Trade Liberalisation and Productivity Growth in Manufacturing

Evidence from Firm-Level Panel Data

Using panel data comprising firm-level information drawn from groups within manufacturing industry which have experienced the most significant tariff reduction, this study investigates the trend in productivity growth since 1988-89. The sample of 2,300 firms and 11,009 observations, spanning the period 1988-89 to 1997-98 is very likely the largest assembled for the purpose thus far. We find no evidence of acceleration in productivity growth since the onset of reforms in 1991-92. The result is evaluated in relation to the changes till date in the policy regime in the Indian economy.

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In a review of research on total factor productivity growth (TFPG) in manufacturing industry in the 1980s we had observed that there remained a puzzle in that two differing methods of estimation – the growth accounting method and the econometric one – produced divergent results [Balakrishnan and Pushpangadan 1998]. In this paper we do not address this issue which remains of some importance to scholarship on the estimation of productivity growth in India. Instead, we move on to study the 1990s. This follows from the fact that both our perception and our own priorities have evolved since our last paper. Principally, it has struck us that as the best received work had posited a relationship between TFPG and what may be referred to as liberal policy regimes, the 1990s are a more appropriate period for a test of the relationship between TFP growth and the change in the policy regime. For after all in the 1980s we had 'not seen nothing yet'. The changes initiated in 1991 dwarf anything by way of liberalisation that may have taken place during the preceding decade. If this view is acceptable, and to us it appears eminently so, the data of the 1990s would serve as a better test bed than any other period thus far.

In this paper we present results of a test for a shift in productivity growth since 1991. We would expect any shift in productivity to occur in those sectors of manufacturing where the reforms have been most pronounced. It is widely held that the defining character of these reforms is the greater openness of the Indian economy. Therefore we have focused on those sectors where trade has been liberalised. While we are aware of many dimensions to trade liberalisation, for the purpose of this study we define trade liberalisation as significant reductions in the tariff rate.

To investigate the existence of a shift in the growth of productivity since the introduction of trade reforms in the Indian economy, data for a panel of 2,300 firms spread over five industry groups (Appendix) at the two digit level of the NIC 1987, yielding over 11,009 observations was assembled from the data base on electronic medium (PROWESS) of the Centre for Monitoring the Indian Economy (CMIE). On the basis of the record of tariff reduction since 1991 the industry groups chosen were machinery, transport equipment and parts, textiles, textile products and chemicals. As far as possible, industries subjected to significant tariff reductions are included. The data on tariff reductions used for this study is presented in Balakrishnan, Pushpangadan and Suresh Babu (2000; henceforth BPS). The period 1988-89 to 1997-98 was chosen for the study, 1997-98 having been the last financial year for which data was available at the time of commencement of the study. The study investigated a shift in productivity growth from the year 1991-92.

Model

From Hall (1988) we have a methodology whereby estimation of a single equation yields both an estimate of the price-marginal cost ratio and of productivity. This methodology has been widely applied in empirical analyses of the consequence of trade reforms for competition and productivity growth in different economies for different periods [Harrison 1994; Srivastava 1996; Krishna and Mitra 1998], and we have proceeded accordingly.

Specify the production function for firm i in industry j at time t as:

$$Y_{ijt} = A_{jt} f_{it} G(L_{ijt}, K_{ijt}, M_{ijt}) \quad ...(1)$$

where Y, K, L and M stand for output, capital, labour and materials inputs, respectively, A_{jt} is an industry-specific index of Hicks-neutral technical progress and f_{it} is a parameter allowing for firm-specific differences. Totally differentiating (1) and dividing through by Y, we have

$$(dY/Y)_{ijt} = (\delta Y/\delta L)(dL/Y)_{ijt} + (\delta Y/\delta K)(dK/Y)_{ijt} + (\delta Y/\delta M)(dM/Y)_{ijt} + (dA/A)_{jt} + (df/f)_{it} \quad ...(2)$$

From the first order conditions for profit maximisation of a firm in Cournot equilibrium the expression for the physical marginal product(s) can be written as:

$$(\delta Y/\delta L)_{ijt} = (w/p)_{jt}\{1/[1+(s_{ij}/e_j)]\} = (w/p)_{jt}\mu_{ij} \quad ...(3a)$$

$$(\delta Y/\delta K)_{ijt} = (r/p)_{jt}\{1/[1+(s_{ij}/e_j)]\} = (r/p)_{jt}\mu_{ij} \quad ...(3b)$$

$$(\delta Y/\delta M)_{ijt} = (n/p)_{jt}\{1/[1+(s_{ij}/e_j)]\} = (n/p)_{jt}\mu_{ij} \quad ...(3c)$$

where p is the product price, w, r and n are the price of labour, capital and materials, respectively, s_{ij} is the market share of firm i in industry j, and μ is the mark-up (price-marginal cost ratio).

Anticipating the estimation to follow, which takes the form of estimating production functions for whole industries, it is assumed that the mark-up varies across industries alone, and not between firms.

measure of the capital stock at replacement cost for the base year. This is done as follows. Suppose the gross fixed assets at historic costs can be defined as

$GFA_t^h = P_tI_t + p_{t-1} I_{t-1} + P_{t-2} I_{t-2} + \ldots$

which can be rewritten as

$$GFA_t^h = P_tI_t \frac{(1+g)(1+\pi)}{(1+g)(1+\pi)-1}$$

and similarly gross fixed assets at replacement costs can be written as

$GFA_t^r = P_tI_t + P_t I_{(t-1)} + P_tI_{(t-2)} + \ldots..$

which can be rewritten as

$$GFA_t^r = \frac{P_tI_t (1+g)}{g}$$

then the revaluation factor R^G, defined as the ratio of the value of the asset at replacement cost to the value of the asset at historic cost will be, if the earliest vintage of capital dates back infinitely,

$$R^G = \frac{(1+g)(1+\pi)-1}{g(1+\pi)}$$

In this study we assumed that the capital stock has finite economic life. Now the revaluation factor becomes

$$R^G = \frac{[(1+g)^{\tau+1}-1]\,(1+\pi)^{\tau}\,[(1+g)(1+\pi)-1]}{g([(1+g)(1+\pi)]^{\tau+1} - 1)}$$

where τ is the life of the machine.

Using the revaluation factor thus obtained we convert the capital in the base year into capital at replacement costs at current prices. We then deflate this value to arrive at a measure of the capital stock in real terms for the base year. The price deflator used is the price index for machinery and machine tools as plant and machinery account for 71.5 per cent of GFA (*RBI Bulletin*, 1990, 44, 3). Subsequent years' investment, $GFA_t - GFA_{t-1}$, is added to the capital stock existing at every time period using the perpetual inventory method.

It should be noted that we have used gross values of capital in our estimates. Dennison (1967) argues that a correct measure falls somewhere between the gross stock, and the net stock, advocating the use of a weighted average of the two with higher weight for the gross as the true value is expected to be closer to it. Empirically implementing this runs into a problem in the Indian context as the figure for capital consumption is difficult to arrive at. Moreover, one often encounters the question of the reliability of the depreciation values reported by the firms as most of these are calculated as per the allowances by the income tax authorities. Another related problem is the computation of the revaluation factor for the net capital stock. This demands the use of accounting depreciation rates as well as economic depreciation rates. Economic depreciation rates can be exogenously determined, endogenously determined or arrived using the one-hoss-shay model. The first one implies borrowing a set of estimates for some other economy, the second one makes use of the assumption of straight line depreciation and the third assumes that the depreciation during the life of a machine is zero and is 100 per cent at the end of the life of the machine. Limitations regarding the three measures are well recognised in the literature. Ambiguity exists on the treatment of depreciation due to obsolescence and depreciation due to physical deterioration. This poses further problems, as one has to deal with the concepts of obsolescence and aging, retirement and discarding (mortality) and the service life of the capital stock. Data required to untangle these issues are more than what is available at present. Thus we prefer gross values to net values.

Labour: The expenditure on wages and salaries was converted into a measure of labour input of firms by administering an estimated average total compensation to labour in the firm's industry for that year. The resulting measure may be seen as labour expressed in 'efficiency units'. The average compensation by industry was computed by dividing each industry's total emoluments by total labour hours from the Annual Survey of Industries (ASI). As, at the time of our investigation, ASI data was available only up to 1995-96 we have used extrapolated values for subsequent years.

Materials: The value of the materials bill was deflated by a materials input-price index. The input-output coefficients for 1989-90 have been used as weights to combine the wholesale prices of the relevant materials. The source of the weights is CSO's input-output table for 1989-90 and the relevant price indices were taken from 'Index Numbers of Wholesale Prices in India, base 1981-82=100', ministry of industry, government of India. EPW

Notes

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1 There are two steps in this derivation. For the summation of factor shares being equal to the ratio of the scale parameter to the mark-up see Harrison (1994). For the derivation of (6) incorporating this see BPS (2000). Note that writing (6) implicitly assumes Cobb-Douglas production technology.

2 All results are available upon request from the authors.

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