Technology Shock in Services and Balanced Growth: A Demand-side Analysis

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Question

Can a positive technology shock to services explain:

- Expansion of services sector vis-a-vis other sectors/rest of the economy.
- Increase the rate of growth in the economy.

Motivation

Growth experience of Indian economy in the post reforms period.

- High rates of growth, particularly in the last decade.
- Services sector increased its share in GDP by almost 15 percentage points between 1991-2010 whereas industry sector's share in GDP has stagnated at 27.8 percent.
- Improvements in information and communication technology (ICT) has improved ways in which services are produced and delivered, which basically challenges Baumol's characterization of services as technologically stagnant.
- Best performing services- Telecommunication, business services and banking finance.

- What insights do dual economy models of agriculture and industry, (starting with Lewis 1954), offer in this regard?
  - Relative price has macroeconomic implications.
  - Impact of relative price depends on the linkages between the two sectors.
- The analysis draws from Dutt 1988 and 1992 and Taylor 1991.

Assumptions

- Two sectors. Industry (I) and service (S).
- Industry's output serves as both consumption good and investment good.
- Service output serves as intermediate input for industry's output. Production of one unit of industry's output requires n units of service output, where n is a constant and $n > 0$.
- Firms in both the sectors operate with excess capacity and set prices applying fixed mark ups on their respective unit costs.

- Price of industry's output is $P_i = z_i(\frac{W}{x_i} + P_s n)$
- Price of service $P_s = z_s(\frac{W}{x_s})$

  where

  z_j= the mark up in sector j; $z_j > 1$
  x_j= labour productivity in sector j.
  W= the money wage
- Relative price $p = \frac{P_s}{P_i} = \frac{z_s/z_i}{x_s/x_i + z_s n}$
- Technology, wage shares and the mark ups in both the sectors are constants. The nominal wage is also constant and same for both the sectors.

- Total income in the economy $= P_i X_i + P_s X_s$
  where

  X_j= Final output of sector j
  $P_j X_j$= Income generated in sector j
- Out of each sector's income a constant fraction $0 < c_j < 1$ contributes to consumption of industry's output.
- Total Consumption expenditure $C = c_i P_i X_i + c_s P_s X_s$
- Real Consumption demand for industry's output

$$\frac{C}{P_i} = c_i X_i + c_s p X_s$$

- Investment functions for industry is $g_i = \frac{I_i}{K_i} = \alpha + \beta_i \frac{X_i}{K_i}$
- Investment function for service $g_s = \frac{I_s}{K_s} = \alpha + \beta_s \frac{X_s}{K_s}$

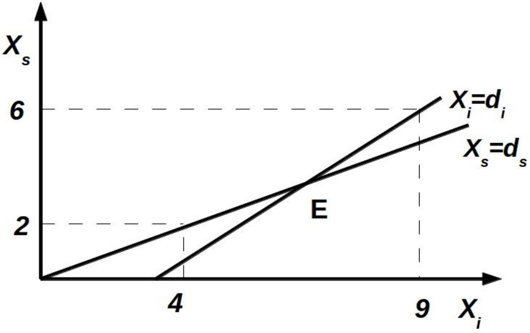
  where

  I_j= Investment demand of sector j
  K_j= Capital stock of sector j
  $g_j = \frac{I_j}{K_j}$= Growth rate of capital in sector j.
  $\frac{X_j}{K_j}$= Degree of capacity utilization in sector j
  α, β_i and β_j are positive constants.
- Rate of depreciation of capital is zero in both the sectors.

- In the short run capital stock is given in both the sectors.
- Demand for industry's output $d_i = C/P_i + I_i + I_s$ or,

$$d_i = (c_i + \beta_i)X_i + (c_s p + \beta_s)X_s + \alpha(K_i + K_s)$$

- Demand for services output $d_s = nX_i$
- At the short run equilibrium $X_i = d_i$ and $X_s = d_s$.



X_s
6
2
$X_i=d_i$
$X_s=d_s$
E
4
9
X_i

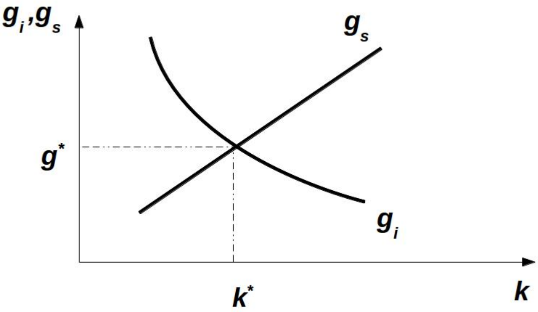
- Rates of accumulation of industry and service at the short run equilibrium respectively are

$$g_i = \alpha + \frac{\beta_i}{D}\alpha(1 + \frac{1}{k})$$

and

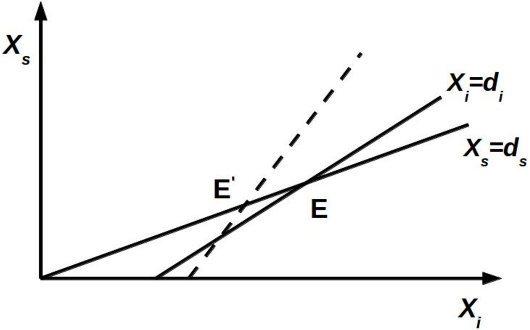
$$g_s = \alpha + \frac{\beta_s n}{D}\alpha(k + 1)$$

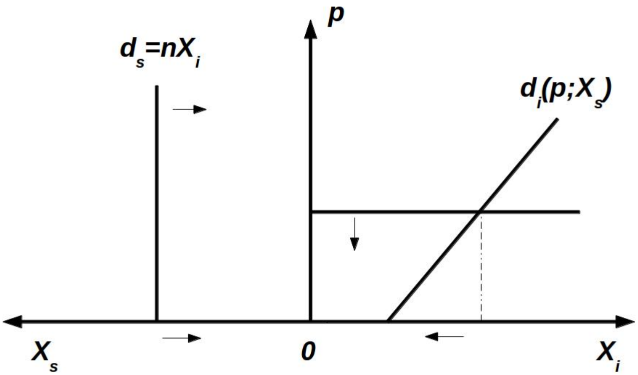
- The rate of change in relative capital stock $k = K_i/K_s$ is, by definition, $\dot{k} = k(g_i - g_s)$
- $k^* = \dfrac{\beta_i}{n\beta_s}$


g_i,g_s
g_s
g*
g_i
k*
k

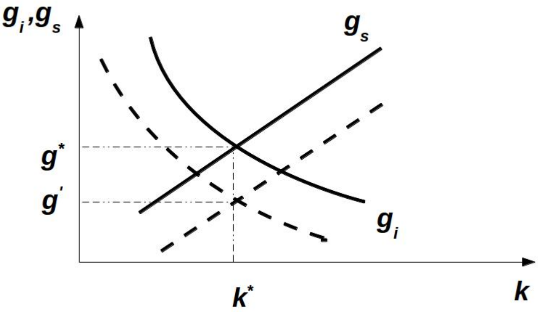
- The relative price, $p = \dfrac{P_s}{P_i} = \dfrac{z_s/z_i}{x_s/x_i + z_s n}$
- Suppose there is positive technology shock which raises labour productivity in services, i.e., x_s increases.
- Everything else remaining the same, p falls.
- With decrease in p
    - Demand for industry's output as a result of one unit production of service output falls. (i.e., $(c_s p + \beta_s)$ falls) $X_i = d_i$ schedule becomes steeper on the (X_i, X_s) plane.

$x_s \uparrow \Longrightarrow p \downarrow \Longrightarrow X_i \downarrow$ and $X_s \downarrow$




p
d_s=nX_i
d_i(p;X_s)
X_s
0
X_i

$x_s \uparrow \Longrightarrow p \downarrow \Longrightarrow k^*$ does not change while $g^* \downarrow$



- **Consider an additional linkage:** One unit consumption expenditure on industrial output gives rise to a complementary expenditure of θ on service output, where θ is a constant and $\theta > 0$.

  Which means if consumption expenditure on the industrial output worth C, there is consumption expenditure worth θC on service output.

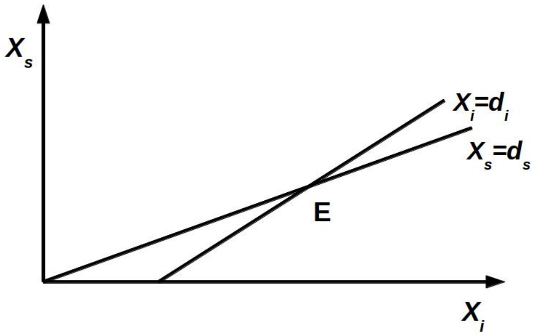
- Real consumption demand for service output

$$\frac{\theta C}{P_s} = \frac{\theta c_i}{p} X_i + \theta c_s X_s$$

- Demand for services output $d_s = \theta(C/P_s) + nX_i$ or,

$$d_s = \theta(\frac{c_i}{p} + n)X_i + \theta c_s X_s$$

- At the short run equilibrium $X_i = d_i$ and $X_s = d_s$.



X_s
$X_i = d_i$
$X_s = d_s$
E
X_i

- Growth rates of capital stock in two sectors respectively are

$$g_i = \alpha + \frac{\beta_i}{D}(1 - \theta c_s)\alpha(1 + \frac{1}{k})$$

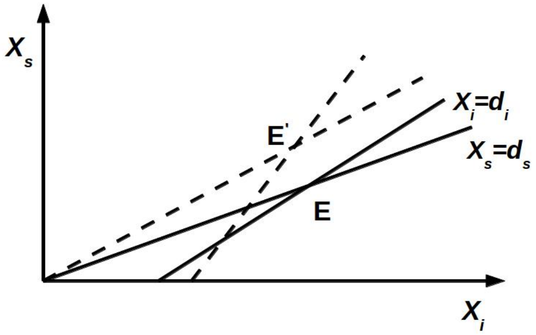
and

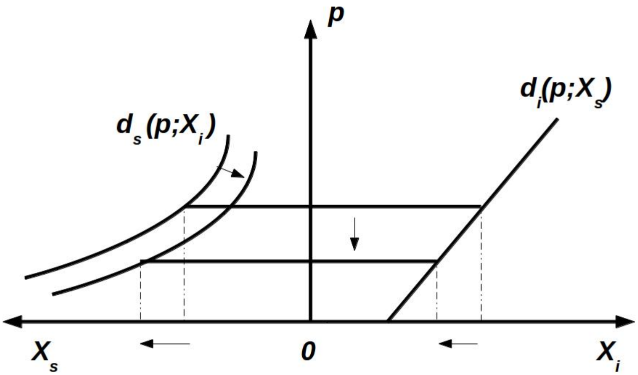
$$g_s = \alpha + \frac{\beta_s}{D}(\theta c_i/p + n)\alpha(k + 1)$$

- The rate of change in relative capital stock $\dot{k} = k(g_i - g_s)$
- $k^* = \dfrac{\beta_i(1 - \theta c_s)}{\beta_s(\frac{\theta c_i}{p} + n)}$

- Suppose there is positive technology shock which raises labour productivity in services, i.e., x_s increases.
- Everything else remaining the same, p falls.
- With decrease in p,
    - Demand for industry's output as a result of one unit production of service output decreases. (i.e., $(c_s p + \beta_s)$ decreases) $X_i = d_i$ schedule becomes steeper on the (X_i, X_s) plane.
    - Demand for service output as a result of one unit production of industrial output increases. (i.e. $(\dfrac{\theta c_i}{p} + n)$ increases) $X_s = d_s$ schedule becomes steeper on the (X_i, X_s) plane.
    - The second effect may dominate the first, for example when θ takes a very large value while n take a very small value.

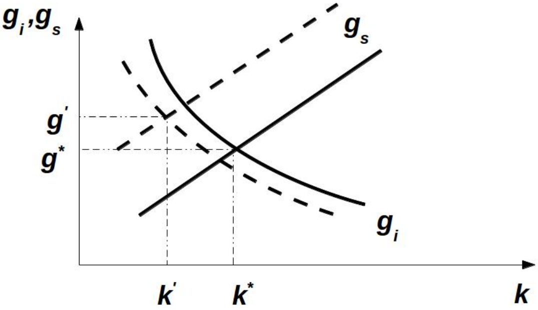
If $\theta >> n$ then with $x_i \uparrow \Longrightarrow p \downarrow \Longrightarrow X_s \uparrow$ and X_i may $\downarrow$




p
$d_i(p;X_s)$
$d_s(p;X_i)$
X_s
0
X_i

$x_s \uparrow \Longrightarrow p \downarrow \Longrightarrow k^* \downarrow$

If in addition $\theta >> n$ then it is likely that $g^* \uparrow$



Conclusion

Coming back to the Indian economy

- Between 1994-95 to 2004-05, private final consumption expenditure accounted for 39 percent of service GDP. (Rakshit 2007)
- In the same period private final consumption of services grew at an average rate 8.64 percent, which is greater than the average growth rate of both overall and service GDP. (Rakshit 2007)
- Between 1991 and 2008 half of services growth is contributed by growth in private final consumption and other half by exports and intermediate demand from industry, with exports growth accounting for increasingly greater shares. (Eichengreen and Gupta 2011)