

*A Note on Modeling Aggregate Productivity Growth: The Importance of Imperfect Markets**

Models of aggregate productivity growth linked to sectoral models of production typically assume that product and factor markets are perfectly competitive. The perfect markets assumption allows intermediate goods to be viewed as internal, offsetting transfers. This paper relaxes the conventional perfect markets assumption. The alternatives of basing aggregate models of productivity growth on value-added versus delivery-to-final-demand frameworks are analyzed. The important finding is that if imperfect markets exist, then the value-added and the delivery-to-final-demand models generate identical measures of aggregate productivity growth only under very restrictive assumptions; moreover, a simple variant of imperfect competition cannot reconcile these productivity measures.

1. Introduction

Since the publications of Solow's (1956, 1957) pioneering works, many models of productivity growth assume that product and factor markets are perfectly competitive. The perfect markets assumption allows intermediate goods to be viewed as internal, offsetting transfers. The assumption is that the interindustry sales and purchases of intermediate products cancel out when all the industries of the economy are consolidated, so that the resulting net output, or net final product, proceeds from a combination of the primary factors of labor and capital. Simply stated, this conventional approach to aggregate productivity analysis abstracts from intermediate input and deliveries to intermediate demand. Only primary inputs and deliveries destined for final demand are relevant.

Gollop (1979, 1982) has shown the importance of accounting for intermediate goods when measuring productivity growth. His important finding is that value-added and delivery-to-final-demand frameworks of productivity growth, in spite of their fundamental difference regarding separability, generate identical measures of aggregate productivity growth when perfect markets is a maintained assumption. Gollop (1987) extends this line of research by showing that the existence of imported intermediate inputs may

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cause total factor productivity studies based on value-added measures to yield an upward bias in aggregate productivity growth estimates. He shows that in the presence of international trade, taxes, and subsidies, modeling aggregate productivity growth in terms of a value-added or a delivery-to-final-demand framework does make a difference. The two rates are equivalent if and only if the economy is closed to imported inputs in domestic production and has either no taxes on deliveries to intermediate demand or an unchanging distribution of intermediate inputs. One goal of this paper is to show that the two rates differ even without these added conditions once the perfect markets assumption is relaxed.

In previous empirical work, Hall (1988) tests for the equality of price and marginal cost, where he theoretically examines the importance of intermediate inputs, but ignores the contribution of intermediate inputs in his estimates. Domowitz, Hubbard, and Petersen (1988) and Norbbin (1993) modify Hall's work, but both studies focus solely on the manufacturing sector. Roeger (1995) provides an alternative method for estimating mark-up ratios that does not require the strong identifying assumptions found in the previous analyses. He uses the hypothesis of imperfect competition to explain the apparent lack of correlation between value-added and delivery-to-final-demand productivity measures in U.S. manufacturing.

This paper shows that a simple variant of imperfect competition cannot reconcile value-added and delivery-to-final-demand productivity measures. This occurs because once the assumption of perfect competition is relaxed, the aggregate rate of productivity growth is expressed as a cost-weighted sum of the sectoral rates of productivity growth plus a term that reflects an inequality between price and marginal cost in intermediate good markets. This additional term, a dead-weight loss term, is quite independent of the sectoral productivity growth rates and, moreover, the value-added model ignores this term. The major contribution of this paper is that the direction and magnitude of the dead-weight loss term cannot be known a priori; this is significant because it implies that it is not possible to adjust the value-added model of aggregate productivity growth by some factor that would account for sectoral mark-ups in intermediate good markets.

Sections 2 and 3 contrast measures of aggregate productivity growth derived respectively, from value-added and delivery-to-final-demand models of economic activity. The main conclusion is derived in Section 4: under the assumption of imperfect markets, the value-added and delivery-to-final-demand models of aggregate production produce identical measures of aggregate productivity growth only when certain restrictive conditions hold. Section 5 presents summary remarks.

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