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The economics of tiered pricing and cost functions: Are equity, cost recovery, and economic efficiency compatible goals?

Karina Schoengold [a,*], David Zilberman [b]

[a] Department of Agricultural Economics and School of Natural Resources, Daugherty Water for Food Institute Faculty Fellow, University of Nebraska-Lincoln, 307A Filley Hall, Lincoln, NE 68583-0922, USA
[b] Department of Agricultural and Resource Economics, Giannini Foundation of Agricultural Economics, University of California-Berkeley, USA

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ABSTRACT

The paper develops a framework to analyze equity and economic efficiency of increasing block rates (IBR) for regulated products such as electricity or water. The model assumes that consumers are heterogeneous in their demand characteristics. Conditions are identified under which economic efficiency and cost recovery can be achieved in a manner that also reduces inequality, which is measured through changes in the Gini coefficient of net income. The use of IBR pricing is found to have a limited capacity to address equity issues while maintaining a balanced budget, as the balanced budget limits the size of the tier. Economic efficiency constraints combined with the balanced budget limit the subsidy. The capacity of IBR pricing to modify equity outcomes increases if supply costs are diverse. Under IBR, a supplier with significant variability in its marginal costs has a greater ability to improve equity while still remaining revenue neutral and maintaining economic efficiency. Under marginal cost pricing, the Gini coefficient is primarily affected by parameters of the demand function but, with IBR, both demand and supply parameters impact this measure. The results are illustrated with a numerical analysis of household water consumption from four utilities in the western United States.

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* Corresponding author. Tel.: +1 402 472 2304.
E-mail addresses: kschoengold2@unl.edu (K. Schoengold), zilber11@berkeley.edu (D. Zilberman).

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1. Introduction

Suppliers of water and energy frequently have their rates regulated by government agencies. Pricing schemes are evaluated by allocation efficiency; the capacity of the suppliers to capture their costs; and the distributional effects of the policies, in particular, impacts on the poor. One approach has been average cost pricing, which guarantees cost recovery and allows suppliers to provide their product at relatively low rates [5]. However, average cost pricing leads to economically inefficient consumption levels. For this reason, economists have often argued to price resources at their long-run marginal cost. While economically efficient, this may be very costly for the poor. An alternative approach is increasing block rates (hereafter, IBR or tiered pricing), where individuals pay a low rate for an initial consumption block and a higher rate as they increase use beyond that block. Increasing block rates are frequently used by regulated suppliers in the United States and worldwide. For example, Borenstein [6] describes the adoption of IBR pricing by California electricity suppliers during the 1980s. An Organisation for Economic Co-operation and Development (OECD) study of water rates in developed countries shows frequent use of increasing block rates [22]. Concerns about conservation have led to a widespread shift in pricing patterns; while only 4 percent of public water suppliers in the United States used IBR in 1982, over 30 percent did by 1997 [22]. Over the same period, the use of decreasing block rates fell from 60 to 34 percent of public water suppliers.

Advocates of IBR argue that it can improve equity by offering the poor a subsidized rate on consumption [1]. Others argue that IBR will encourage overconsumption if the subsidized block is too large. For example, a study of water suppliers by the Asian Development Bank [2] found that the average size of the subsidized block is almost 300 percent of basic needs. Thus, if IBR pricing is not properly designed, it could lead to consumption in excess of economically efficiently levels. Given the growing reliance and political support for IBR pricing it is important to fully understand the effect of IBR on economic efficiency and equity. This paper contributes to that understanding by developing an integrated model of heterogeneous suppliers and consumers of a regulated natural resource and using the modeling framework to determine the limitations of IBR pricing.

In this paper, we determine under what conditions tiered pricing can be used to improve equity while maintaining economic efficiency and revenue neutrality. While we present the model in terms of water, the results can be generalized to energy and other inputs. We show that, under certain conditions, a regulated supplier can achieve all three goals. The feasibility depends critically on the underlying cost structure and the parameters of the demand function. Specifically, suppliers with variation in the marginal cost of inputs (which may reflect the diversity of sources) and without extremely poor customers are best able to improve equity with tiered pricing. The economic efficiency and balanced budget constraints set an upper bound on the tier and limit the size of the subsidy. Relaxing the balanced budget constraint when cross-sector subsidization is feasible allows improvements in equity. However, that improvement may come at the cost of the increased use of scarce resources.

To determine the potential for tiered pricing to improve equity, we develop an analytical model of a regulated supplier with heterogeneous customers. We demonstrate how shifts in parameters of the benefit or marginal cost functions affect the design of an optimal tiered pricing rate structure. We develop a measure of the equity effects of the IBR based on the use of Gini coefficients and compare the impacts of a single rate structure with increasing block rates. We include a numerical analysis of water consumption in four utilities in the western United States to show how equity is affected with a change in the rate structure.

Much of the previous literature on the economics of tiered pricing has examined the consumer response to a tiered pricing rate structure. Most of the work in this field has been empirical [18,8,26,4,25,6,15]. There has been a paucity of theoretical work examining the feasibility and implications of tiered pricing. Wilson [31] briefly discusses the issue but only in the context of decreasing block rates and a profit-maximizing monopolist. Bar-Shira and Finkelshtain [3] find that IBR affects the long-run incentives for entry and exit into an industry, thus affecting the long-run optimal outcome. However, they find that, when the number of firms is fixed, the social optimum may be achieved through IBR. Certain limitations of IBR in developing countries include the feasibility of every family unit having its own meter [30] or unintended impacts on large families [30,10]. However, suggestions exist to remedy this problem, such as customer-specific block rates and quantities [24]. None of these papers has developed a theory of how to design tiered pricing to achieve equity goals.

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