

TECHNOLOGY INVESTMENT IN POLLUTION CONTROL IN SUB-SAHARAN AFRICA: THE CASE OF THE NIGERIAN MANUFACTURING INDUSTRY

Ph.D. Thesis: Summary of Findings

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Industry has been reckoned to contribute much to environmental pollution in developed countries and much research has been done to proffer technological solutions. However, until last decade the technological impact of policies aimed at promoting environmentally sustainable industrial development was virtually uninvestigated. So far, work in this area has been largely limited to developed countries. However, there has been increasing advocacy that developing countries need not follow the environmentally unfriendly development path of industrialised countries. With regard to this, little is known about technology adoption or application to curb external diseconomies of production among industrial firms in developing countries, especially in Africa. In the thesis, the notion of environmentally benign technologies (EBTs) refers to those technological artefacts, measures or body of scientific knowledge, which facilitate the reduction or elimination of external diseconomies of manufacturing enterprises. The inquiry focused on the food & beverages and the textile sectors. The two sectors were chosen because they are widely regarded as being water pollution intensive, and they are largely traditional low technology industries where developing countries have appreciable technological mastery. Moreover, it could be shown that the two sectors make significant contributions to manufacturing in sub-Saharan Africa, contributing at least two-fifths of manufacturing value added in most countries where they appreciably exist.

The theoretical model developed for the empirical analysis identified two categories of adoption causalities for EBTs. The first is the regime of environmental policy under which firms are operating, and we have referred to it as the *major driver* of EBT adoption. The second comprises of factors that relate to firm-level technological capabilities, firm characteristics, and regulation implementation. These we have termed *auxiliary drivers* of EBT adoption. We also defined firms' technology responses to either major or auxiliary driver(s) to be in the form of technology response for pollution abatement (henceforth, TPA) or technology response for pollution prevention (henceforth, TPP). The central hypothesis in the analytical framework, which we have called '*major versus auxiliary driver*' hypothesis, could be stated thus: '*in developing countries where environmental policy is generally considered relatively weak, the auxiliary drivers of EBT adoption may take precedence over environmental policy as stimuli for environmentally benign technical change in the manufacturing industry*'.

Generally speaking, the results of the study make two important contributions to knowledge. First, the theoretical framework developed proposed a re-thinking of the bounds of environmental policy as stimulus for environmentally benign technical change that reduces or eliminates the external diseconomies of manufacturing firms. While environmental policy remains an important determinant of firms' investment in EBTs, our model demonstrated that it is plausible that non-environmental regulation factors could also serve as important stimuli for investments in EBTs, especially in developing countries where environmental regulatory measures are comparatively weak. Secondly, the thesis presents the results of a pioneering research on the technological impact of environmental regulation in a sub-Saharan African

manufacturing context. It has shown that industries in Africa are capable of, and in fact, are already implementing technological innovations that ameliorate industrial pollution.

With specific reference to Nigeria, this treatise revealed that Nigerian firms are employing conventional end-of-pipe technologies, viz., industrial wastewater treatment plants, to reduce the negative externality of industrial wastewater effluents. Evidence was also given of process related or integrated techniques that reduce wastewater at the source. The analyses showed that most of the secondary and tertiary wastewater treatment plants were adopted after the end of a three-year moratorium given to firms to comply with Nigerian environmental regulatory law, S.I.8/S.I.9 enacted in August 1991. This indicates that the Nigerian environmental policy has been effective in stimulating the adoption of EBTs with respect to industrial wastewater pollution abatement. Similar effects were however not so vividly observable with respect to the adoption of technologies that reduce industrial wastewater pollution at the source, especially among the textile firms. It was also noted that decisions of affiliates of multinational enterprises (MNEs) to adopt were not significantly affected by the implementation of the S.I.8/S.I.9 law. Case study illustrations showed that the international norm or environmental policy of the parent companies played important roles in the MNE affiliates' decisions to invest in EBTs.

When the influences of the main and auxiliary drivers on TPA and TPP were isolated, the results showed that the environmental policy variable has significant influence on TPA and TPP adoption, but may not be considered to play the role of the major driver of TPA or TPP adoption. Auxiliary driver variables such as ownership structure of the firm, firm size, and human capital aspect of internal capability for innovation (represented by percent workforce with higher education) and policy implementation strategy gained more prominence as stimuli of either TPA or TPP adoption.

From the findings of the thesis, some important policy implications of the study emerged. Divestment policies that may increase foreign ownership in publicly owned manufacturing enterprises or policies aimed at encouraging multinational investments in manufacturing (e.g. foreign direct investment policies), have potentials of improving firms' performance in technology investment in pollution control. In this respect, the larger the firm, the more the prospect of better environmental performance. In the same vein, policies that encourage large-scale greenfield manufacturing investments or promote the growth of existing small and medium-scale industries into large-scale manufacturing have potentials for stimulating EBT adoption. It should however be noted that, there is no clear indication from the empirical findings that subsidiaries of multinational firms have implemented environmentally benign technologies that are essentially superior to those implemented by local firms. The results further indicated that technology and industrial policies that foster internal technical capability development among Nigerian manufacturing enterprises would inadvertently stimulate firms' investments in technologies that promote environmentally sustainable industrialisation.

Furthermore, the current Nigerian environmental policy lays much emphasis on TPA (end-of-pipe) solutions to industrial wastewater problems, and the Nigerian industrial/technology policies have so far been silent on cleaner production as policy objective. Evidence of TPP adoption provided in the thesis however suggests that there is a good prospect for cleaner production programmes in the Nigerian manufacturing industry. Environmental, technology and industrial policies could thus be made to encourage environmentally benign technical change that would result in a regime of cleaner production among Nigerian firms.

From the foregoing, we have stressed that technology and industrial policies could be made to achieve the objective of environmentally sustainable industrial development. This does not however imply that attention should be shifted away from improving environmental regulatory measures. Rather, in view of scarce resources for full blown or elaborate environmental regulatory frameworks as exist in developed countries, a focus on technology and industrial policy measures that take the environment into consideration could enhance the regime of environmental sustainability as much as environmental policy would. Environmental policy may perhaps play a more important role as a driver of environmentally benign technical change in industry only after the transformation of developing economies into industrial economies.

In conclusion, it is pertinent to note that policy focus aimed at strengthening the ability of the auxiliary drivers to provide stimuli for EBT adoption could be more attractive to industry, and at the same time achieves the social welfare objectives. It may thereby be possible to not only promote the eco-restructuring of industry; but also increase the capacity of stakeholders, industrial firms, and policy makers to overcome the perceived conflicts between environmental regulation and industrial development. Furthermore, though we have only an anecdotal confirmation of Porter's hypothesis in the thesis, the promotion of the auxiliary drivers as determinants of environmentally benign technology responses could be an exploration that might lend some credence to Porter's hypothesis on the compatibility of environmental regulation and industrial development for the Nigerian case. Finally, in addition to the policy implications of the study, it is important to reiterate that this treatise is a contribution towards an appreciative theory that redefines the bounds of environmental policy as stimulus for environmentally benign technical change in industrial manufacturing.