Testing Stolper-Samuelson Theorem in the Indian Context

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ABSTRACT

The purpose of this paper is to examine the Stolper-Samuelson Theorem in the context of India which is one of the central results of Heckscher-Ohlin theory. This theorem provides a definite way of analysing the effect of change in the prices of goods on the prices of factors of production due to tariffs. Since the theorem has been couched in terms of increasing tariffs however, the paper attempts to look for obverse of this theorem by emphasising on a certain issue. Since tariffs are declining, then it is argued that import-substituting industries would suffer at the cost of export-promoting industries. The study deals with three variables- Factor Price Ratio (FPR), Terms of Trade (TOT) and Wholesale Price Index (WPI) covering period 1992-2010. Year has been taken as the exogenous variable. The methodology has been developed for the construction of semi-log and multiple regression models to analyse the impact of Terms of Trade on Factor Price Ratio. The paper shows that Stolper-Samuelson Theorem does not hold good in the case of India and it is the Wholesale Price Index which actually shows a favourable impact on FPR.

Keywords: Import-Substitution, Stolper-Samuelson theorem, Factor-Price Equalization Theorem, Terms of Trade, Factor Price Ratio, Wholesale Price Index.

1.0 Introduction

International trade theory has shaped the economic policy of many nations for the past 50 years and is the driver behind the formation of World Trade Organization and regional trade blocs such as the European Union and North American Free Trade Agreement (NAFTA). The 1990s, in particular, saw a global move towards freer trade. It is important to understand, therefore, what trade theories are and why they have been successful in shaping the economic policy of many nations and the competitive environment that governs international business.

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There are number of theories that explain why it is beneficial for a country to engage in international trade. These theories explain the pattern of international trade observed in the economy. Although no single theory may explain the apparent pattern of international trade, taken together, the theory of Comparative Advantage, the Heckscher-Ohlin theory, the Product life-cycle theory etc do suggest which factors are important. The Stolper-Samuelson theorem is one of the central results of Heckscher-Ohlin theory, which is one of the principle theories of international trade. With regard to the pattern of trade, it is considered essential to explain the pattern of exports and imports of goods and services between countries.

While Heckscher-Ohlin theorem is concerned with the pattern of trade, Stolper-Samuelson theorem investigate the effect of the imposition of a tariff on the domestic prices of factors that is on the distribution of income. In addition to Stolper-Samuelson theorem, there is another theorem called Factor-Price Equalization Theorem which deals with the optimization of world trade. The Stolper-Samuelson theorem is closely linked to the Factor-Price Equalization theorem, which states that, regardless of international factor mobility, factor prices will tend to equalize across countries that do not differ in technology. These theories will analyse the relationship between commodity prices and factor prices by considering the terms of trade effects.

2.0 Theoretical Framework

There are a number of theories which explain the pattern of specialisation in international trade. These are described below.

**Comparative Advantage theory:** In his book *Principles of Political Economy and Taxation*, David Ricardo (1817) took Adam Smith’s theory one step further by exploring what might happen when one country has an absolute advantage in the production of all goods. According to him, the principle was that trade could be beneficial even if one country was more efficient in the production of both commodities. The basic premise of this theory is that potential world production is greater with unrestricted free trade than it is with restricted trade. Comparative advantage arises because of differences in labour productivity.

**Heckscher-Ohlin theory:** Swedish economists Eli Heckscher (1919) and Bertil Ohlin (1933) put forward a different explanation of comparative advantage. They argued that comparative advantage arises from differences in national factor endowments. The Heckscher-Ohlin theory predicts that countries will export those goods that make intensive use of factors that are locally abundant, while importing goods that make intensive use of factors that are locally scarce. This theory attempts to explain the pattern
of international trade by arguing that free trade is beneficial. Unlike Ricardian theory, this theory argues that pattern of international trade is determined by differences in factor endowments, rather than differences in productivity.

**Stolper-Samuelson theorem:** This theorem was derived in 1941 within the framework of the Heckscher-Ohlin model by Wolfgang Stolper and Paul Samuelson. This theorem has some restrictive assumptions.

- The economy consists of only two sectors - Export sector and Import sector.
- Two factors are used - labour and capital.
- The factors are fully mobile between sectors.
- There are constant returns to scale.

This theorem basically tells the relationship between commodity prices and factor prices assuming that the market is perfectly competitive. Finally, this theorem has also been used to explain the political economy of responses to changes in country’s exposure to trade.

There are two propositions in this theorem:

**Proposition 1:** Commodity prices influence factor prices.

**Proposition 2:** A rise in the commodity price would raise the return of the intensively used factor more than proportionally.

**Factor Price Equalization theorem:** This theorem is closely linked to Stolper-Samuelson theorem which predicts that international trade will equalize factor prices in the trading countries even though the factors are immobile across countries. FPE theorem presupposes that all markets are perfectly competitive which implies that profits are zero in every industry in the long run. Hence, per unit profits are also zero.

### 2.1 Terms of Trade

A country’s terms of trade measures a country’s export prices in relation to its import prices, is expressed as:

\[
\text{Index of export prices} \times 100
\]

\[
\text{Index of import prices}
\]

A rise in the prices of imported goods, with the prices of exports remaining unchanged indicates a fall in the terms of trade because it will now require more exports to import the same quantity of goods.
A rise in the prices of exported goods, with the prices of imports unchanged indicates a rise in the terms of trade because it will now take fewer exports to purchase the same quantity of imports.

2.2 Import Substitution

From the beginning of the planning era, India adopted an inward-looking development strategy, also known as Import substitution Strategy of industrial development. The present study focuses on testing the Stolper-Samuelson Theorem in the Indian Context which tells the relationship between commodity prices and factor prices. Tariffs are the main cause for bringing about changes in the factors of production. Before relaxation of tariffs, the development strategy was based on Capital Goods Industry, particularly machine-making industry which produced machines. The core capital goods industry was not bulk import-substitution industry. There were bulk of import-substituting industries that were labour-intensive. India was known for broad-based industrialisation and this lead to other large ancillary industries, intermediate industries etc. Apart from capital goods industry, import-substitution was also there in consumer goods industry. Although the strategy of development was promoting capital goods industry, it is expected that import-substituting industry was labour-intensive.

The import of capital goods in the absence of domestic production would have been capital-intensive because such imports were from developed countries whose factor endowments were capital-intensive. For a whole decade after Independence, the capital goods industry had not developed and it was still importing capital goods. The import-substituting industry in India was, therefore, labour-intensive because it was competing with imports but had adopted appropriate technologies that were labour-intensive. Hence, broad-based industrialisation was not capital-intensive because India was still specialising with labour-intensive techniques.

3.0 Literature Review

Chipman (1969) reviewed Factor Price Equalization theorem and Stolper-Samuelson (SS) theorem in order to bring out the difference between these theorems. The FPE theorem predicts that there is one-to-one correspondence between commodity prices and factor prices. On the other hand, the SS theorem predicts that there is a special kind of relationship between commodity prices and factor prices.

There are two versions of SS theorem:

Local version: given an equilibrium condition, an increase in the price of a commodity will bring about more than proportionate increase in the price of intensive factor.
Global version: given in advance the association between goods and factors, starting from an equilibrium point, a change in any commodity price will lead to more than proportionate increase in the already specified factor.

If a theorem has more than two commodities and two factors, then it no longer holds that a more proportionate increase in one factor price will lead to a fall in remaining factor prices. This case is considered Weak form of SS theorem. Hence, the SS theorem (strong and weak form) is true locally for $n=2$ and globally whenever reversal of factor intensity is ruled out. However, it is not true for $n>2$ even when it guarantees full factor price equalization.

Khan (1970) reviewed two of the most important propositions in the current theory of International Trade- Heckscher-Ohlin theorem and Stolper- Samuelson theorem.

Heckscher-Ohlin theorem is explained in two different ways:
- In terms of factor prices or
- In terms of physical factor supplies.

The first definition was adopted by Bertil Ohlin and the second definition was suggested by Jones. The first definition which is in terms of factors prices was a mere tautology because the relationship is two way and does not explain anything. Heckscher-Ohlin theory basically revolved around itself i.e. the country is relatively better endowed in that factor which is relatively cheaper in that country. And if that country exports capital-intensive commodity, then due to the Samuelson relationship between factor and commodity price ratio, capital must be cheaper and is better endowed in capital. Thus, factor endowments of the country are deduced from its trade pattern.

On the other hand, Jones defined factor endowments according to physical supplies that the country is relatively better endowed with capital in which capital is relatively abundant in the physical sense, irrespective of its price. Heckscher-Ohlin theorem becomes meaningful where the pattern of trade cannot be deduced directly from factor endowments and vice-versa. Demand conditions should be such that the commodity should be relatively cheaper and thus be exported.

Stolper-Samuelson theorem proved that free trade will reduce the reward of the scarce factor whereas imposition of tariff has the opposite effect. The effect of tariff on factor prices will depend upon the interaction of the direct effect and the terms of trade effect in the absence of perfectly elastic curve of other country. The direct effect raises the domestic price of imports whereas terms of trade effect reduce the domestic price of imports.

However, Stolper-Samuelson theory gets reversed when there will be an improvement in the reward of abundant factor. This happens when foreign demand for a country’s
export is inelastic, so the terms of trade will be greater than its direct effect, then the domestic price of imports will actually fall. Hence, there will be a movement of factors from import industry to export industry.

Similarly, government has shown the effect of tariff on factor rewards. When government spends all tariff proceeds on export commodity, this will lead to an improvement in the reward of the abundant factor. Samuelson theorem is thus reversed. When government spends all tariff proceeds on imports, the reward of the scarce factor will improve. Finally, when government spends tariff proceeds partly on exports and partly on imports, then also reward of the abundant factor will improve. Hence, a country can improve the reward of the scarce factor by imposing tariff if the demand for its imports is accompanied by fiscal measures.

Yeh (1994) explained Stolper-Samuelson theorem in the presence of domestic distortions. Domestic distortion arises when there is a divergence between market prices and opportunity costs. The purpose of this article is to show that in the presence of domestic distortions, the factor used intensively in the expanding industry could be worse off even though the real return to the factors in both the industries is increased. On the other hand, the factor used intensively in the contracting industry could be better off even though the real return to the factor in both the industries is decreased. In this article, there are two factors Labour and Capital and two commodities X and Y. X is labour intensive and Y is capital intensive. All production functions are homogenous of degree one. Domestic distortion is caused by: (1) Government spending, and (2) Market imperfections.

In the case of government spending, the government gives subsidy to producers in industry Y. Perfect competition prevails in both input and output markets. After trade takes place, labour intensive industry expands and it is shown that labour class would be worse off and similarly capital intensive industry would be better off. Where domestic distortion is due to market imperfections, in that case it is assumed that labour intensive industry is under monopoly but perfect competition still prevails in the capital intensive industry Y and input markets. After trade takes place, the real return to factor (labour) in both industries is decreased. But it is shown that labour class would be better off even though the real returns to the labour class are both decreased after this industry contracts. Hence, Stolper-Samuelson is proved even in the presence of domestic distortions.

Cheng, Sachs and Yang (2004) extended the Heckscher-Ohlin theory which considers all trade patterns including autarky and in which both commodity and factor prices are endogenously determined. Four core trade theorems were examined- HO theorem, factor price equalisation theorem (FPE), the Stolper-Samuelson theorem (SS) and Rybczynski theorem (RY). The main findings of this article are: Transaction costs
play an important role in determining the equilibrium trade structure. If trading efficiencies are low in either trading country, the equilibrium will occur in autarky. But as trading efficiencies are improved, international trade emerges and this will lead to increase the level of international division of labour. The HO theorem holds when prices of goods and factors are endogenously determined and all trade patterns are considered but it needs to be refined to account for transaction costs and differences in technology. The FPE theorem does not hold outside the diversification cone (parameter subset i.e. factor endowments within which both countries produce both goods in equilibrium). This theorem holds only if there is no comparative productivity difference between the trading countries and zero transaction cost. The SS theorem holds within the diversification cone if the changes in prices are due to a change in taste or endowment but may not hold if changes in price are due to changes in transaction cost parameters. This theorem does not hold outside the diversification cone. The RY theorem does not always hold within an equilibrium structure as equilibrium changes from one structure to another.

Hence, the results basically contrast between traditional and extended HO theorem. Traditional analysis assumes exogenous prices of goods and factors and tries to investigate the effect of change in other variables in response to change in prices. Moreover, traditional analysis is confined with one structure only and ignores other structures of general equilibrium. Thus, the results may be misleading. Further research is required to study the effect of international trade. Tariffs need to be introduced to analyse the welfare implications of trade barriers.

Kowalcyk and Riezman (2009) presented estimates from a model of general equilibrium in the world of perfect competition. Terms of trade are contentious since terms of trade effect across all nations are zero. Presenting the estimates moving from non cooperative tariff equilibrium to global free trade in the world of perfect competition implies large terms of trade effects. For countries whose terms of trade improve, they may constitute more than half of their gains from free trade. For countries whose real income falls from free trade, the terms-of-trade effects are so large that they dominate any positive contribution from the consumption effects. On the other hand, in the monopoly trade model, the main sources are efficiency gains and distortions due to mark-up pricing, hence terms of trade effects represent smaller share of welfare gains so as to eliminate all distortions as compared to competitive model where underlying sources of gains are only efficiency gains. In this article treating the Nash equilibrium as the benchmark, the authors are interested to know how large the terms of trade effects are relative to change in real income from a move to global free trade.
A general equilibrium model is framed where three endowment economies traded three goods. Initially it is assumed that countries individually set non-cooperative optimal tariffs, then consider alternatives whether to join Free Trade Area (FTA) or Custom Union (CU) or move to global free trade. For instance: taking country 1 the largest, then it is found that large country would forego terms of trade gains from applying its optimal tariff and would require a transfer for free trade. Small countries experience terms of improvement but if transfers were implemented, then they would surrender half of their gains from free trade as payments to the large country. Hence, it is useful to extend this paper by incorporating substitution effects in production thereby making terms of trade and international side payments, larger or smaller relative to any total income change. Additional substitution might raise the volume of trade in non-cooperative Nash equilibrium and thus, terms of trade would be larger as compared to free trade. An investigation should be done whether the incorporation of transportation cost raise or lower the importance of international side payments.

From the above, it can be said that the validity of Heckscher-Ohlin model has been questioned since the classical Leontief Paradox. As for the Stolper-Samuelson Theorem itself, Davis and Mishra (2006) pointed that “it is time to declare Stolper-Samuelson dead”. They argue that the Stolper-Samuelson Theorem is “dead” because following trade liberalisation in some developing countries (particularly in Latin America), wage inequality rose and, under the assumption that these countries are labour-abundant, the SS Theorem predicts, that wage inequality should have fallen. Thus, an alternative view would be to recognise that the SS Theorem predicts a relationship between output prices and relative wages.

4.0 Rationale and Objectives of the Study

Before WTO, individual countries were liberalising but there was no global forum which favoured the reduction in tariffs. However, the global environment and domestic environment were constantly evolving. With the creation of WTO, liberalisation and globalisation have emerged in a big way and the global environment, amongst other things, now affects factor prices, interest rates etc.

The basic premise of Stolper-Samuelson Theorem is that the price of imports ordinarily rises due to protectionism. The consequences of this price rise are:
(a) Import-Substitution industries get protection.
(b) The intensive factor in the economy stands to gain because of which Factor Price Ratio is affected.
The presumption is that import price would rise is based on the notion that tariffs increase over a period of time. After liberalisation and globalisation, the global business environment across countries has been altered. The consequence is that tariffs have been constantly falling. Therefore, the objective of this paper is to look for obverse of this theorem. It is argued that since tariffs are constantly reducing then import-substituting industries would be suffering at the cost of export industries.

In this context, three issues arise:
(i) Tariffs are going down.
(ii) Import-substituting industries suffer while export-competing industries gain.
(iii) The change in Terms of Trade influences the Factor Price Ratio.

Thus, the role tariffs play in international trade has declined in modern times. Since 1990s, many developed countries have reduced tariffs and trade barriers and in 1995, Globalisation got a boost in the form of WTO. These changes in the global environment have some implications for trade theory. The implication of trading environment and trade policies has been captured in trade theories. Hence, our interest is in revisiting these theories in the light of new trading environment and trade policies that have followed liberalisation and globalisation.

4.1 Objectives and hypotheses
While the Stolper-Samuelson Theorem has been couched in terms of increasing tariffs, the attempt in this paper is to test the obverse of this theorem because in the context of globalisation, tariffs have in fact declined. Hence, the objectives of this study are:
- To study the trends in Terms of Trade, Wholesale Price Index and Factor Price Ratio.
- To measure the growth rate of variables.
- To measure the determinants of Factor Price Ratio.

To test and verify Stolper-Samuelson Theorem, the following hypothesis have been tested.

**Primary Hypothesis**
Null Hypothesis (Ho): Commodity prices do not influence factor prices.
Alternate Hypothesis (H₁): Commodity prices influence factor prices.

**Secondary Hypothesis**
Null Hypothesis (Ho): Commodity prices influence factor prices proportionally.
Alternate Hypothesis (H₂): Commodity prices influence factor prices more than proportionally.
5.0 Data and Methodology

The purpose of this paper is to test Stolper-Samuelson Theorem in the Indian Context which is one of the principal theories of international trade. It provides a definite answer to a central question: What is the effect of changes in the prices of goods, caused for example by changes in tariffs, on the prices of factors of production? This theorem tells the relationship between commodity prices and factor prices.

5.1 Data collection

The original data set used in this paper is composed of different variables:

- **Factor Price Ratio (FPR):** It is defined as a ratio of Wages to Rental Price of Capital.
  \[
  FPR = \frac{Wages}{Rental \ Price \ Of \ Capital} \\
  FPR = \frac{w}{r}
  \]
  Per capita Net National Income is taken as proxy for wages and Interest Rate on Central Government Securities is taken as proxy for rental price of capital.

- **Terms of Trade (TOT):** It is defined as a ratio of Unit Value of Exports to Unit Value of Imports.
  \[
  TOT = \frac{Unit \ Value \ Of \ Exports}{Unit \ Value \ Of \ Imports}
  \]
  \[
  TOT = \frac{UVX}{UVM}
  \]

- **Wholesale Price Index (WPI):** It is considered as a control variable.

These variables are observed annually over the period 1992-2010. The data is collected from secondary and tertiary sources and consist of 19 data points. The variable FPR is considered as a dependent variable whereas variables such as TOT and WPI are considered independent variables. Year is an exogenous variable which is also considered as an independent variable. The data is presented in Table 1.

5.2 Methodology

To test the Stolper-Samuelson Theorem in the Indian context and consider the effect of changes in the commodity prices on the prices of factors of production, we have used a special framework, with mainly two factors labour and capital. Tariffs are the main cause for bringing change in the factor prices.

**Derivation of Stolper-Samuelson Theorem**

Considering a two good economy that produces only wheat and cloth, with labour and land, being the only factors of production, wheat a land-intensive industry and cloth a labour-intensive one, and assuming that price of each product equals its marginal cost, the theorem can be derived.
Table 1: Data Set of Variables

<table>
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<tr>
<th>Year</th>
<th>Per Capita Net National Income (1)</th>
<th>Interest Rate (2)</th>
<th>Factor Price Ratio</th>
<th>Export Value index (3)</th>
<th>Import Value Index (4)</th>
<th>Terms of Trade</th>
<th>Wholesale Price Index (5)</th>
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<td>104.82</td>
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<td>72.85</td>
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<td>6396.82</td>
<td>1128.14</td>
<td>1392.72</td>
<td>81.00</td>
<td>280.26</td>
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</table>


The price of cloth should be:

\[ P(C) = ar + bw \] ......................... (1)

where \( P(C) \) stands for the price of cloth, \( r \) stands for rent paid to land owners, \( w \) for wage levels and \( a \) and \( b \) for the respective amount of land and labour used.

Similarly, the price of wheat should be:

\[ P(W) = cr + dw \] ......................... (2)

where \( P(W) \) stands for the price of wheat, \( r \) and \( w \) for rent and wages, and \( c \) and \( d \) for the respective amount of land and labour used.
If, then, cloth experiences a rise in its price, at least one of its factors must also become more expensive, for equation 1 to hold true, such that the relative amounts of labour and land are not affected by changing prices. It can be assumed that it would be labour, the intensively used factor in the production of cloth that would rise. When wages rise, rent must fall, in order for equation 2 to hold true. But a fall in rent also affects equation 1. For it to still hold true, then, the rise in wages must be more than proportional to the rise in cloth prices.

Hence, a rise in the price of the product, then, will more than proportionally raise the return to the most intensively used factor, and a fall on the return to the less intensively used factor.

The methodology of this paper consists of three steps:
(i) To analyse the trends through Linear Trend Model.
(ii) To measure the growth rate of variables through Semi-log Model.
(iii) To measure the determinants of FPR through Multiple Regression.

**Linear Trend Model**
The simplest functional form is the linear functional form where the relationship between the dependent and independent variable is graphically represented by a straight line (Gujrati, 2012). It is represented as follows:

$$Y_t = \alpha + \beta t + \mu_t$$

The above equation is linear in variables as well as linear in parameters. In this model, the time variable $t$ is known as the trend variable. If the slope coefficient is positive, there is upward trend in $Y$, whereas if it is negative, there is downward trend in $Y$.

**Semi-log Model**
A semi-log function is the best for determining growth rates. This function is represented as follows:

$$Y = f(time)$$

$$Y_t = Y_0 (1 + r)^t$$

Where $r$ is the compound rate of growth of $Y$. Taking the natural logarithm, the equation becomes:

$$\ln Y_t = \ln Y_0 + t \ln(1 + r)$$

Now letting

$$\alpha = \ln Y_0$$
$$\beta = \ln(1 + r)$$

Adding the disturbance term, we obtain:

$$\ln Y_t = \alpha + \beta_1 + \mu_t$$
In the above equation, regressand is the logarithm of Y and the regressor is “time”. In this model, the slope coefficient measures the constant proportional or relative change in Y for a given absolute change in the value of regressor, that is,

\[ \beta = \frac{\text{relative change in regressand}}{\text{absolute change in regressor}} \]

Using differential calculus one can show that –

\[ \beta_1 = d\left(\frac{\ln Y}{dX}\right) = (1/Y)\left(\frac{dY}{dX}\right) = \left(\frac{dY}{Y}\right)/dX \]

For small changes in X and Y, this relation may be approximated by-

\[ \frac{(Y_t - Y_{t-1})/Y_{t-1}}{(X_t - X_{t-1})} \]

Thus, \( \beta \) is a measure of the relative change of Y over time and hence, it is the exponential growth rate.

The coefficient of the trend variable in this model, \( \beta_1 \), gives the instantaneous (at a point in time) rate of growth and not the compound (over the period of time) rate of growth. '

\( r \) measures the annual compound growth rate that is

\[ \beta_1 = \ln(1 + r) \]
\[ \text{Antilog } \beta_1 = (1 + r) \]
\[ r = \text{Antilog } \beta_1 - 1 \]

In our study, Semi-log model is used to measure the growth rate of variables which includes FPR, TOT and WPI.

**Determinants of FPR**

To study the complex phenomena like SS theorem, it is not sufficient to look at commodity prices. It is necessary to embed the commodity prices into the general equation which takes account of exogenous factors and the distributive effect of inflation. We use multiple regression to identify the determinants of FPR.

The estimating equation is as follows:

\[ Y_t = \alpha + \beta_1 T + \beta_2 TOT + \beta_3 WPI + \mu_t \]

where \( T = \text{Year}, \) TOT = \text{Terms of Trade} and WPI = \text{Wholesale Price Index}

The Primary hypothesis is tested by looking at the coefficient of Terms of Trade and t-statistic whether Terms of Trade (TOT) influence Factor Price Ratio (FPR) or not. The Secondary hypothesis is tested by applying t-test whether Terms of Trade influence Factor Price Ratio more than proportionally or not.
6.0 Results and Analysis

6.1 Trend Analysis

*Export Value Index and Import Value Index*

Export value index and Import value index being the commodity prices are shown in Figure 1. The figure shows a fluctuating trend in which import prices (import value index) are rising faster than the export prices (export value index). Over the past 18 years, export value and import value reached the maximum value of 1128.14 and 1392.72 in 2010 respectively. With a rise in import price, India’s import-competiting industry is getting implicit protection although it is producing capital goods. It may be using technologies of production that are labour-intensive. The implication is that despite fall in tariffs, import price is rising which implies that Terms of Trade are falling. Hence, this will encourage import-competiting sector to expand at the expense of the export-promoting sector.

**Figure 1: Trend Analysis of Value Index**

While the export prices follow the same pattern, it is growing relatively slower than imports. This would discourage export-promoting industries. If it is assumed that export-
promoting industries have become capital-intensive because the nature of exports has changed, then in a relative sense, India’s export would have become more capital-intensive.

Hence, the operation of SS theorem comes with following features: (i) Import prices rise, and (ii) Export prices grow relatively slower than the import prices.

**Per Capita Income and Interest rate**

Per Capita Income and interest rate are taken as proxies for wage rates and rental price of capital respectively. As per capita income’s scale is large, hence it is taken in log terms so that both per capita income and interest rate are comparable. The trend analysis is presented in Table 2. Figure 2 show that Per Capita Income which represents wages shows a rising trend. On the other hand, Interest rate which represents rental capital shows a declining trend.

![Figure 2: Trend Analysis of Factor Prices](image_url)

Though India was labour-abundant, the long-term strategy of development for the production of capital goods might expect techniques of production that is \((K/L)\) to be relatively low. Therefore, the combined expansion of the relatively labour-intensive sector and contraction of the relatively capital-intensive sector raises the aggregate
demand for labour to capital, and so puts upward pressure on the wage. Thus, a higher wage must imply fall in the return to capital which in turn raises the Factor Price Ratio.

**Wholesale Price Index**

This is assumed to be the control variable because of expected differential effects of inflation on different economic classes. If it so happens that there is a differential effect then, the factor price ratio would get disturbed. As shown in Figure 3, over the past 18 years, this indicator reached a maximum value of 280.26 in 2010 and minimum value of 100 in 1992; hence there is a rising trend in Wholesale Price Index.

**Figure 3: Trend Analysis of Wholesale Price Index (WPI)**

![Wholesale Price Index Trend Analysis](image)

It can be seen from the above analysis that despite decline in the tariffs, the import prices has been rising faster than the export prices. However, the trend is showing the contradictory result against the argument specified that is since tariffs are constantly reducing; import-substituting industries would suffer at the cost of export-promoting industries. But it is shown that with reduction in tariffs, import-substituting industries are getting implicit protection. Therefore, while there has been an impact of globalisation on reducing tariffs, there may be other factors responsible for increasing the import prices. For example, petroleum prices, prices of intermediates (chemicals, minerals, fertilizers) and food may have grown so much that even after netting for reduction in tariffs, the import price has risen. On the other hand, per capita net national income which represents wages shows a rising trend whereas interest rate which represents rental price
of capital shows a declining trend. Thus, higher wages imply fall in rental price of capital.

6.2 Semi-log Model
Let us suppose,

\[ FPR = f(\text{time}) \]

\[ FPR = e^{a+bt} \]

Taking log both sides and adding the error term, the following estimating equation is:

\[ \ln FPR = \alpha + \beta t + \mu_t \]

After applying regression, the actual estimated equation comes out to be:

\[ \ln FPR = -282.74 + 0.145t \]

(p-Value) (1.44E-15) (9.29E-16)

Over the period 1992-2010, factor price ratio increased at the yearly rate of 14.5%. This is the instantaneous growth rate. On the other hand, annual compound rate of growth is 15.61% which is slightly higher than the instantaneous growth rate. Hence, FPR has grown at 15.61% over the past 18 years (Figure 4).

Figure 4: Growth rate of Factor Price Ratio

Then taking,

\[ TOT = f(\text{time}) \]

\[ TOT = e^{at+bt} \]
Taking log both sides and adding the error term, the estimating equation is:

$$\ln TOT = \alpha + \beta t + \mu_t$$

After applying regression, the actual estimated equation comes out to be:

$$\ln TOT = 45.336 - 0.0204 t$$

p-Value (7.81E-07) (3.08E-06)

It is pertinent to note that Terms of Trade declined at the yearly rate of 2.04%. However, they are also declining at 2.02% over the past 18 years (Figure 5).

**Figure 5: Growth Rate of Terms of Trade**

Then taking,

$$\text{WPI} = \text{f} \text{ (time)}$$

$$\text{WPI} = e^{\alpha \t+ \beta t}$$

Taking log both sides and adding the error term, the following estimating equation is:

$$\ln WPI = \alpha + \beta t + \mu_t$$

After applying regression, the actual estimating equation coming out to be:

$$\ln WPI = -100.552 + 0.0528 t$$

p-Value (5.2E-19) (2.24E-19)

Over the period 1992-2010, WPI increased at the yearly rate of 5.28% which is the instantaneous growth rate. On the other hand, the annual compound rate of growth on WPI is 5.42%. This implies that WPI is growing at a very good pace (Figure 6).
By analysing the growth rates of FPR, TOT and WPI, it is found that a fall in TOT is definite because it has a negative sign and is statistically significant. A falling trend in TOT is benefitting import-substituting industry as import prices are rising faster than the export prices despite a reduction in tariffs. FPR shows a rising trend shown in figure 4 and is statistically significant. Hence, a rise in FPR is definite.

*This gives the preliminary confirmation of the SS Theorem.* But the impact of TOT on FPR is not definite because implicit protection of import-substituting industries has not resulted an increase in the factor price of the intensive factor. Hence, this is the weak evidence of SS Theorem because TOT is indirectly influencing FPR.

6.3 Determinants of FPR

The determinants of FPR have been identified through multiple regression. The estimating equation is:

\[ Y_t = \alpha + \beta_1 T + \beta_2 TOT + \beta_3 WPI + \mu_t \]

After applying regression, the actual estimated equation comes out to be:

\[
FPR = 415572.49 - 211.175T - 4.83467TOT + 55.243WPI
\]

p-Value (0.16100) (0.158325) (0.78331) (0.003316)

The results are shown in Table 2.
### Table 2: Results of Multiple Regression

#### Summary Output

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#### ANOVA

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<th>t Stat (TOT=1)</th>
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#### Residual Output

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<th>FPR</th>
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</tbody>
</table>
The effect of FPR is shown in Figure 7.

\[ Y = \hat{\gamma} + \mu_t \]

\[ FPR = \hat{\alpha} + \hat{\beta}_1 T + \hat{\beta}_2 TOT + \hat{\beta}_3 WPI \]

\[ FPR = 415572.49 - 211.175 T - 4.8346 TOT + 55.243 WPI \]

It can be seen from Figure 7 that the estimation is fairly good.

Figure 7: Estimating the Factor Price Ratio

From the summary output shown above, we now analyse the determinants of FPR one by one to see whether they are influencing FPR or not.

**Year:** The coefficient of ‘Year’ is large and negative, that is -211.175. This is statistically insignificant which means that there is a very large factor which is pulling wages. General factors such as training and development of workers, organisational efficiency and technical efficiency show that capital productivity is growing faster than labour productivity. Hence, these factors are actually depressing wages which signifies a negative impact on FPR.

**Terms of Trade:** The coefficient of TOT is negative and statistically insignificant. The negative sign is confirming the SS Theorem because it precisely shows that a falling trend is benefitting import-substitution industries. However, the protection does not result an increase in the factor price of the intensive factor. Hence, TOT is not causing a rise in FPR.
Wholesale Price Index: The effect of ‘Year’ and ‘Terms of Trade’ is not evident on Stolper-Samuelson Theorem. That is why WPI is referred because a part of wage inflation is on account of general inflation which has a positive sign and is statistically significant. WPI is actually compounding the effect of Time and TOT which indicates that the distributive effect of inflation is felt more on wages rather than on rental price of capital.

Therefore, it would mean that the effect of WPI is outweighing the effect of ‘Time’ and Terms of trade. A gain in FPR is due to an increase in the organised labour over the 18 year period which stands to gain in nominal wages due to inflation-linked wage rates.

6.4 Testing of Primary Hypotheses

The primary hypotheses is tested by looking at the coefficient of Terms of Trade and t-statistic.

The hypotheses is stated as follows:
Null Hypothesis($H_0$): $\beta_2 = 0$
Alternate Hypothesis($H_1$): $\beta_2 \neq 0$

The hypothesis is two-tailed which states whether Terms of Trade influence Factor Price Ratio or not.

Null Hypothesis states that Terms of Trade do not influence Factor Price Ratio. On the other hand, Alternate Hypothesis states that Terms of Trade influence Factor Price Ratio. The t-statistic is represented as:

$$ t = \frac{estimator - parameter}{estimated \ standard \ error \ of \ estimator} $$

$$ t_{(\alpha,n-k)} = \frac{\hat{\beta} - \beta_{H_0}}{s.e.(\hat{\beta})} $$

Test Criterion: If Cal $t_{(\alpha,n-k)} > Tab t_{(\alpha,n-k)}$, then reject null hypothesis.

The calculated t value is:

$$ t = \frac{-4.834604856 - 0}{17.26725196} $$

$$ t = -0.27998693 $$

By applying multiple regression, the calculated t-statistic comes out to be -0.27998693. The tabulated t value at 5% significance level with 15 degrees of freedom is 2.131.
Here, the tabulated t value exceeds the calculated t value, thus null hypothesis cannot be rejected. This implies that the Terms of Trade do not influence Factor Price Ratio.

6.5 Testing of Secondary Hypothesis

The Secondary hypothesis is stated as follows:
Null hypothesis ($H_0$): $\beta_2 = 1$
Alternate hypothesis ($H_1$): $\beta_2 > 1$

The hypothesis is one-sided as we want to see if Terms of Trade influence Factor Price Ratio more than proportionally or not. The Null hypothesis states that a rise in the import price raises the return of the intensively used factor that is wages proportionally. On the other hand, alternate hypothesis states that a rise in the import price raises the return of the intensively used factor that is wages more than proportionally.

The t-statistic is represented as:

\[
t = \frac{\text{estimator} - \text{parameter}}{\text{estimated standard error of estimator}}
\]

\[
t_{(\alpha, n-k)} = \frac{\hat{\beta} - \beta_{H_0}}{s.e. (\hat{\beta})}
\]

**Test Criterion:** If $\text{Cal } t_{(\alpha, n-k)} > \text{Tab } t_{(\alpha, n-k)}$, then reject null hypothesis.

The computed t value is:

\[
t = -\frac{4.834604856 - 1}{17.26725196} = -0.337900024
\]

Since the computed t value (-0.337900024) does not exceed the critical t value (1.753) at 5% level of significance with 15 degrees of freedom, therefore, we would not reject the null hypothesis.

*This shows that TOT influence FPR proportionally that is a rise in the price of imports would raise the return of the intensively used factor that is wages equally or proportionally.*
As our concern was to examine the effect of decrease in tariffs due to liberalisation and globalisation, on analysing the *Multiple Regression Model*, it becomes clear that Terms of Trade effect is a net effect adjusted for decline in tariffs which implies that import price is rising despite decline in tariffs. It could be perhaps on account of certain imports like petroleum, crude oil etc. It is also observed that falling TOT results in implicit protection for import-substituting industries. However, the impact of protection is not definite on the FPR. It is WPI which shows an impact on FPR. A rising trend in WPI reflects a distributive effect of inflation which is favouring labour class.

_Hence, the results obtained from the hypothesis show that the propositions of the SS Theorem are not found to hold good. SS Theorem effect is not directly seen. Thus, there are certain anomalies observed with respect to SS Theorem:_

- It is expected when tariffs fall, import-substituting industries lose. However, actually when tariffs are falling, even then import-substituting industries gain because of implicit protection.
- SS Theorem didn’t take account of the distributive effect of inflation which actually benefits the import-substituting industries, in other words, the abundant factor.

### 7.0 Conclusion

The Stopler Samuelson Theorem provides a definite answer to a central question in applied economics: what is the effect of changes in the prices of goods, caused for example by changes in tariffs, on the prices of factors of production? This theorem is linked to Factor-Price Equalization Theorem (FPE) which states that regardless of international factor mobility, factor prices will tend to equalize across countries that do not differ in technology. These theories analyse the relationship between commodity prices and factor prices. _Stolper-Samuelson Theorem_ was derived in 1941 to investigate the effect of the imposition of tariff on the domestic prices of factors. Tariffs are the main cause for bringing change in the factors of production. According to Stolper-Samuelson (1941), when protectionism is on the rise, import prices increase and import-competing industries benefit such that demand for such industries increases. This favours the factors of production employed in that industry. Hence, import-substituting industries get protection and the intensive factor stands to gain. However, after liberalisation and globalization, the global business environment has been altered. The consequence is that tariffs have been constantly falling. Therefore, the purpose is to test the obverse of this theorem.
The objective of this paper is to test Stolper-Samuelson Theorem in the context of India. Using time-series data over the period 1992-2010, we test and verify SS theorem, using linear trend analysis, semi-log model and multiple regression analysis. The linear trend shows that import prices are rising faster than the export prices which results in the implicit protection for import-competing industry. A rising trend in FPR shows that wage is the intensive factor which stands to gain. The semi-log model gives only the preliminary confirmation of SS Theorem because the impact of TOT on FPR is not definite as protection does not result an increase in the price of the intensive factor. Hence, this is the weak evidence of Stolper-Samuelson Theorem. The multiple regression Model is used to identify the determinants of FPR. By analysing the determinants, it is found that the effect of WPI is outweighing the effect of Time and TOT which shows that the distributive effect of inflation is felt more on wages rather than on rental price of capital. The testing of primary hypotheses shows that the SS Theorem doesn’t hold good. Despite this, the main contribution of the paper is not to ignore the distributive effect of inflation which by itself is altering the FPR in favour of import-substitution industries. It has been noticed that Heckscher-Ohlin theory is inadequate as an explanation for historical and modern trade patterns. Therefore, SS Theorem came up. But the validity of SS Theorem has also been questioned as the theorem is not found to hold good. This may be because of non-availability of data on wage rates and rental price of capital.

While the logic of SS Theorem is found to be true, on analysing the multiple regression model, it is found that the effect is not significant. This shows a criticism of SS Theorem that one major factor that is WPI is not included in the analysis. Hence, there is a need to have a broader framework for understanding the relationship between commodity prices and factor prices. Thus, only the rider of the SS Theorem is proved. It is found that the import prices are unnecessarily high. Therefore, it would help to control the prices of capital goods and intermediates so that Terms of Trade improve. This will shift resources from import-substituting industries to export-promoting industries. Hence, this will benefit exports and current account balance.

In further research, tariffs should be explicitly taken into account so as to measure its effect separately. The model can be extended to simultaneous equation model if it is justified. As it is known that estimating elasticity is essential in trade analysis, hence a double-log Model can be incorporated. Unlike Semi-log model, double-log model measures the elasticity. Hence, this model can be used further to estimate the elasticity of Factor Price Ratio with respect to Terms of Trade. To improve empirical findings, it is advisable to get better variables and proxies.
References


**Weblinks**


