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An update on inter-country differences in recovery and utilization of recycled paper

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ABSTRACT

The use of recovered paper as raw material in the paper and board industry has increased heavily during recent decades. At the same time, growing environmental awareness has raised the interest in recycling and a more sustainable way of living, at least in high-income countries. This paper combines these topics and explores how economic, demographic and environmental factors have affected the recovery and utilization of recycled paper between 1992 and 2010 in a sample of 70 countries. This study updates and extends the previous research on the topic using panel data and panel data estimation methods. The results confirm the roles of economic determinants but also indicate that concern for the environment impacts the recovery of recycled paper particularly in high-income countries. Moreover, the motives for recycling appear to depend on the income level of a country, which is something that future policies should consider.

1. Introduction

The use of recovered paper[1] as a raw material for paper and board has been growing faster than that of any other material during recent decades, and the world's recycled paper collection increased by an impressive 575% between 1970 (30.8 million tons) and 2010 (208 million tons) (FAO, 2012). In more detail, recovered paper collection increased by 64.3% between 1970 and 1980, by 66.7% between 1980 and 1990, by 69.7% between 1990 and 2000, and by 45.4% between 2000 and 2010. Thus it appears that the growth has actually been decelerating in the 2000s. However, paper and board production today uses more recycled than virgin fiber as input (FAO, 2012). This development has been facilitated by technological progress in such areas as deinking and screening of impurities (Diesen, 2007) and by the good price competitiveness of recycled fiber. Recovered paper is cheaper than wood pulp, even in periods of high prices. Currently, recycled paper is used as a raw material when its availability is secured and when its usage is economically rational (Berglund et al., 2002; Berglund and Söderholm, 2003a; Miranda et al., 2010).

In addition, environmental regulation and consciousness at both the producer and consumer level have contributed to the increase in the demand for recovered paper (e.g., Collins, 1998; Lundmark, 2001; Berglund et al., 2002; Berglund and Söderholm, 2003a; Huhtala and Samakovlis, 2002; Samakovlis, 2003; Miranda and Blanco, 2010; Miranda et al., 2010). Through the use of recovered materials, natural resources are saved, emissions reduced and the burden of solid waste becomes smaller (van Beukering and Bouman, 2001). However, the allocation of recycling benefits between virgin and recycled fibers is a difficult question, as recently indicated by Laurijssen et al. (2010) in analyzing CO_2 and energy impacts of paper recycling in the Netherlands.

Recent decades have witnessed a surge of interest in environmental issues in many countries. In general, environmental awareness has been promoted by education, e.g., on the potential benefits of recycling (Bolane, 2006). There is also evidence that this awareness manifests itself in a higher recycled paper collection rate in Europe and that environmental awareness is a major determinant of paper recovery in European countries (Miranda and Blanco, 2010). At the same time, higher environmental awareness does not necessarily result in more active recycling in developing countries, where the primary motives for recycling appear to be economic (Cointreau, 1987; Bolane, 2006). This difference highlights that recycled paper recovery and utilization should be analyzed separately for developed high-income countries and developing lower-income countries (see also van Beukering and van den Bergh, 2006).

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[1] The terms recycled paper, recovered paper and waste paper are used interchangeably in this paper.

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Despite the skyrocketing use of recovered paper in the paper and board industry and the associated increases in its recovery and utilization, the studies focusing on country-level differences in recycled paper collection and use are rare and their results inconclusive. In addition, the existing studies are mainly from the early years of the 2000s. The recent changes in paper and board production imply that also the factors behind paper recycling and recovered paper utilization might have changed. This paper attempts to fill the research gap by updating and extending the study of Berglund et al. (2002). In their study, Berglund et al. identify and analyze the most important determinants of inter-country differences in recycled paper recovery and utilization rates. The current study brings the analysis of Berglund et al. up to date using panel data between 1992 and 2010 and by considering country-level differences in environmental awareness. Moreover, separate models are estimated for high-income and lower-income countries due to the apparent differences in the motives for recycling in the two groups of countries. In contrast to Berglund and Söderholm (2003a), who make a distinction between high- and middle-income countries, the current study includes some genuinely low-income countries in the analysis in order to be able to compare countries that are at truly different stages of economic development. The results should be of interest to policymakers who use or plan to use recovery and utilization rates as policy targets. The results could also serve as a starting point for forecasting future patterns in the recovery and utilization of recycled paper.

2. Recycled paper recovery and utilization

2.1. Key concepts and recent trends

A country's status with respect to recycled paper can be described by two ratios: the recovery rate and the utilization rate (e.g., Grace et al., 1978; Berglund et al., 2002). The recovery rate (*RR*) measures the supply of recovered paper from domestic sources. This rate is calculated by dividing recovered paper collection ($RP_{collect}$) by total paper and paperboard consumption (PB_{cons}, which is equal to the sum of domestically produced and imported paper and board minus paper and board exports):

$$RR = \frac{RP_{collect}}{PB_{cons}} \quad (1)$$

The second important ratio, the utilization rate (*UR*), denotes the extent to which recycled paper is used in paper and board production. This ratio is defined as the ratio of a country's recovered paper consumption (RP_{cons}) and its total domestic paper and board production (PB_{prod}):

$$UR = \frac{RP_{cons}}{PB_{prod}} \quad (2)$$

According to a provider of information for the global pulp and paper industry (RISI) (2012) and the authors' calculations, the highest recovery rates of the year 2010 could be found in South Korea (95.8%) and Norway (92.1%), and the lowest recovery rate could be found in Peru (15.9%). The highest recovery rates are made possible for example by packaging paper imports from China and other Far-Eastern countries (Miranda et al., 2010). At the same time, the utilization rate varied from 116% in El Salvador to 4.9% in Finland. A country's utilization rate can exceed 100% if recovered paper is the primary raw material in paper making. In general, the utilization rate tends to peak in Eastern Europe and Southeast Asia, whereas the lowest rates are found in forest-rich Northern countries that are significant exporters of paper and board products. Fig. A.1 depicts recovery and utilization rates for the sample of countries analyzed in this study.

The volume of global recycled paper trade has also been on the increase in recent years. Many high-income countries with some of the highest recovery rates (such as Germany, Netherlands, United Kingdom and Japan) are at present exporting very high volumes of recovered paper to developing countries with less paper consumption and less developed recovery schemes. In 2010, China was by far the largest importer of recycled paper with the imports of over 24.7 million tons (RISI, 2012).

Fig. 1a and b depicts the evolution of recovery and utilization rates between 1992 and 2010 in countries that are at different stages of economic development. The division of countries into high-income countries and lower-middle-income and low-income countries follows the World Bank's country classification (see Section 3.3 for details). Fig. 1a shows that the recovery rate has been on the increase in both rich and poorer countries. The increase exceeds 20 percentage points in the high-income countries, where the recovery rate was higher already in 1992. The rise is smaller at approximately 15 percentage points in lower-middle-income and low-income countries. These differences between the two groups of countries suggest that different factors might explain their recovery rate, implying that the subsequent recovery rate analysis should be performed separately for rich and poorer countries (see also van Beukering and Bouman, 2001; Berglund and Söderholm, 2003a,b; van Beukering and van den Bergh, 2006).

Fig. 1b shows the changes in the utilization rate in high-income countries and lower-middle-income and low-income countries. As seen from the figure, the utilization rate has been higher in developing countries than in developed countries. The utilization rate has also been on the rise in the former, where the upsurge in the utilization rate amounts to approximately 20 percentage points between 1992 and 2010. The simultaneous changes have been much smaller at below 10 percentage points in high-income countries. As a result, the recycled paper utilization level has diverged in the two groups of countries during recent years. The figure thus suggests that the level of economic development impacts also the utilization rate, either directly or indirectly.

2.2. Previous empirical econometric literature

Some earlier studies (most notably van Beukering and Bouman, 2001; Berglund et al., 2002; Berglund and Söderholm, 2003a,b) have analyzed recycled paper recovery and utilization. Table A.1 in Appendix presents an overview of previous empirical work. The current study concentrates on the studies that have applied econometric techniques and quantitative data in the analysis. In particular, it follows Berglund et al. (2002), who formulate the following model for the recovery rate in country *i*:

$$\ln RR_i = \alpha_0 + \alpha_1 \ln GDPpc_i + \alpha_2 \ln URB_i + \alpha_3 \ln POP_i. \quad (3)$$

The explanatory variables include a country's gross domestic product (GDP) per capita (*GDPpc*), urban population as % of the total population (*URB*, also called urbanization) and population density (*POP*). The role of GDP per capita in the equation is twofold. First, as GDP per capita increases, also the opportunity costs of labor-intensive activities, such as recovery and recycling of waste paper, tend to rise. However, in high-income countries where labor costs are high, sorting of waste paper is nowadays mainly automated. In low-income countries sorting is still mainly manual, meaning that labor costs continue to play a role.[2] Second, environmental laws and policies are in general stricter and the recycling infrastructure more advanced in high-income countries, meaning that the recovery rate could also be positively correlated with GDP per capita. Although

[2] We thank a reviewer for pointing this out.