with scavengers relationships of exploitation and of mutual profit and mutual assistance; that is, relationships of political clientelism.
d. Stimulation
   When scavengers get organized and receive external support, it can result in grassroots development. It can be argued that only supportive policies can unlock the development potential of the informal recycling sector.

(2) Exploitation: due to the existence of intermediaries—middlemen and scrap dealers—as well as their limited organization and education, scavengers are often subject to exploitation, being paid as little as 5 per cent of the prices paid by industry. A growing number of experiences has demonstrated that supportive policies and scavenger organization can end this exploitation.

(3) Scavengers' health: daily contact with waste has a serious impact on scavengers' health. Mexico City scavengers have a life expectancy of 53 years, while the general population's is 67 years. The prevalence of infectious diseases is high. And a study of the zabbaleen in Port Said, Egypt, showed that the infant mortality rate was 1/3 (i.e., one death of an infant under one year of age out of every 3 live births). This is several times higher than the rate for the region as a whole. The prevalence of enteric and parasitic diseases among the zabbaleen is much higher than the one for the region. And in Cairo, one in four babies born in the scavenger communities dies before reaching their first year. In Manila, more than 35 diseases have been identified on scavenger communities and slums, including diarrhoea, typhoid fever, cholera, dysentery, tuberculosis, anthrax, poliomyelitis, skin disorders, pneumonia, and malaria. Most health risks derive from scavengers' contact with wastes of all kinds while recovering and sorting materials. Health risks can be minimized by involving scavengers in source-segregation programmes in which residents and businesses used different bins for recyclable and non-recyclable materials (Cointreau 2006; Meyer 1987).

(4) Organization and empowerment: Many scavengers are illiterate or have a low educational level. Only when they get organized they can alter the unfavourable power relations and repressive public policies that affect them.

(5) Child labour issues: Scavenging is one of the worst forms of child labour. Yet, it is a common activity throughout the developing world. Brazil has had the most remarkable success in minimizing child labour in scavenging by including scavenger families in the *Bolsa Familia*, a conditional cash transfer programme that requires children to attend school (Medina 2010).

(6) Smuggling of hazardous and e-waste: Unscrupulous individuals and businesses from developed countries sometimes smuggle municipal, hazardous, and electronic waste under the guise of exporting recyclables to countries in Africa, Asia, and Latin America. Most developed countries have enacted stringent regulations for the handling and disposal of hazardous and electronic wastes. This translates into high costs for their processing, recycling, or disposal of these wastes. Simply dumping these wastes in developing countries is much cheaper. Current practices for the dismantling and recovery of recyclable materials from e-waste entail serious risks to the health of those engaging in it.

5 Scavenging and international development agencies

Scavengers or waste pickers have been largely ignored by researchers and international development agencies. Despite the fact that there are about 15 million scavengers worldwide, with an economic impact of several billion dollars, that this activity has the potential to create jobs, reduce poverty, and improve industrial competitiveness, there is not a single academic programme that studies the informal recycling sector. The following Table 4 demonstrates that major development organizations are behind the curve and mostly ignore scavenging.

6 Concluding remarks

The industrialization of China and India has been fuelled by recycling waste from around the world, creating the world's largest recycling effort. In the process, global supply chains have developed providing recyclable materials to the Chinese and Indian industry. The significance of recycling activities and their truly global character differ from supply chains when the West industrialized. China, India, and other emerging countries recycle because it makes economic sense: it is profitable for everyone in the supply chain. The fact that recycling also renders environmental benefits is incidental and does not figure in industry's decision to recycle in emerging countries.

Scavengers recover most of the recyclables in developing countries. There are big gaps in our knowledge of scavenging, but we know it is an activity that provides an income to at least 15 million people worldwide, with an economic impact of billions of dollars each year. Many scavengers are subject to exploitation by middlemen and affected by repressive/unsupportive public policies. Scavengers' low incomes are often the result of this exploitation and lack of support.

When scavengers are supported they can change the unfavourable power relations. The results can constitute a perfect example of sustainable development: jobs can be created,

poverty can be reduced, industry can be supplied with inexpensive raw materials, natural resources can be conserved, and the environment can be protected. Scavenger cooperatives, micro-enterprises, and public-private partnerships can be successful models to formalize and incorporate scavengers into domestic and global supply chains.

External support is necessary in order to unlock the development potential of scavenging. Unfortunately, scavenging is ignored by most multilateral, bilateral, and international non-governmental agencies that work in international development and environmental protection. Scavenging has also received scant attention from scholars.

Scavengers do suffer from serious problems that need to be addressed, particularly the risks to their health and child labour. Nevertheless, a growing number of experiences demonstrate that formalization and organization can solve or greatly minimize these problems. In Brazil, for instance, scavengers have been given legal status as a legitimate stakeholder in the waste management system and they can receive loans, grants, and training. Brazilian scavengers now enjoy benefits such as reduction in child labour, empowerment, increase in earnings, reduction in police harassment, and better working and living conditions.

Industrial policy in developing countries should include active support for the informal recycling sector. Working with the informal sector can create jobs, reduce poverty, improve industrial competitiveness, conserve natural resources, protect the environment, and save cities money by reducing the amount of wastes that need to be collected, transported and disposed of.

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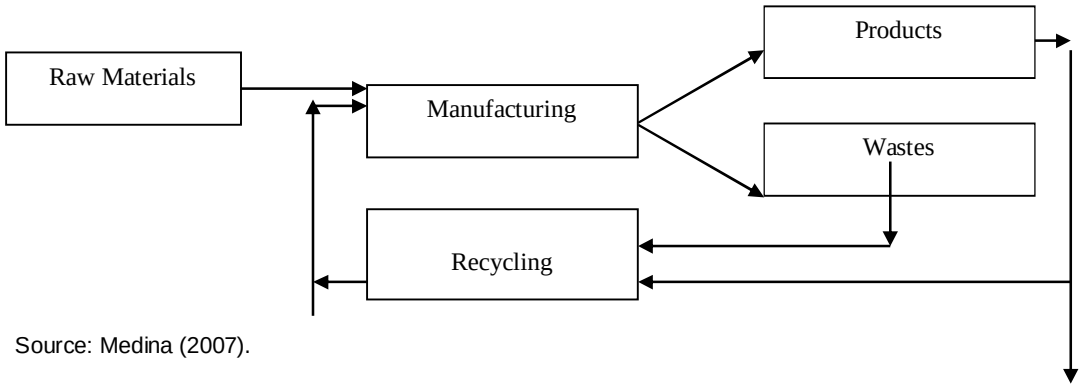
Box 1: A more environmentally sustainable model of production and consumption



Source: Medina (2007).

Table 1: Environmental benefits from substituting secondary materials for virgin resources (%)

Environmental benefit	Aluminum	Steel	Paper	Glass
Reduction of energy use	90–97	47–74	23–74	4–32
Reduction of air pollution	95	85	74	20
Reduction of water pollution	97	76	35	--
Reduction of mining wastes	--	97	--	80
Reduction of water use		40	58	50

Source: Cowles Letcher (1986).

Table 2: Estimated economic impact of scavenging in selected cities, 2007 (US$/year)

City	Economic impact
Mexico City*	95 million
Bogotá, Colombia*	56 million
Buenos Aires, Argentina*	50 million
Manila, Philippines*	40 million
Cairo, Egypt**	281 million
New Delhi, India*	54 million

Notes. *includes only the recovery of recyclable materials and not the manufacturing of products made from waste materials. **includes income from waste collection, sale of recyclables, and manufacturing activities.

Source: Medina (2007).

Table 3: Recycling and climate change

Material	Saved CO_2 emission in recycling compared with virgin manufacture (ton/ton)	Saved 'hidden flow generation' in recycling compared with virgin manufacture (ton/ton)
Copper	13–19.7	346.04
Aluminum	4.6–12.4	36.15
Steel	0.9–1.3	7.85
Plastic		1.7–4.7
Paper and cardboard	1.3–1.7	1.04
Glass	0.6	2.17

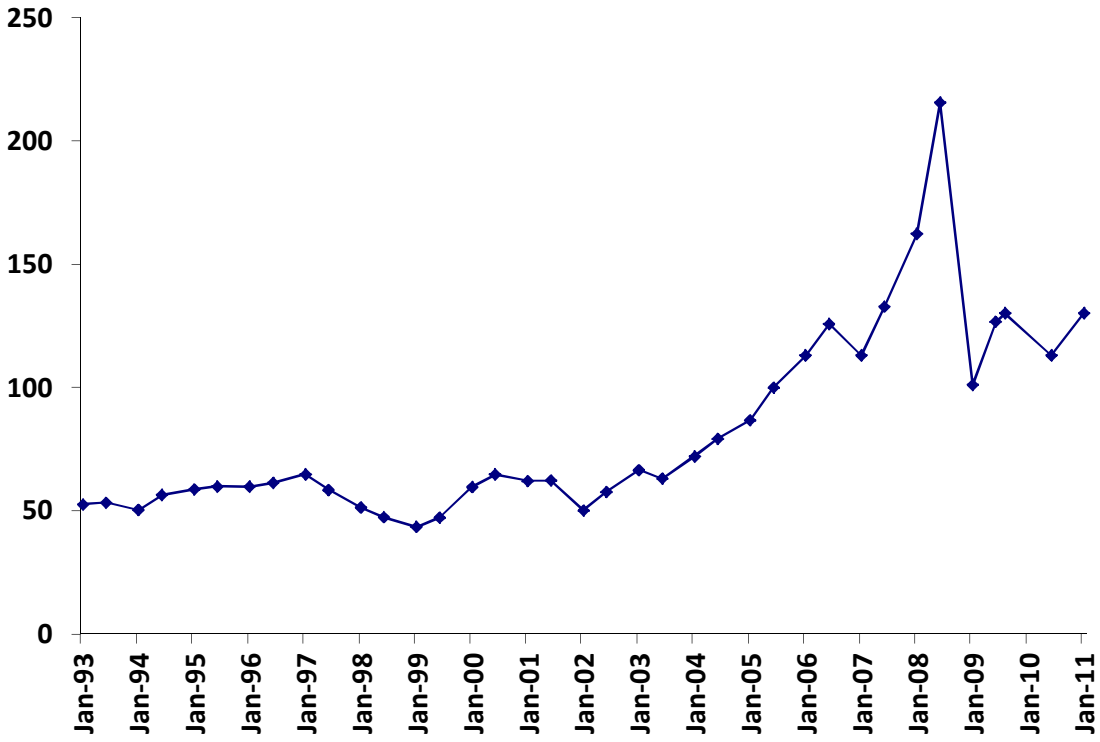
Source: ISWA (2009).

Table 4: International development agencies and scavengers

Organization	Initiative to support scavengers	Actions to support scavengers
The World Bank	No	Several and growing
Asian Development Bank	No	One project in Vietnam
InterAmerican Development Bank	No	One project in Colombia
African Development Bank	No	No
UNEP	No	No
ILO	No	Campaign to eliminate child labour in scavenging
UNIDO	No	No
USAID	No	No
AVINA Foundation	Yes	Several and growing

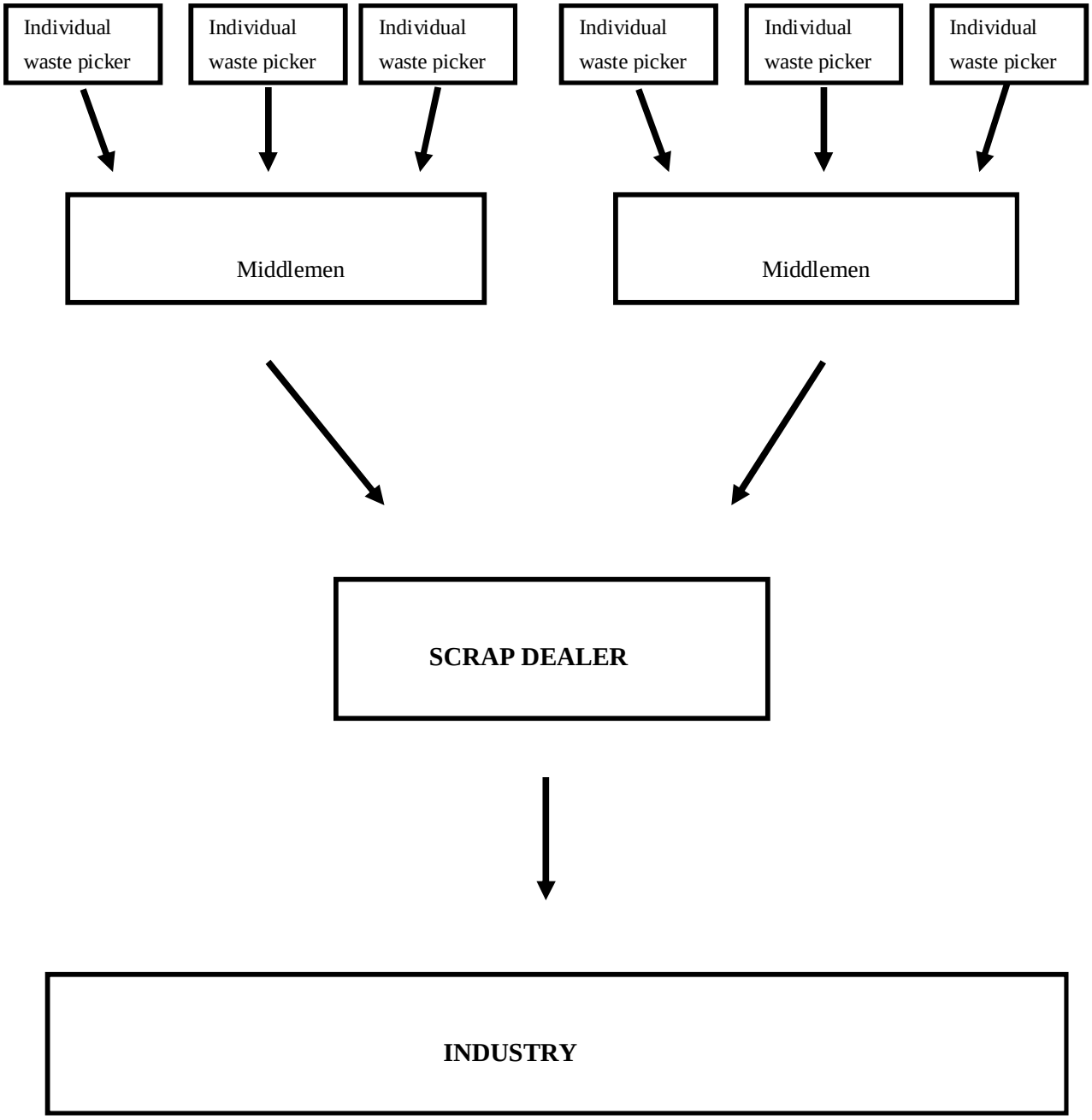
Source: Medina (2009).

Figure 1: Commodity price index, 1993–2011



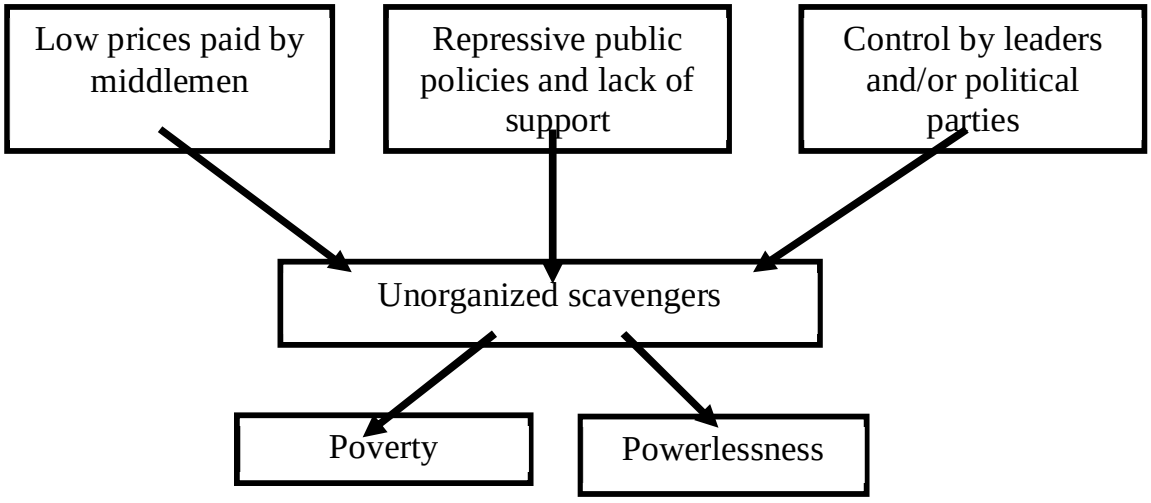
Source: prepared using IMF data (http://www.imf.org/external/np/res/commod/index.aspx).

Figure 2: Typical supply chain for recyclable materials



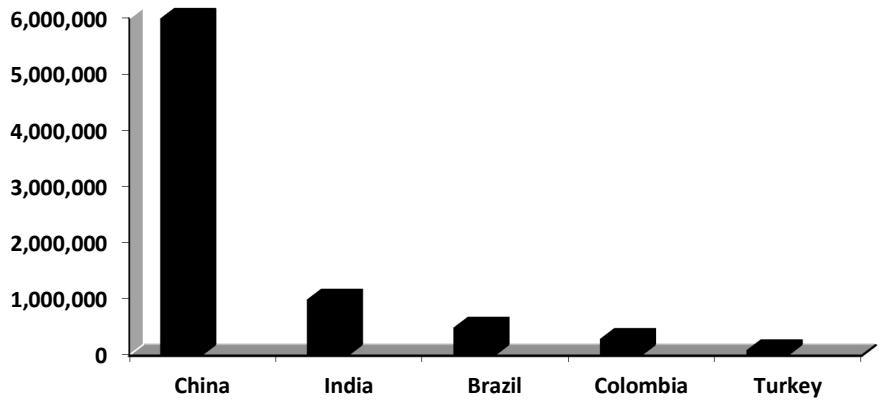
Source: Based on Medina (1997).

Figure 3: Typical power relations in scavenging in developing countries



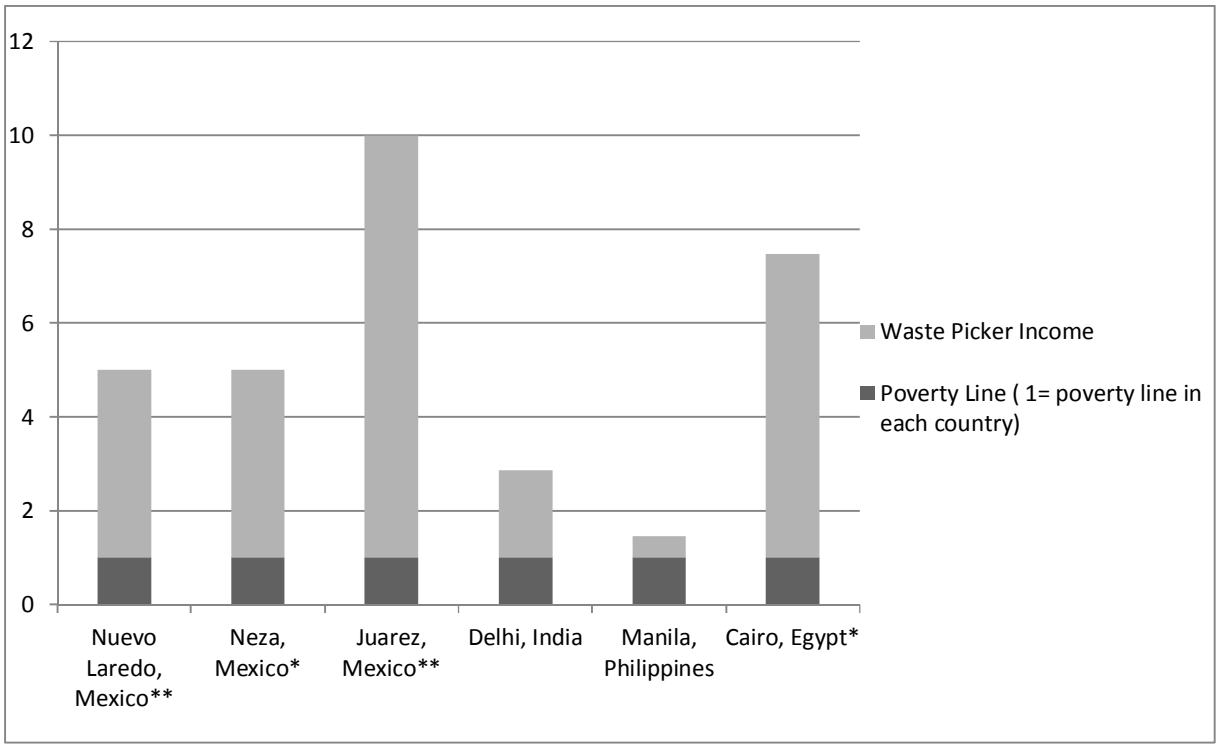
Source: Based on Medina (1997).

Figure 4: Estimated number of waste-pickers in selected countries



Source: Medina (2007, 2008).

Figure 5: Scavenger income in selected cities



Source: Medina (2007).