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Abstract

We attempt to explore the long-term equilibrium relationship between India's real exchange rates and sectoral productivity trends using internationally comparable productivity databases such as KLEMS databases for India, China, Euro area, USA, UK and Japan. Our panel-ARDL results find support for an 'extended' Balassa-Samuelson hypothesis that allows for labour market frictions that does not allow for wage equalisation between traded and non-traded sectors within a country. These empirical findings are also robust to both labour productivity and total factor productivity as alternative measures of sectoral productivity. This mechanism continues to find some support when we separate out distribution sector, that comprises wholesale and retail trade in the domestic services sector. Our empirical evidence suggests that India's real exchange rate is anchored to domestic fundamentals and is closely aligned to its fair value over a medium to long-time horizon.

I. Introduction

Over the past several decades, there have been many studies linking productivity differences and real exchange rates between trading partners. While this area of research is significantly influenced by the seminal papers of Balassa and Samuelson, both published in 1964, they differ in terms of underlying assumptions regarding factor market frictions, trading environments of different countries etc. In case of India, two recent developments have reinvigorated interest in this field. They are: (a) an appreciating trend in India's real effective exchange rate for almost a decade and (b) a possible structural change in the sectoral productivity patterns between India and its trading partners that might lead to a change in India's external sector dynamics, namely the exchange rate movements. While there are several theories that have been propounded to explain the equilibrium appreciation in the real exchange rates, Balassa-Samuelson theory which is a productivity-biased explanation of real exchange rate movements, has remained an influential area that are still being examined for most countries. According to the Balassa-Samuelson hypothesis, an appreciating 'real' exchange rate could be an equilibrium phenomenon when the productivity level between two trading partners deviates on a permanent basis. Several recent policy debates in India highlight this effect (Rajan (2016)) for the recent period, however, only a limited number of studies have put it to test so far.

Most of the empirical studies on Balassa-Samuelson hypothesis until the end of last century have used changes in per-capita income or aggregate value added per worker as proxies for productivity changes in cross-sectional or panel setup. This is mainly because reliable and comparable estimates of sectoral productivities, namely the total factor productivities were difficult to obtain across all major trading partners. The availability of sectoral productivity data for India and its major trading partners in the recent years is perhaps an advancement that could shed new light on some of the earlier findings and contribute towards broadening the ambit of this literature.

We analyse the case for an emerging market economy like India, where detailed sectoral productivity data is now available in the recently updated India-KLEMS database. The industry-level productivity estimates in India-KLEMS, including the total factor productivity, help us overcome several challenges since analogous industrial productivity databases are available for India's major trading partners. While this can help us obtain comparable productivity estimates, the data also comes with its own challenges, namely, differences in reporting periodicity (financial year vs calendar year) and limited data coverage for recent years, which necessitates forecasting the key series for the recent periods. The latter point is particularly challenging because country specific national account statistics come with different reporting formats and require extra caution for arriving at comparable productivity estimates for the recent years in line with the KLEMS classifications. We have used the best possible use of available techniques to overcome some of these challenges.

Furthermore, in most studies, a group of emerging and developing economies' productivity gaps are studied vis-à-vis one developed nation, mainly the USA or UK for Latin American or African countries, Japan for emerging Asia, Germany for Central and Eastern Europe. These studies, therefore, arrive at an 'average' Balassa-Samuelson effect for the group of developing nations. For the purpose of this study, we consider India as the reference country, which means we estimate the bilateral productivity differences between India and the issuers of major world currencies separately to explain movements in India's real exchange rates. Our estimates, therefore, provide us the 'average' effect of India's productivity movements on a basket of currencies. Since our estimates are more India specific, it is likely to provide enhanced guidance to policy making in India.

We start with the 'basic' Balassa-Samuelson framework that comprises of only traded and non-traded sector productivity changes vis-à-vis the real exchange rate movements. We gradually incorporate labour market frictions in terms of sectoral wage differentials, the distribution sector, and the *terms of trade* to improve the model's explanatory powers. Our empirical specifications broadly follow Camarero (2008) and we use the pooled mean group panel ARDL econometric methodology proposed by Pesaran et. al. (1999) for our estimations. Our empirical findings suggest that the Balassa-Samuelson effect mostly holds for India for the period between late 1990's to 2019. In other words, we find that the appreciation of Rupee when the inflation differentials are accounted for, is associated with higher productivity growth in India's traded sector, vis-à-vis its partner country's traded sector. Our findings also suggest that the relationship is generally negative with respect to the non-traded sector. However, we observed a sign reversal for the coefficients of traded and non-traded sectors' productivity differentials when a separate distribution sector is introduced. This finding is consistent with Lee and Tang (2003) who point out that a sign reversal for the traded and non-traded sectors could be possible when there is strategic pricing by the market players in the presence of limited tradability of goods and services.

The rest of the paper is organised as follows: Section II summarises a brief survey of cross-country findings; Section III describes the data. Besides India-KLEMS, it describes the productivity data for Euro area, UK, the USA, Japan, and China, highlighting their similarities and differences. In section IV, we elaborate the empirical methodology, and in section V, we report our empirical results and their policy implications. Finally, Section VI notes the concluding observations.

II. Literature

The Balassa-Samuelson model in its most simplified form states that as productivity of the traded-goods sector rises relative to the non-traded sector, nominal wages will increase in both traded and non-traded sectors, leading to an overall increase in the price levels of the developing country, known as the "Penn Effect" following Summers and Heston (1991). Thus, as developing countries grow and their productivities improve, a rising price—or an appreciating currency after accounting for the inflation differential between countries—is an equilibrium phenomenon. Most of the empirical tests for the Balassa-Samuelson effect in the earlier years include a regression of price level of GDP which is the real exchange rate for country ‘i’ as dependent variable and GDP per capita in purchasing power parity terms as an independent variable. The regression coefficient β measures the equilibrium impact of economic growth on real exchange rate. In these studies, it is assumed that the changes in productivity growth will get reflected in the changes in per capita income (Berka et. al (2018).

If we consider a set of countries that have witnessed divergent growth rates, the existing literature generally supports the Balassa-Samuelson effect between/among these countries (Hsieh (1982) and Marston (1987)). Specific examples include some of the south-east Asian countries compared with Japan during seventies and eighties (Ito, Isard and Symansky (1997)), Central and Eastern European countries compared with western Europe during nineties (Halpern and Wyplosz (2001), Kovács (2002), Égert (2002a,b), Mihaljek and Klau (2004), Égert et al. (2003)), Latin American countries compared with the USA (Drine and Rault (2003)); Choudhri and Khan (2005) among 16 developing countries etc. that provide evidence lending support to this hypothesis. Berka et. al. (2018) provides supporting evidence using sectoral productivity data for the Eurozone countries.

Empirical findings for the group of countries that did not grow at very divergent speeds, however, remain mixed. For example, in the context of OECD countries, Canzoneri, Cumby and Diba (1999), Drine and Rault (2005), García-Solanes and Torrejón-Flores (2009) obtain supporting evidence only for the part of the hypothesis that is generally termed as Baumol and Bowen (1966) effect. This effect relates differences in productivity with the differences in prices between traded and non-traded sectors in an economy. However, the second part of the hypothesis that links price differences with the real exchange rate, are generally not supported in these studies. Lothian and Taylor (2008) also explain a part of the real exchange rate movement between US Dollar and Pound-Sterling in a sample between 1820-2001 through this hypothesis. This study, however, did not provide evidence in favour of Balassa-Samuelson Hypothesis between UK and France.

However, deviating from the standard Balassa-Samuelson model, there are some variants that overcome challenges that some of the above studies face. For instance, Camarero (2008), MacDonald and Ricci (2005) broadly support the Balassa-Samuelson effect by incorporating a separate distribution sector, which comprises of wholesale and retail trade in the domestic services sector. In these studies, productivity differences in the distribution sector influences real exchange rate in the same way that the traded sector does. Bordo et. al. (2017) provides evidence of cross-regime variation in the productivity effects that are consistent with the movements in trade costs. This cross-regime variation can reduce or even reverse the overall effects of the model in a sample of long-period. Within selected exchange rate regimes, however, Bordo et. al. (2017) provides evidence that support the hypothesis. Choudhri and Schembri (2010) indicates that factors such as variations in elasticity of substitution between home and foreign traded goods, adjustment of the terms of trade can alter the sign and the magnitude of the impact of productivity differences on exchange rate.

In the Indian context, Banerjee and Goyal (2019) supports the Balassa-Samuelson hypothesis for a set of emerging economies that includes India, for the period between 1995 and 2017. However, an examination of Balassa-Samuelson effect in explaining the recent phenomenon in Indian Rupee’s exchange rate is limited. In order to fill the gap, we focus on Indian Rupee’s bilateral exchange rates with the major currencies in the world viz. US Dollar, UK Pound, Euro, Japanese Yen and Chinese Renminbi after accounting for India’s inflation differentials with these countries, for a relatively shorter period between early 2000’s and 2019 and examine whether their movement is consistent with the Balassa-Samuelson effects.

III. Data

For our research, we use productivity databases, namely, the KLEMS data for India, Euro area, Japan, USA and UK, and the China Industrial Productivity (CIP) database that have been made available relatively recently. These databases provide internationally comparable estimates of total factor productivity (TFP), and the sectoral labour productivity. Our sample period broadly captures the period for which India had a uniform market-determined exchange rate policy following the adoption of a full current account convertibility since 1993 as part of the economic liberalisation initiated in 1991. As the available studies, notably Bordo et. al. (2017) point out that shifts in the nominal exchange rate regimes significantly alter the productivity effects on exchange rates, our sample period would possibly overcome major estimation biases caused by the changes in nominal exchange rate regimes within sample period.

KLEMS database, though broadly comparable across countries, needed certain regrouping of the available sectors. This is primarily due to the fact that testing of Balassa-Samuelson hypothesis would mainly require classification of the reported industries into the traded, which represents the manufacturing sector, and the non-traded, which consists of services activities and other non-traded industrial activities such as electricity, gas, water supply, and construction. In some extensions of the model, we have used a separate 'distribution' sector which represents the domestic wholesale and retail trade. In the baseline specification, this sector was included in the non-traded sector. To represent the sectoral productivities, we compute weighted average of value added per employee and the total factor productivity in traded, non-traded, distribution and non-traded excluding distribution sectors from the KLEMS and CIP databases for our sample set of countries. Second, a challenge arises because of mismatches in the period under coverage across the countries in this sample set. To overcome this, we estimate relevant data series, namely, the Gross Value Added (GVA) and Capital Stock based on the respective national account statistics beyond the published range in KLEMS and CIP to arrive at the estimates of productivity growths in different sectors. This was uniformly done for all the sample countries till the end of 2019. To obtain bilateral real exchange rates, we used nominal exchange rate and Consumer Price Inflation (CPI) for each of the major trading partners. While these three are the broad steps in our data conversion and making series uniform for our analysis, the details of the data transformation and projections for each trading partners are as follow:

Euro area, UK, USA and Japan

The latest EU KLEMS version released in 2019 by the Vienna Institute for International Economic Studies (wiiw) is the main source of data for the Euro area, Japan, UK and USA. For our study, we have taken a group of EU countries represented by EU11 that consists of Austria, Belgium, Czech Republic, Denmark, Germany, Spain, Finland, France, Italy, Netherlands and Sweden. The statistical database of EU KLEMS 2019 release includes industry level estimates of value added, labour input, capital services, total factor productivity, and compensation to labour. We have estimated the average nominal wages and the average labour productivities for traded, non-traded and distribution sectors for these countries using the available series in EU KLEMS. Box I in the Annex explains the methodology followed in estimating the growths in nominal wages and labour productivity at our end, and the methodology that EU KLEMS follows in the estimation of industry-level TFP growths. In EU KLEMS, manufacturing is reported as a single industry (code C in Table 1a in the Annex). Therefore, the reported TFP growth for the manufacturing sector in EU KLEMS is taken as representative of the productivity growth for the traded sector. EU KLEMS divides the services activities into several industries (codes G to S in Table 1a in the Annex). Utility which consists of the supply of electricity, gas and water; and the construction activities are represented in codes D to F in the database (Table 1a in the Annex). For TFP growth in the non-traded sector, we have taken weighted average of the industry level TFP growth rates across services, construction and utilities, where the weights are the share of each industry in the aggregate gross value added. The Industry code G in EU KLEMS represents the distribution sector. The growth in TFP and labour productivity for this industry code from the EU KLEMS database is, therefore, taken as the representatives of productivity growths for the distribution sector, where necessary. Amongst the EU11 countries, since the national currency of Austria, Belgium, Germany, Spain, Finland, France, Italy and Netherlands is Euro, their data on value added are reported in Euro. Whereas data for Czech Republic, Denmark and Sweden are reported in their own national currencies. For these three countries, we convert the industry level value added data into Euro using yearly average exchange rates that are obtained from the EU KLEMS metadata. Finally, we obtain the annual industry-level estimates of value added at constant 2010 prices measured in Euro for the EU11 by aggregating the sectoral value added across these 11 countries.

For EU11, all the above series are available for the calendar years 2001-2017; for UK they are available for the period 1995-2016; for Japan they are available between 1995-2015; and for the USA, they are available between 1997 and 2017. Data upto 2019 are not available in the EU KLEMS database. Therefore, we estimate the TFP growths and labour productivity using the country and the Euro Area national accounts data, obtained from CEIC upto 2019. The estimates of TFP growth require three key series, the value added, labour input and capital services. Next, we discuss the method of extending these series for traded, non-traded and distribution sectors separately.

CEIC reports the annual growth rates in aggregate gross domestic product (GDP) upto 2019, that we take as representative of the growth in aggregate value added. CEIC's OECD database contains monthly industrial production indices, separately for the manufacturing sector, construction sector and production indices for the industrial sector up to 2019. Annual growth rates calculated from CEIC data is used for extending the EU KLEMS value added series for the manufacturing and construction up to 2019. In the OECD databases, the industrial sector is composed of manufacturing, mining and utilities sectors. Hence, we use the industrial sector and manufacturing sector growth rates as available, for calculating the growth rates for the utilities and mining sectors taken together. Since growth rate of the manufacturing sector and overall growth rate of the industrial sector are available for 2018, 2019, we can calculate the combined growth rate of utilities and mining activities for these years using a weighted average approach. In this approach, industrial sector's production growth rate at time t can be expressed as a weighted average of the manufacturing sector growth rate and the growth rate of utilities-mining sector taken together at time t:

$$g_{industry,t} = (w_{man})g_{man,t} + (1 - w_{man})g_{utl\sim mining,t}$$

Here w_{man} is the manufacturing sector's share of value added in the overall value added in the industrial sector (manufacturing, utilities, mining). We use 2017 data on industry-level value added from EU KLEMS for calculating this weight and treat it as a constant for 2018 and 2019. $g_{industry,t}$ represents the growth rate in industrial sector, and $g_{man,t}$ represents the growth rate in manufacturing sector in CEIC. Using the above relation, $g_{utl\sim mining}$ can be calculated for the years 2018, 2019 which is then applied to extend the EU KLEMS series for utilities up to 2019. Using the similar technique, we estimate the value-added growth for the agriculture and services sectors taken together[2]. The aggregate GDP growth rates, industrial sector growth rates and construction sector growth rates as obtained from the CEIC database are used in this process. The growth rate of agriculture and services sectors taken together can be calculated from this weighted average relation:

$$g_{econ,t} = w_{ind}g_{ind,t} + w_{con}g_{con,t} + (1 - w_{ind} - w_{con})g_{agri\sim serv,t}$$

[2] Agriculture's share in the aggregate GDP is very small in the OECD countries. Therefore, we combine it with the services sector.

Here, weights w_i are the sector $i's$ share of value added in overall real value added. The 2017 data on industry level value added data from EU KLEMS is used for calculating these weights, which are treated as constant for 2018 and 2019. The estimated g_{agri_serv} is then applied to extend the EU KLEMS series for the industry codes G to S (Table 1a in the Annex) under services up to 2019. As regards the labour input series, we extend it up to 2019 assuming the median growth rate in labour input between 2012-2017 for each industry for 2018 and 2019.

We forecast the growth in capital services for traded and non-traded sectors separately using autoregressive models for the missing years. For this purpose, we use a country-level panel data which consists of growth rates in capital services as available in EU KLEMS, CIP and India KLEMS for years available in the databases since 1997. The dependent variables are the capital services growth rates for the traded and non-traded sectors, in separate models. In addition to the stochastic trend in capital services growth rates represented by the autoregressive terms, we controlled for the growths in aggregate gross fixed capital formation (GFCF) for the countries to account for the overall investment climate. Table 2a in the Annex reports the regression results. We have forecasted capital services growth rates for Euro area, UK, USA, Japan and India using each of these models. The final forecasts for the traded and non-traded sectors are obtained by taking simple averages of the forecasts obtained from individual models for each country.

The growths in nominal wages are estimated using the methodology described in Box I in the Annex. We assume an unchanged value of the labour's share in value added from the last observation for each country. The above procedures for estimating the growths in GVA and capital services were carried out for the traded and non-traded sectors only. We could not provide these estimates for the distribution sector for the missing years. Hence, for models that involved distribution sector were restricted only for the period for which the official data was available, except for China. For China, we could estimate the growths in employment and capital services using disaggregated industry level official data from CEIC that we explain later. Therefore, for China, we use the full sample, i.e. till 2019.

India

The latest version of the India KLEMS Database published in 2020 is used as the main source of data for India. India KLEMS reports the industry-wise data on value-added, labour input, capital services and TFP growth rates for the period between India's financial years 1980-81 to 2017-18. The financial year in India runs between the months of April and March. For example, the financial year 1980-81 would cover a period between April 1980 to March 1981. The other countries and the EU, on the other hand, report their data for the calendar year. In order to bridge this mismatch, we match our data based on India's financial year, to the maximum overlapping period of the others. For example, we assume India's data for 1980-81 as the representative of the calendar year 1980, since the financial year 1980-81 covers nine months, viz. April to December of 1980 as compared to only three months of 1981, viz. January to March. The industry classifications available in India KLEMS data is provided in Table 3a in the Annex. For our study, we define industries 3-15 as the traded sector, which represents manufacturing activities. Non-traded sector covers industries 16-27, that cover electricity, gas and water supply, construction and services activities. We exclude industries 1 and 2 which are agriculture and mining, respectively, from our analysis.

India KLEMS provides estimates of TFP, gross value added and the labour income shares for these industries upto the financial year 2017-18. The financial year 2017-18 is taken as representative of the calendar year 2017, as explained earlier. We estimate the implied average wage for both traded and non-traded sectors using the methodology explained in Box I in the Annex upto this period. India's national account reported gross value added for manufacturing, services, construction and electricity, gas, water supply separately upto the most recent period covered in our study. We use the growth rates of these sectors to extend the value-added series for traded and non-traded sectors, separately. For the labour input, we use the median growth rate of labour input over the last five years, to extend the series for 2018 and 2019. We forecast the capital services growth rate using the models that we report in Table 2a in the Annex. We assume the labour's share in value added to remain unchanged since 2017-18. Finally, we estimate the TFP growth rates and the implied average wage for both traded and non-traded sectors following the methodology described in Box I in the Annex.

China

The China Industrial Productivity (CIP) Database Round 3.0 released in 2015 by the Research Institute of Economy, Trade and Industry (RIETI), Japan is the primary source of data for China. CIP 3.0 database reports industry level data on gross output, intermediate inputs, labour input and capital services. We estimate industry-wise TFP growths using the methodology described in Box I in the Annex. The industry classification in CIP 3.0 is presented in Table 4a in the Annex. For our purpose, we consider industry codes 6-24 as traded sector while sectors with codes 25-37 are treated as non-traded sector. Sector 27 represents distribution sector. Sectors with codes 1-5 that represent agriculture and mining are excluded from the study. CIP 3.0 database reports the industry level data on gross output and value of intermediate inputs for the period 1995-2010, each of these are reported in current as well as previous year prices. We deduct intermediate inputs (current prices) from gross output (current prices) to obtain value added at current prices for the period 1995-2010. Similarly, we deduct intermediate inputs (previous year prices) from gross output (pervious year prices) to obtain real value-added data (previous year prices) for the period 1995-2010. Finally, we calculate the (chained volume index) of value added at constant prices using current and previous year prices data. This completes the compilation of industry level estimates of value-added at current and constant prices for the years 1995-2010. The indexes for both labour input and capital services are available in the CIP database up to 2010. From the given data on labour compensation and value added in the CIP database, we estimate industry-wise TFP using the methodology described in Box I in the Annex. We arrive at aggregated TFP growth rates for traded, non-traded and non-traded sector excluding the distribution sector up to 2010 by computing a weighted average of the industry level TFP growth rates, where weights are the industry shares in aggregate value added.

The industry-level estimates of value added are not available from the CIP database between 2011 and 2019. We obtain these estimates from CEIC that reports these data form the National Bureau of Statistics (NBS), China. We obtain GDP (2010 prices) growth up to 2019 for primary industry (agriculture), secondary industry (mining, manufacturing, utilities), construction and tertiary industry (services) from CEIC. We used the growth rate of value added in secondary industry as proxy for the growth in value added from the traded sector, which is manufacturing, and extend the CIP series upto 2019. We extend the construction and services industries' value-added series using the respective growth rates of value added from the CEIC. For the labour input between 2011 and 2019, we obtain data on number of employees for disaggregated industries within traded and non-traded sectors from CEIC. CEIC reports the monthly data on the number of employees for almost all of the CIP industries separately since 2012. For our estimates of productivity beyond 2010, however, it is not necessary to take the disaggregated data. We obtain the industry wise data and aggregate them according to traded and non-traded sectors. The growth in these estimated aggregated labour employment series has been used to extend the labour input series for the aggregate traded and non-traded labour input series. We extend the aggregate capital services indices for the traded and non-traded sectors using the aggregate data on industry-wise total assets and current assets from CEIC, as reported by China's National Bureau of Statistics. For this purpose, we use the growth in net fixed capital stock which is defined as total assets minus the current assets. Before we use it to extend the traded sector capital services growth, we deflate the sector wise net fixed assets by the general fixed assets investment price index obtained from CEIC. Since data on real net fixed assets for services sectors (CIP codes 27-37) is not available in the NBS financial database, we use a different technique for extending the capital services input index series up to 2019 for the services sectors (CIP codes 27-37): First, we obtain the overall fixed assets investment data from NBS which is available up to 2019. We deflate this series using a general fixed assets investment price index available from NBS to obtain a generalised real fixed assets investment data up to 2019. We use the growth in real fixed assets investment as a proxy for overall growth in real fixed assets for the secondary industry and the services sectors taken together. Next, we calculate the combined growth in real fixed assets for the secondary sector i.e. the mining, manufacturing, utilities and construction sectors taken together, using the NBS data on real fixed assets obtained earlier. The growth in real fixed assets in the services sector for any time t is then calculated using a weighted average approach:

$$g_{ind\sim serv,t} = w_{ind} g_{ind,t} + (1 - w_{ind}) g_{serv,t}$$

Here, w_{ind} is 2010's share of the secondary industry that consists of manufacturing, mining, utility and construction activities, in the aggregate real capital stock. This share could be directly calculated from CIP 3.0 data. $g_{ind\sim serv,t}$ and $g_{ind,t}$ are the aggregate (secondary and tertiary) growth rate and the growth rate of real capital stock in secondary industry, respectively. Using the above relationship, g_{serv}, i.e. the growth rate of real fixed capital stock for services sector is calculated up to 2019. This is then applied to extend the capital services input index for each CIP service sector (codes 27-37) up to 2019.

The period of analysis in this study is the calendar year 2000-2019. We exclude 2020 due to the global outbreak of COVID-19 pandemic that caused an unprecedented reduction in the employment, investment and output. While information on output and investment could be collected from the releases of the National Account Statistics of each country and for Euro area, release of employment data would take significant lag by some country authorities. Since the estimates of productivity is derived using these three main information, any extrapolation of the same based on the past trends in employment would be inappropriate.

IV. Empirical Specifications and Stylised Facts

Standard Balassa-Samuelson specification

The 'standard' Balassa-Samuelson model suggests the following:

$$\widehat{P_t} - \widehat{P_t^*} = \widehat{e_t} + (1-\alpha)\left(\frac{\mu_N}{\mu_T}\widehat{A_{T,t}} - \widehat{A_{N,t}}\right) - (1-\alpha^*)\left(\frac{\mu_N^*}{\mu_T^*}\widehat{A_{T,t}^*} - \widehat{A_{N,t}^*}\right) \qquad \text{eq. (1)}$$

Where P_t and P_t^* represent the overall price levels in the home country and the trading partner's, respectively, at time point t. e_t represents the nominal exchange rate expressed in home currency per unit of foreign country at time t. $A_{T,t}$ and $A_{T,t}^*$ represent the productivity in traded sector T in home and foreign countries, respectively, while $A_{N,t}$ and $A_{N,t}^*$ represent the productivity in the non-traded sector N in home and foreign countries, respectively. All of these variables are measured in their growth from the previous period, as indicated by the $\widehat{\ }$ notation. μ represents the labour's share in value added, which is roughly equal to the ratio of total wage payments and the gross value added in each sector and in each country. α represents the share of traded sector in aggregate gross value added in each country, separately. Literature calls it a 'standard' model, since it is the most simplified version of the Balassa-Samuelson model with the following assumptions:

1. Purchasing Power Parity (PPP) holds in the traded goods sector, i.e. prices of traded goods are equalised internationally, implying:

$$P_{T,t} = e_t P_{T,t}^*$$

2. Perfect domestic mobility of labour which means that wages are equalised in the traded and non-traded sectors and also no mobility of labour internationally.

3. Perfect mobility of capital internationally which means the rental price of capital is equalised between home and foreign.

An appreciation of home currency in nominal terms can be expressed as:

$$-\widehat{e_t} = (1-\alpha)\left(\frac{\mu_N}{\mu_T}\widehat{A_{T,t}} - \widehat{A_{N,t}}\right) - (1-\alpha^*)\left(\frac{\mu_N^*}{\mu_T^*}\widehat{A_{T,t}^*} - \widehat{A_{N,t}^*}\right) - \left(\widehat{P_t} - \widehat{P_t^*}\right) \qquad \text{eq. (2)}$$

An appreciation of home currency in 'real' terms would be expressed as:

$$-\widehat{e_t} + \left(\widehat{P_t} - \widehat{P_t^*}\right) = (1-\alpha)\left(\frac{\mu_N}{\mu_T}\widehat{A_{T,t}} - \widehat{A_{N,t}}\right) - (1-\alpha^*)\left(\frac{\mu_N^*}{\mu_T^*}\widehat{A_{T,t}^*} - \widehat{A_{N,t}^*}\right) \qquad \text{eq. (3)}$$

In the 'basic' Balassa-Samuelson framework, we denote the model-determined 'real' appreciation in bilateral exchange rate between domestic and foreign currency as $\widehat{bs_{1,t}}$:

$$\widehat{bs_{1,t}} = \left[(1-\alpha)\left(\frac{\mu_N}{\mu_T}\widehat{A_{T,t}} - \widehat{A_{N,t}}\right) - (1-\alpha^*)\left(\frac{\mu_N^*}{\mu_T^*}\widehat{A_{T,t}^*} - \widehat{A_{N,t}^*}\right)\right] \qquad \text{eq. (4)}$$

Extended Balassa-Samuelson specification

In the 'extended' Balassa-Samuelson model, the assumption of 'no labour market frictions', i.e. the assumption 2 above, is relaxed. In this model, the 'real' appreciation of domestic currency can be expressed as:

$$\widehat{bs_{2,t}} = -\widehat{e_t} + \left(\widehat{P_t} - \widehat{P_t^*}\right)$$

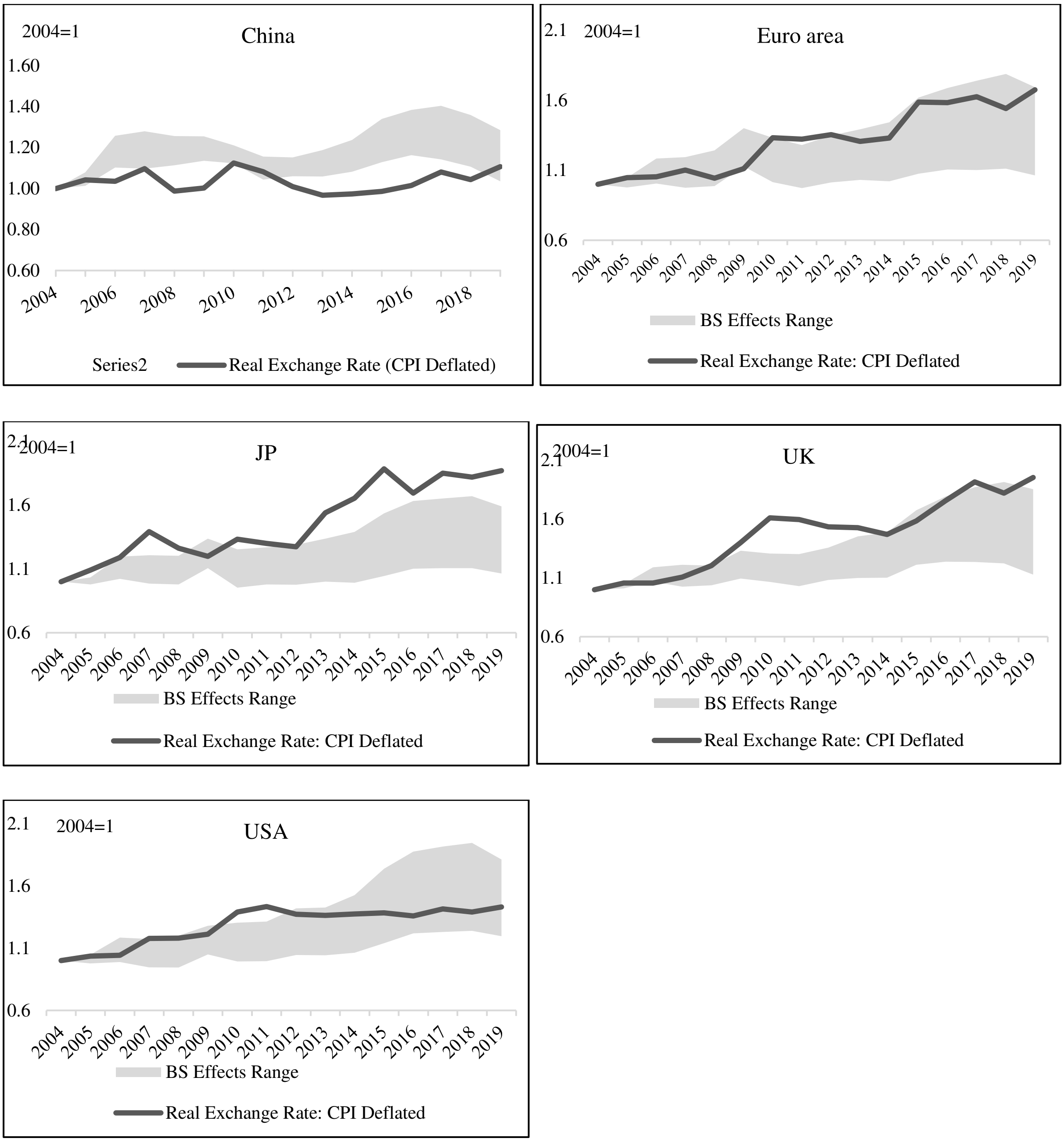
$$= (1-\alpha)\left(\frac{\mu_N}{\mu_T}\widehat{A_{T,t}} - \widehat{A_{N,t}}\right) - (1-\alpha^*)\left(\frac{\mu_N^*}{\mu_T^*}\widehat{A_{T,t}^*} - \widehat{A_{N,t}^*}\right) - \mu_N(1-\alpha)\left(\widehat{w_{T,t}} - \widehat{w_{N,t}}\right) + \mu_N^*(1-\alpha^*)\left(\widehat{w_{T,t}^*} - \widehat{w_{N,t}^*}\right)$$

eq. (5)

Where $w_{T,t}$ and $w_{T,t}^*$ represent the real wage in the traded sector in home and foreign country, respectively, while $w_{N,t}$ and $w_{N,t}^*$ represent the real wage in the non-traded sector in home and foreign country, respectively. The derivation of the equations (1) to (5) is provided in Box II in the Annex.

In Figure 1 below, we plot the bilateral 'real' exchange rates which is the market determined exchange rate between India and the country/region, deflated by the relative price as represented by the officially released Consumer Price Indices (CPI), as the dark line, in comparison to their levels in 2004. A 'real' appreciation of INR is represented by an increase in the value of the plotted ‘real’ exchange rates. Equations 4. and 5. provide two theory-determined estimates of the ‘real’ exchange rates as $\widehat{bs_{1,t}}$ and $\widehat{bs_{2,t}}$. We repeat both these estimates using TFP and the labour productivity. Therefore, we obtain four estimates of model-determined ‘real’ exchange rates. In Figure 1, the grey sheds represent the range of these four estimates, the difference between the maximum and the minimum value of the estimates. Figure 1 suggests that the ‘real’ appreciation of Indian Rupee against USA, UK, Euro area and Japan are broadly in line with the relative positions in productivity, and in wages in traded and non-traded sectors. Tables 5a.1 to 5a.3 in the Annex also corroborate these findings. For China, although there are some divergences between the trends suggested by the grey range and the dark line, the short-run changes are similar for many years. Tables 5a.1 to 5a.3 in the Annex, in the similar way, suggest that the productivity growth in case of China exceeded that of India in some cases, which means the potential role of some other factors that we do not account for in Balassa-Samuelson framework are at play in determining the real exchange rate between India and China. These figures, however, are only indicative, and do not fully reflect any causal relationship between productivity growth and exchange rate movements. In order to fill the gap, we conduct formal econometric tests of the relationships using the methodology described later in this section. The estimated coefficients are reported in the next section.

Figure 1: Sectoral Productivity, Wage and Real Exchange Rate



Source: Authors' Calculations based on KLEMS and China Industrial Productivity databases.

Our empirical estimation of the Balassa-Samuelson hypothesis is largely based on equations (4) and (5). However, it may be noted that the theoretical equations (4) and (5) are expressed in terms of traded sector productivity net of non-traded sector productivity in each country. For better interpretation and making the results policy relevant, we estimate our empirical models in terms of country differences in sectoral productivities, e.g. the traded sector productivity in home country relative to the traded sector productivity in the partner country. This is broadly the empirical structure that is being followed in most of the available literature. From the productivity databases for India, China, Japan, EU area, UK and the USA, we observe each of $\widehat{A_{T,t}}$, $\widehat{A_{N,t}}$, $\widehat{w_{T,t}}$, $\widehat{w_{N,t}}$. Our empirical framework broadly follows Camarero (2008) where we regress India's bilateral exchange rates adjusted for India's aggregate price level relative to the price level in respective partner country, on the productivity gap between India and the partner country. We conduct these testing in a panel data setup where we have India's bilateral exchange rate and productivity differentials with all the country/regions mentioned above. Our estimates in the long-run are based on the following five relations:

1. $rer_{it}^{cpi} = \beta_1 proddifft_{it} + \beta_2 proddiffnt_{it} + \epsilon_{it}$
2. $rer_{it}^{cpi} = \beta_1 proddifft_{it} + \beta_2 proddiffnt_{it} + \partial_1 tot_{it} + \epsilon_{it}$
3. $rer_{it}^{cpi} = \beta_1 proddifft_{it} + \beta_2 proddiffnt_{it} + \gamma_1 wagedifft_{it} + \gamma_2 wagediffnt_{it} + \epsilon_{it}$
4. $rer_{it}^{cpi} = \beta_1 proddifft_{it} + \beta_2 proddiffnt_{it} + \gamma_1 wagedifft_{it} + \gamma_2 wagediffnt_{it} + \partial_1 tot_{it} + \epsilon_{it}$
5. $rer_{it}^{cpi} = \beta_1 proddifft_{it} + \beta_2 proddiffntexd_{it} + \beta_3 proddiffd_{it} + \epsilon_{it}$
6. $rer_{it}^{cpi} = \beta_1 proddifft_{it} + \beta_2 proddiffntexd_{it} + \beta_3 proddiffd_{it} + \partial_1 tot_{it} + \epsilon_{it}$
7. $rer_{it}^{cpi} = \beta_1 proddifft_{it} + \beta_2 proddiffntexd_{it} + \beta_3 proddiffd_{it} + \gamma_1 wagedifft_{it} + \gamma_2 wagediffntexd_{it} + \gamma_3 wagediffnd_{it} + \epsilon_{it}$
8. $rer_{it}^{cpi} = \beta_1 proddifft_{it} + \beta_2 proddiffntexd_{it} + \beta_3 proddiffd_{it} + \gamma_1 wagedifft_{it} + \gamma_2 wagediffntexd_{it} + \gamma_3 wagediffnd_{it} + \partial_1 tot_{it} + \epsilon_{it}$

Where $proddifft_{it}$, $proddiffnt_{it}$, $proddiffd_{it}$ and $proddiffntexd_{it}$ represent productivity differences between India and the partner country in traded, non-traded, distribution sectors and the non-traded sector excluding the distribution sector, respectively. Distribution sector includes the wholesale and the retail trades, which in all the country databases, are reported as a single industry as explained earlier. $wagedifft_{it}$, $wagediffnt_{it}$, $wagediffd_{it}$ and $wagediffntexd_{it}$ represent the wage differential between India and the partner country in traded, non-traded, distribution and non-traded sector excluding the distribution sector, respectively. Finally, tot_{it} represents the price of India's manufacturing produce that represent the traded sector, relative to that of the partner countries. rer_{it}^{cpi} is the bilateral real exchange rate between India and the major world currencies. The parameters of our primary interest are $proddifft_{it}$, $proddiffnt_{it}$, $proddiffd_{it}$ and $proddiffntexd_{it}$. Eq. (4) suggests that if the labour's shares in value added are roughly in the same proportion between traded and non-traded sectors across countries, and the share of traded sector into the aggregate value added in India's partner country is equal or more than that in India, a higher relative productivity in traded sector in India would result in an appreciation of India's real exchange rate vis-à-vis that country. Hence, we would expect β_1 to be positive. On the other hand, given these conditions on the parameters, we would expect β_2 to be negative. MacDonald and Ricci (2005) observe that the distribution sector acts in the same way that traded sector does, which means, a positive shock to the distribution sector productivity would cause a 'real' exchange rate appreciation. This means, we would expect β_3 to be positive. The productivity indicators are available either in annual growth rates or in index form in all the country databases. For estimating the long-run relationships, first we estimate the bilateral country growth differentials, and then we convert them into indices with a base as the starting year of the sample. Following the conventional literature, we first use the gaps in sectoral labour productivity, i.e. value added per unit of labour as explanatory variables in the above models. Second, we repeat all the regressions by using the gaps in the sectoral TFP as obtained using the available productivity databases.

V. Results

In this section, we discuss the results of estimation of models explained in the previous section. We use the pool mean group estimation methodology proposed by Pesaran et al. (1999) for Panel data. The methodology is based on the Autoregressive Distributed Lags (ARDL) framework that can be applied when variables are of mixed order of integration (Shin and Pesaran (1999)). Tables 5a.1 and 5a.2 in the Annex show that our variables exhibit mixed order of integration based on the reported unit root tests. For our main purpose, we will interpret the long term cointegration coefficients. The short-term dynamics and stability of the relationship, on the other hand, is evaluated in terms of sign and significance of the Error Correction coefficients. We discuss our findings below.

V.1 Basic BS Model estimates

In Table 1 below, we provide the estimates of 'basic' Balassa-Samuelson specifications, as in Equation 4 in the previous section. As measure of sectoral productivity, we use both labour productivity and total factor productivity (TFP) in turn. In both the models in Table 1, we regress bilateral 'real' exchange rates between India and the partner countries on the productivity gaps in both traded and non-traded sectors as separate regressors. Our estimate based on the sectoral labour productivity suggests that the productivity differences in the traded sector are positively associated with the 'real' exchange rate appreciation (in Model 1). The sign of this coefficient is consistent with the Balassa-Samuelson theory as outlined in Equation 4. The coefficient for the non-traded sector, however, is positive, which is not consistent with the theoretical prediction. When we use TFP as measures of productivity (in Model 2), we observe that the signs of the coefficients for both traded and non-traded sector productivity differences are opposite from their theoretical predictions. However, it may be mentioned that these results pertain only to a very basic setup, which we expand in the following cases.

Table 1: Balassa-Samuelson (BS) Model: Basic

Dependent Variable: Real Exchange Rate (CPI Deflated)		
	Labour Productivity	Total Factor Productivity
	(1)	(2)
Productivity- Traded	0.26^{***} (0.098)	-1.68^{***} (0.56)
Productivity- Non-Traded	0.87^{***} (0.087)	2.19^{***} (0.81)
Short run		
Error Correction	-0.80^{**} (0.34)	-0.18^{***} (0.047)
Number of observations	103	108
Log-likelihood	201.1	190.2
AIC	-390.1	-368.4

Standard errors in parentheses
* p < 0.10, ** p < 0.05, *** p < 0.01

V.2 Relaxation of BS assumptions: PPP Assumption

In Table 2 below, we allow the terms of trade (ToT), i.e. the price of India's exported goods in relation to the imported goods for each of its trading partner as another explanatory variable. In other words, we relax the condition of 'law of one price' for traded sector[3]. The estimation based on labour productivity in Model 1 in Table 2 continues to suggest positive relationship between traded sector productivity differentials and the 'real' exchange rates. The coefficient for the non-traded sector, however, turns statistically insignificant, while retaining its positive sign. The coefficient of ToT, however, is significant only at 10 percent. In case of TFP in Model 2, the coefficients of both the traded and non-traded sectors now display signs that are consistent with the theory. The coefficient of the traded sector is positive and for the non-traded sector, it is negative, supporting the Balassa-Samuelson hypothesis in Equation 4. Both the

[3] While we are aware that PPP theory, is generally used in the context of a fixed basket of commodities (i.e., identical goods) unlike the net terms of trade which are derived from unit prices of actual export and import baskets, following the broad stance of literature, we used net ToT as a proxy variable in our regression specifications.

coefficients are statistically significant. The coefficient of ToT is positive and statistically significant too.

Table 2: Balassa-Samuelson Model: Relaxation of PPP

Dependent Variable: Real Exchange Rate (CPI Deflated)		
	Labour Productivity	Total Factor Productivity
	(1)	(2)
Productivity- Traded	0.36^{*} (0.20)	0.20^{***} (0.072)
Productivity- Non-Traded	0.34 (0.30)	-0.75^{***} (0.083)
Terms of Trade	0.27^{*} (0.15)	0.77^{***} (0.032)
Short run		
Error Correction	-0.67^{***} (0.14)	-0.43^{***} (0.11)
Number of observations	103	103
Log-likelihood	220.0	278.0
AIC	-426.0	-542.0

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

V.3 Relaxing Assumptions: Flexible Labour Market

Next, we relax the assumption of perfectly flexible labour market, assumed so far in the derivation of Equation 4. The assumption means that the labour forces are free to move between any sector, and as a result, the wages equate across sectors instantaneously. We relax this assumption and assume that there exist labour market rigidities. As a consequence, labour do not move immediately between sectors and hence, wage rates do not equalise. The 'extended' version of the Balassa-Samuelson model is presented in Equation 5. In the empirical framework, in addition to the explanatory variables used so far, we add the wage rate differentials for traded and non-traded sectors between India and the partner countries as additional explanatory variables[4]. The wage rate differentials are derived using the

[4] We checked for collinearity among productivity differential and wage differential, and it was found to be non-existent. Our empirical framework is based on Camarero (2008).

methodology explained in Box 1 in the Annex. The estimation results of the 'extended' Balassa-Samuelson model are reported in Table 3 below. In the 'extended' Balassa-Samuelson framework in models 1 and 2, the coefficients of traded and non-traded sectors are positive and negative, respectively, that are consistent with the theory in Equation 5. The signs of the wage differentials are also consistent with the theory. The estimates are robust to the inclusion of ToT. However, the coefficient of the ToT term is statistically insignificant. The estimated coefficients of the 'extended' Balassa-Samuelson model using TFP as a measure of sectoral productivity in model 3 also remain consistent with the theory. The coefficient of the non-traded sector turns positive, but loses its statistical significance, when ToT in introduced in model 4. In other words, the coefficient of non-traded sector is not robust to the inclusion of ToT in the model that uses TFP as measure of sectoral productivity. From the theoretical specifications in Equations 4 and 5 in the previous section, it can generally be argued that, it is the traded sector productivity growth net of non-traded sector productivity growth that drives the movement in real exchange rate. It is not necessary that a declining non-traded sector productivity should accompany an appreciating 'real' exchange rate. The theoretical specification suggests that the 'net' effect of the traded sector productivity dominates. In fact, in all our earlier specifications, we consistently observe positive coefficients of the traded sector productivity gaps. It is not surprising if the coefficient of non-traded sector productivity turns non-negative for an economy like India where the aggregate productivity growth had been higher than most of the countries in the sample for most period. Therefore, broadly, we may infer that, under the more realistic assumptions such as the labour market frictions, the Balassa-Samuelson theory holds in India, and the productivity differentials between India and the trading partners explain appreciating 'real' exchange rates of India for over last one decade.

Table 3: Balassa-Samuelson Model: Labour Market Rigidities

Dependent Variable: Real Exchange Rate (CPI Deflated)				
	Labour Productivity		Total Factor Productivity	
	(1)	(2)	(3)	(4)
Productivity- Traded	0.33*** (0.053)	0.43*** (0.082)	0.56*** (0.12)	1.82*** (0.48)
Productivity- Non-Traded	-0.85*** (0.15)	-0.92*** (0.16)	-0.53*** (0.16)	0.28 (0.51)
Wage Traded	-0.26*** (0.070)	-0.36*** (0.092)	-0.28*** (0.11)	-0.90** (0.39)
Wage Non-Traded	0.91*** (0.087)	0.95*** (0.096)	0.68*** (0.11)	0.69** (0.28)
Terms of Trade		0.037 (0.067)		0.59** (0.28)
Short run				
Error Correction	-0.83*** (0.30)	-0.80*** (0.31)	-0.69** (0.31)	-0.33* (0.18)
Number of observations	103	103	98	113
Log-likelihood	199.3	208.5	193.8	207.3
AIC	-382.6	-398.9	-371.5	-396.7

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

V.4 Relaxing Assumptions: Distribution sector

In Table 4, in introduce a distribution sector following Camarero (2008), MacDonald and Ricci (2005) etc. Distribution sector comprises of wholesale and retail trades in the domestic services sector. Consequently, the non-traded sector in Table 4 excludes distribution sector. When we account for a separate distribution sector in models 1 and 2 in Table 4, we observe a sign reversal of the coefficients of traded and non-traded sector productivity differentials, from Table 3. The sign reversal is consistent with Lee and Tang (2003) who argued that the limited tradability of goods and services may provide scope for strategic pricing decisions, which impacts the aggregate 'real' exchange rate movements, reversing the Balassa-Samuelson effect. Our data might support the limited tradability of goods and services in India when the domestic wholesale and retail trades are accounted for. The coefficients of traded and non-traded sectors, however, continue to support the Balassa-Samuelson hypothesis, when we introduce distribution sector into the models 3 and 4, which measure sectoral productivity by TFP. The coefficients of the distribution sector, however, are statistically insignificant.

Table 4: Balassa-Samuelson Model: Distribution Sector

Dependent Variable: Real Exchange Rate (CPI Deflated)				
	Labour Productivity		Total Factor Productivity	
	(1)	(2)	(3)	(4)
Productivity- Traded	-0.70^{***} (0.23)	-0.45 (0.44)	0.40^{**} (0.18)	0.74^{***} (0.17)
Productivity- Non-Traded	1.20^{***} (0.45)	1.79^{***} (0.54)	-0.66^{***} (0.21)	-1.52^{***} (0.25)
Productivity- Distribution	-0.079 (0.19)	0.22 (0.27)	0.28^{*} (0.17)	0.015 (0.088)
Wage Traded	1.07^{***} (0.30)	0.59 (0.55)	0.31^{**} (0.15)	-0.34^{***} (0.10)
Wage Non-Traded	0.0080 (0.23)	0.074 (0.29)	1.40^{***} (0.25)	0.93^{***} (0.15)
Wage Distribution	-0.63^{**} (0.25)	-1.12^{***} (0.32)	-0.65^{***} (0.16)	-0.21^{***} (0.068)
Terms of Trade		0.65 (0.44)		1.36^{***} (0.26)
Short run				
Error Correction	-0.54^{***} (0.096)	-0.45^{***} (0.12)	-0.44^{**} (0.22)	-0.51^{***} (0.13)
Number of observations	97	97	97	97
Log-likelihood	208.8	217.5	208.1	235.4
AIC	-397.6	-412.9	-396.1	-448.7

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

In a nutshell, we can say that the Balassa-Samuelson theory broadly explains the appreciation of Indian Rupee's 'real' exchange rates for over last one decade. This means, when we control for the labour market frictions, we observe positive association between the traded sector productivity differential and the real exchange rate, while the relationship with the non-traded sector is generally negative. This means, on average, the 'real' appreciation of Indian Rupee in in last one decade is generally driven by higher productivity growth in India's traded or manufacturing sector vis-à-vis the sector's growth in the major trading partners, i.e. Euro area, USA, UK, China and Japan. On the other hand, the productivity differential of the non-traded sector for India vis-à-vis the partner countries are generally observed to be associated negatively with the 'real' exchange rate appreciation. The results generally hold when we measure sectoral productivity by both average labour productivity and TFP. One exception is observed for the case when we account for a separate distribution sector in the models that are based on sectoral labour productivity. In this case, we observe a sign reversal of the Balassa-Samuelson effect. The theory, however, remains valid in the models based on TFP.

V.6 Agricultural Prices

In our paper, we had excluded agriculture from the data. However, it is generally recognised that the large share of agriculture in Indian consumption basket affects both wages and consumer price inflation in India. The unusually sharp agricultural inflation and rise in agricultural real wages over 2007-11 as driven by special circumstances of repeated food price peaks and large government spending in rural construction remains as an example of an inversion of the BS effect at work (Goyal, 2014, Goyal and Baikar, 2015). Wage growth in agriculture exceeded that in productivity in the sector, causing inflation, and therefore, reflected in an appreciation in the 'real' exchange rate of Indian Rupee. In fact, Figure 1 shows that India's 'real' exchange rate jumps after the global financial crisis until 2011, relative to US, UK, but flattens after that when agricultural real wage growth had softened by 2012. Thus, the results as shown in Fig 1 hints at the Balassa-Samuelson effect's inversion as outlined above. In order to overcome this issue, we alternatively re-estimated the 'real' exchange rate based on a production-based inflation indicator. Due to the unavailability of consistent and comparable producer price index or wholesale price index for the entire sample period, we rely upon the KLEMS databases and CIP for constructing the aggregate production-based price indices for each country. The KLEMS and the CIP databases provide industry-wise value-added series for the entire sample period both in current prices and in constant prices, which we use for constructing the aggregate price deflators. In the following model in Table 5, we use Indian

Rupee's 'real' exchange rate which is deflated by this newly constructed production-based price indices, as dependent variable. Since the coefficients of distribution sector turn out to be statistically insignificant in most cases in Table 4, we omit this variable and execute the models in Table 5 with only traded and non-traded sector productivity and wage variables. In these specifications, however, non-traded sector consists of the distribution sector. The results in Table 5 continue to support the Balassa-Samuelson hypothesis for India. In both models 1 and 2 that use labour productivity as measure of sectoral productivity, the sign of the coefficients are consistent with the theoretical predictions. However, their magnitudes are different based on whether we include terms of trade or ToT. In models 3 and 4, that use TFP as measure of sectoral productivity, the hypothesis is being supported.

Table 5: Balassa-Samuelson Model: Agricultural Prices

Dependent Variable: Real Exchange Rate (KLEMS Deflated)				
	Labour Productivity		Total Factor Productivity	
	(1)	(2)	(3)	(4)
Productivity- Traded	0.23^{*} (0.13)	2.41^{***} (0.65)	0.52^{***} (0.11)	2.52^{***} (0.60)
Productivity- Non-Traded	-0.74^{***} (0.23)	-2.75^{***} (0.54)	-1.19^{***} (0.20)	-0.20 (0.50)
Wage Traded	-0.016 (0.13)	-1.37^{***} (0.45)	-0.15 (0.11)	-1.41^{***} (0.42)
Wage Non-Traded	0.39^{***} (0.14)	1.05^{***} (0.24)	0.45^{***} (0.13)	0.80^{***} (0.30)
Terms of Trade		0.84^{***} (0.26)		1.02^{***} (0.30)
Short run				
Error Correction	-0.68^{*} (0.36)	-0.29 (0.24)	-0.57^{**} (0.29)	-0.30^{*} (0.16)
Number of observations	98	103	108	108
Log-likelihood	187.8	204.6	198.8	211.4
AIC	-359.7	-391.1	-381.6	-404.8

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

V.6. Short run dynamics

So far, our interpretations of the Balassa-Samuelson effect have rested upon the long-run coefficients derived from the estimates based on Pesaran (1999). The validity of these long-run results, however, depend on the fulfilment of stability conditions in the short-run. The stability conditions of the models are represented by negative and statistically significant error correction terms. This condition means that, on average, the estimation errors of the last period, gets corrected or reversed in the current period. This condition is captured by the negative sign. In all the models presented above, the condition is satisfied. This means, the models broadly satisfy the stability conditions. Statistically speaking, all these variables together constitute a system that has stable or mean-reverting error component. Intuitively, in the long-run, we observe an economically stable co-movement of the sectoral productivity differentials and the real exchange rates in India vis-à-vis the set of countries. This also serves as another validation of the Balassa-Samuelson effect to a large extent.

V.7 Robustness Check

As the robustness check for our results in the 'extended' Balassa-Samuelson models in Table 3, we re-estimated the models where we use only the reported data from India KLEMS and EU KLEMS. In other words, we do not include the projected data series for labour productivity and TFP for India KLEMS and EU KLEMS beyond what is being reported by the databases. For China, however, we retain the projected data between 2010 and 2019 as these are obtained from the official sources at much sectoral disaggregation. Table 6 below presents the results. Coefficients in models 1 and 2 in Table 6 that are based on labour productivity continue to have the same signs as our main results. In model 4, which uses TFP as a measure of sectoral productivity, the coefficients of traded sector confirm the positive sign. However, the coefficients of non-traded sector in both models 3 and 4, that use TFP, turn positive. This is not a violation of the results that we obtained in Table 3, as we explained earlier in subsection

V.3 that a positive coefficient for the non-traded sector productivity differential may be consistent with Balassa-Samuelson theory, when a country experiences higher aggregate productivity growth such as India.

Table 6: Robustness Check for the Balassa-Samuelson Estimates

Dependent Variable: Real Exchange Rate (CPI Deflated)				
	Labour Productivity		Total Factor Productivity	
	(1)	(2)	(3)	(4)
Productivity- Traded	0.34*** (0.035)	0.30*** (0.077)	0.18 (0.11)	1.35*** (0.47)
Productivity- Non-Traded	-1.37*** (0.11)	-1.25*** (0.10)	2.31*** (0.51)	1.98*** (0.62)
Wage Traded	-0.39*** (0.048)	-0.37*** (0.075)	-0.11 (0.12)	-0.14 (0.27)
Wage Non-Traded	1.25*** (0.074)	1.17*** (0.070)	0.81*** (0.19)	-0.31 (0.21)
Terms of Trade		-0.054 (0.086)		1.45*** (0.41)
Short run				
Error Correction	-0.63** (0.30)	-0.69** (0.33)	-0.78*** (0.21)	-0.33*** (0.083)
Number of observations	88	88	78	93
Log-likelihood	175.3	186.3	187.8	181.2
AIC	-334.5	-354.5	-359.5	-344.5

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

We did not conduct the robustness check for Table 4 that accounts for a separate distribution sector. Table 4 is, in fact, estimated only on the reported KLEMS data for India, Euro area, USA, UK and Japan. It is because of non-availability of any capital and TFP estimates for the distribution sector. As explained in the 'Data' section, we had forecasted the capital growth rate for these countries using an autoregressive model of order 1, augmented by the aggregate growth in the gross fixed capital formation, available from their national accounts. We used this methodology to forecast the aggregate capital services growth rates for traded and non-traded sector. We did not use this methodology for the distribution sector alone, since it is a much smaller sector as compared to traded and non-traded, and therefore, may be subject to larger forecast error.

VI. Conclusion

Debates surrounding movements and changes in the real effective change rate have been a core of research in open economy macroeconomics. Major theories that explain the locus of real effective exchange rate (REER) include purchasing power parity (PPP) and the Balassa-Samuelson (BS) hypothesis. These theories evaluate whether the law of one price and changes in productivity explain the movements in REER. In line with globalization, financial crisis, and spillover, questions relating to India's real effective exchange rates have often surfaced in academic and policy debates. In this paper, we attempt to address some of the recent debates on India's real effective exchange rate in light of PPP and BS hypotheses.

In this domain, available studies so far mainly concentrated on increase in per capital income as a proxy for productivity changes. However, the availability of comparable KLEMS data among India's trading partners gives as an opportunity to further investigate the BS debate using this rich dataset. This makes our findings robust in term of data granularity, industry segregation, new dimensions of bilateral trade and real exchange rate movements.

Our baseline estimates that assumed all the classical assumptions of BS model suggested weak evidences in support of BS hypothesis. However, as we relaxed the assumption of perfect labour mobility and introduced labour market frictions proxied by wage the differentials, we find strong empirical support for BS effect. These findings were robust when we used labour productivity changes and total factor productivity changes. While traditional BS concentrates on traded and non-traded sectors only, we in line with recent literature, we introduced a distribution sector that comprises of the domestic retail and wholesale trades and our results continue to support the BS Hypothesis when we use total factor productivity changes. The short-run dynamics also suggested stability in the underlying relationships as suggested by the sign and the significance of the *error correction terms*. These findings seem to suggest that the movements in the real exchange rates could be explained by the underlying productivity changes as suggested in the Balassa Samuelson effect. Our study therefore indicates that India's real exchange rate are anchored to domestic fundamentals and closely aligned to its fair value over a medium to long time horizon.

Going forward, this study may be extended taking into consideration change in consumer preferences, productivity changes, product variation and changes in the mode of international trade flows, especially in light of the recent pandemic situations and its aftermath.

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Annex

Box I: Estimation method of key variables for regression

i. TFP Growth

The standard approach for calculating industry-level TFP growth is described by the Tornqvist weighted equation:

$$\Delta \ln TFP_{j,t} = \Delta \ln Y_{j,t} - \bar{v}_{\mathrm{K,j,t}} \Delta \ln K_{j,t} - \bar{v}_{\mathrm{L,j,t}} \Delta \ln L_{j,t}$$

Where:

$\Delta \ln Y_{j,t}$ is the growth in real value added in industry j at time t;

$\Delta \ln K_{j,t}$ is the growth in capital services input in industry j at time t;

$\Delta \ln L_{j,t}$ is the growth in labour services input in industry j at time t;

$\bar{v}_{\mathrm{X,j,t}} = \frac{v_{X,j,t} + v_{X,j,t-1}}{2}$, $X = \{K, L\}$

$v_{X,j,t} = \frac{P_{X,j,t} X_{j,t}}{P_{Y,j,t} Y_{j,t}}$, is the share of (nominal) compensation of input X in the nominal value added in industry j at time t.

Since we assume constant returns to scale, we have:

$v_{L,j,t} + v_{K,j,t} = 1$ or equivalently

$\bar{v}_{\mathrm{L,j,t}} + \bar{v}_{\mathrm{K,j,t}} = 1.$

ii. Labour productivity growth

Since labour productivity growth is defined as ‘output per worker,’ industry level labour productivity growth can be obtained as:

$\Delta \ln LP_{j,t} = \Delta \ln Y_{j,t} - \Delta \ln L_{j,t}$

Where:

$\Delta \ln Y_{j,t}$ is the growth in real value added in industry j at time t;

$\Delta \ln L_{j,t}$ is the growth in labour services input in industry j at time t;

iii. Nominal Wage growth

Industry level data on wages is not directly reported in any of the industrial productivity databases. We calculate the growth in nominal wages using an indirect approach- as the difference in growth rates between labour compensation and labour services input:

$$\Delta \ln w_{j,t} = \Delta \ln(wL)_{j,t} - \Delta \ln L_{j,t}$$

Where:

$\Delta \ln(wL)_{j,t}$ is the growth in (nominal) labour compensation in industry j at time t;

$\Delta \ln L_{j,t}$ is the growth in labour services input in industry j at time t.

Box II: THEORETICAL SPECIFICATION OF BALASSA-SAMUELSON MODEL

Real Exchange Rate:

$$RER_t = \frac{P_t}{e_t P_t^*}$$

Eq. 1

(e_t is INR/Foreign currency.)

Cobb-Douglas Price Indices of traded goods and non-traded goods prices in home and foreign:

$$P_t = P_{T,t}^{\alpha} P_{N,t}^{1-\alpha}$$

Eq. 2

$$P_t^* = P_{T,t}^{*\alpha^*} P_{N,t}^{*1-\alpha^*}$$

Eq. 3

Taking logs, totally differentiating the above, and substituting 2, 3 in 1:

$$\widehat{RER_t} = \widehat{P_t} - \widehat{P_t^*} - \widehat{e_t} = \alpha\widehat{P_{T,t}} + (1-\alpha)\widehat{P_{N,t}} - \alpha^*\widehat{P_{T,t}^*} - (1-\alpha^*)\widehat{P_{N,t}^*} - \widehat{e_t}$$

$$\widehat{RER_t} = \widehat{P_t} - \widehat{P_t^*} - \widehat{e_t} = (1-\alpha)\left(\widehat{P_{N,t}} - \widehat{P_{T,t}}\right) - (1-\alpha^*)\left(\widehat{P_{N,t}^*} - \widehat{P_{T,t}^*}\right) + \widehat{P_{T,t}} - \widehat{P_{T,t}^*} - \widehat{e_t}$$

Eq. 4

Firm Problem

Traded Goods Sector Production Function:

$$Y_{T,t} = A_{T,t} K_{T,t}^{1-\mu_T} L_{T,t}^{\mu_T}$$

Non-traded Goods Sector Production Function:

$$Y_{N,t} = A_{N,t} K_{N,t}^{1-\mu_N} L_{N,t}^{\mu_N}$$

Normalise: Price of traded goods = 1 and relative price of non-traded goods $p_t = \frac{P_{N,t}}{P_{T,t}}$

Capital is assumed to be perfectly mobile, i.e. rental price of capital is equalised across traded and non-traded goods sectors:

$$r_{T.t} = r_{N,t} = r_t$$

FOCs:

$$\mu_T A_{T,t} \left(\frac{K_{T,t}}{L_{T,t}}\right)^{1-\mu_T} = w_{T,t}$$

$$(1-\mu_T) A_{T,t} \left(\frac{K_{T,t}}{L_{T,t}}\right)^{-\mu_T} = r_t$$

$$\mu_N p_t A_{N,t} \left(\frac{K_{N,t}}{L_{N,t}}\right)^{1-\mu_N} = w_{N,t}$$

$$(1-\mu_N) p_t A_{N,t} \left(\frac{K_{N,t}}{L_{N,t}}\right)^{-\mu_N} = r_t$$

Taking logs and totally differentiating FOCs:

$$\widehat{A_{T,t}} + (1-\mu_T)\widehat{k_{T,t}} = \widehat{w_{T,t}}$$

$$\widehat{A_{T,t}} - \mu_T \widehat{k_{T,t}} = \widehat{r_t}$$

$$\widehat{p_t} + \widehat{A_{N,t}} + (1-\mu_N)\widehat{k_{N,t}} = \widehat{w_{N,t}}$$

$$\widehat{p_t} + \widehat{A_{N,t}} - \mu_N \widehat{k_{N,t}} = \widehat{r_t}$$

Solving the above for $\widehat{p_t}$ by substituting out $\widehat{k_{T,t}}$ and $\widehat{k_{N,t}}$:

$$\widehat{p_t} = \widehat{P_{N,t}} - \widehat{P_{T,t}} = \frac{\mu_N}{\mu_T}\widehat{A_{T,t}} - \widehat{A_{N,t}} - \mu_N\left(\widehat{w_{T,t}} - \widehat{w_{N,t}}\right) + \left(\frac{\mu_T - \mu_N}{\mu_T}\right)\widehat{r_t}$$

Eq. 5

Standard Specification of the Balassa-Samuelson Model

Assumptions:

4. Purchasing Power Parity (PPP) holds in the traded goods sector, i.e. prices of traded goods are equalised internationally:

$$P_{T,t} = e_t P_{T,t}^*$$

Log differentiating:

$$\widehat{e_t} = \widehat{P_{T,t}} - \widehat{P_{T,t}^*}$$

Eq. 6

5. Perfect domestic mobility of labour i.e. wages are equalised in the traded and the non-traded goods sector. No mobility of labour internationally.

$$w_{T,t} = w_{N,t} \text{ or } \widehat{w_{T,t}} - \widehat{w_{N,t}} = 0$$

Eq. 7

6. Perfect mobility of capital, internationally i.e. rental price of capital is equalised between home and foreign. Rental price of capital is assumed to be an exogenously determined constant:

$$r_t = r_t^* = r \text{ i.e. } \widehat{r_t} = \widehat{r_t^*} = \hat{r} = 0$$

Eq. 8

Substituting 7, 8 in 5:

$$\widehat{p_t} = \widehat{P_{N,t}} - \widehat{P_{T,t}} = \frac{\mu_N}{\mu_T}\widehat{A_{T,t}} - \widehat{A_{N,t}}$$

Eq. 9

Substituting 6 and 9 (and the corresponding equation for foreign) in 4:

$$\widehat{RER_t} = \widehat{P_t} - \widehat{P_t^*} - \widehat{e_t} = (1-\alpha)\left(\frac{\mu_N}{\mu_T}\widehat{A_{T,t}} - \widehat{A_{N,t}}\right) - (1-\alpha^*)\left(\frac{\mu_N^*}{\mu_T^*}\widehat{A_{T,t}^*} - \widehat{A_{N,t}^*}\right)$$

$$\widehat{P_t} - \widehat{P_t^*} = \widehat{e_t} + (1-\alpha)\left(\frac{\mu_N}{\mu_T}\widehat{A_{T,t}} - \widehat{A_{N,t}}\right) - (1-\alpha^*)\left(\frac{\mu_N^*}{\mu_T^*}\widehat{A_{T,t}^*} - \widehat{A_{N,t}^*}\right)$$

Eq. 10

Extended Specification of the Balassa-Samuelson model

Assumptions:

1. Purchasing Power Parity (PPP) holds in the traded goods sector, i.e. prices of traded goods are equalised internationally:

$$P_{T,t} = e_t P_{T,t}^*$$

Log differentiating:

$$\widehat{e_t} = \widehat{P_{T,t}} - \widehat{P_{T,t}^*}$$

Eq. 11

2. Labour market frictions: Labour no longer perfectly mobile i.e. wages may not equalise across the traded and the non-traded goods sector. No mobility of labour internationally.
3. Perfect mobility of capital, internationally i.e. rental price of capital is equalised between home and foreign. Rental price of capital is assumed to be an exogenously determined constant:

$$r_t = r_t^* = r \text{ i.e. } \widehat{r_t} = \widehat{r_t^*} = \hat{r} = 0$$

Eq. 12

Substituting 12 in 5:

$$\widehat{p_t} = \widehat{P_{N,t}} - \widehat{P_{T,t}} = \frac{\mu_N}{\mu_T}\widehat{A_{T,t}} - \widehat{A_{N,t}} - \mu_N\left(\widehat{w_{T,t}} - \widehat{w_{N,t}}\right)$$

Eq. 13

Substituting 11, 13 (and the corresponding equation for foreign in 4:

$$\widehat{RER_t} = \widehat{P_t} - \widehat{P_t^*} - \widehat{e_t}$$

$$= (1-\alpha)\left(\frac{\mu_N}{\mu_T}\widehat{A_{T,t}} - \widehat{A_{N,t}}\right) - (1-\alpha^*)\left(\frac{\mu_N^*}{\mu_T^*}\widehat{A_{T,t}^*} - \widehat{A_{N,t}^*}\right)$$

$$- \mu_N(1-\alpha)\left(\widehat{w_{T,t}} - \widehat{w_{N,t}}\right) + \mu_N^*(1-\alpha^*)\left(\widehat{w_{T,t}^*} - \widehat{w_{N,t}^*}\right)$$

i.e.

$$\widehat{P_t} - \widehat{P_t^*} = \widehat{e_t} + (1-\alpha)\left(\frac{\mu_N}{\mu_T}\widehat{A_{T,t}} - \widehat{A_{N,t}}\right) - (1-\alpha^*)\left(\frac{\mu_N^*}{\mu_T^*}\widehat{A_{T,t}^*} - \widehat{A_{N,t}^*}\right) -$$

$$\mu_N(1-\alpha)\left(\widehat{w_{T,t}} - \widehat{w_{N,t}}\right) + \mu_N^*(1-\alpha^*)\left(\widehat{w_{T,t}^*} - \widehat{w_{N,t}^*}\right)$$ *Eq. 14*

Table 1a: Industry classifications in EU KLEMS 2019

Industry Code	Industry Description
TOT	Total economy (A-U)
A	Agriculture, forestry and fishing
B	Mining and quarrying
C	Total manufacturing
D	Electricity, gas, steam and air conditioning supply
E	Water supply; sewerage; waste management and remediation activities
F	Construction
G	Wholesale and retail trade; repair of motor vehicles and motorcycles
H	Transportation and storage
I	Accommodation and food service activities
J	Information and communication
K	Financial and insurance activities
L	Real estate activities
M_N	Professional, scientific, technical, administrative and support service activities
O-Q	Public administration, defence, education, human health and social work activities
R_S	Arts, entertainment, recreation; other services and service activities, etc.
T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use
U	Activities of extraterritorial organizations and bodies

Table 2a: Determinants of Capital Services Growth Rates

Dependent variable: YoY Growth Rate in Capital Services

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Traded Sector				*Non-traded Sector*			
GFCF	0.19^{***}	0.36^{***}	0.19^{***}	0.094	0.20^{***}	0.42^{***}	0.20^{**}	0.16^{**}
	(0.034)	(0.054)	(0.038)	(0.085)	(0.049)	(0.014)	(0.058)	(0.045)
Capital Services in traded-Lag 1	0.26^{**}	0.25^{**}	0.36^{**}	0.33^{**}				
	(0.075)	(0.082)	(0.098)	(0.11)				
GFCF-Lag 1				0.24				0.083
				(0.16)				(0.057)
Capital Services in non traded-Lag 1					0.17	0.15	0.16	0.10
					(0.095)	(0.10)	(0.086)	(0.11)
N	93	93	87	87	93	93	87	87
R^2	0.38	0.40			0.34	0.38		
AIC	-414.8	-417.6	.	.	-457.4	-462.6	.	.

Notes: All variables are in growth. GFCF indicates the aggregate Gross Fixed Capital Formation.

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3a: Industry classifications in India KLEMS 2020

SL No.	Industry code	KLEMS Industry Description
1	AtB	Agriculture, Hunting, Forestry and Fishing
2	C	Mining and Quarrying
3	15t16	Food Products, Beverages and Tobacco
4	17t19	Textiles, Textile Products, Leather and Footwear
5	20	Wood and Products of wood
6	21t22	Pulp, Paper, Paper products, Printing and Publishing
7	23	Coke, Refined Petroleum Products and Nuclear fuel
8	24	Chemicals and Chemical Products
9	25	Rubber and Plastic Products
10	26	Other Non-Metallic Mineral Products
11	27t28	Basic Metals and Fabricated Metal Products
12	29	Machinery
13	30t33	Electrical and Optical Equipment
14	34t35	Transport Equipment
15	36t37	Other Manufacturing, recycling
16	E	Electricity, Gas and Water Supply
17	F	Construction
18	G	Trade
20	60t63	Transport and Storage
19	H	Hotels and Restaurants
21	64	Post and Telecommunication
22	J	Financial Services
23	71t74	Business Service
24	L	Public Administration and defence; Compulsory Social Security
25	M	Education
26	N	Health and Social Work
27	70+O+P	Other services

Table 4a: Industry classifications in China Industrial Productivity 3.0 2015

CIP Code	CIP Sector Description	Acronym
1	Agriculture, forestry, animal husbandry & fishery	AGR
2	Coal mining	CLM
3	Oil & gas excavation	PTM
4	Metal mining	MEM
5	Non-metallic minerals mining	NMM
6	Food and kindred products	F&B
7	Tobacco products	TBC
8	Textile mill products	TEX
9	Apparel and other textile products	WEA
10	Leather and leather products	LEA
11	Sawmill products, furniture, fixtures	W&F
12	Paper products, printing & publishing	P&P
13	Petroleum and coal products	PET
14	Chemicals and allied products	CHE
15	Rubber and plastics products	R&P
16	Stone, clay, and glass products	BUI
17	Primary & fabricated metal industries	MET
18	Metal products (excluding rolling products)	MEP
19	Industrial machinery and equipment	MCH
20	Electric equipment	ELE
21	Electronic and telecommunication equipment	ICT
22	Instruments and office equipment	INS
23	Motor vehicles & other transportation equipment	TRS
24	Miscellaneous manufacturing industries	OTH
25	Power, steam, gas and tap water supply	UTL
26	Construction	CON
27	Wholesale and retail trades	SAL
28	Hotels and restaurants	HOT
29	Transport, storage & post services	T&S
30	Information & computer services	P&T
31	Financial Intermediations	FIN
32	Real estate services	REA
33	Leasing, technical, science & business services	BUS
34	Government, public administration, and political and social organizations, etc.	ADM
35	Education	EDU
36	Healthcare and social security services	HEA
37	Cultural, sports, entertainment services; residential and other services	SER

Table 5a.1: Average Labour Productivity (LP) Growth by Country/Region 2000-2019 (%)

Country	LP Traded			LP Non-Traded			LP Distribution		
	2000-09	2010-19	Overall	2000-09	2010-19	Overall	2000-09	2010-19	Overall
CHINA	6.67	7.67	7.17	-1.32	2.88	0.78	3.75	5.07	4.41
EU	1.17	2.12	1.67	-0.14	0.50	0.20	1.11	1.57	1.35
INDIA	4.77	4.43	4.60	2.24	3.36	2.80	3.65	7.67	5.66
JAPAN	1.93	2.66	2.29	-0.97	0.31	-0.33	0.74	0.77	0.76
UK	2.91	1.14	2.03	0.09	0.54	0.32	1.48	2.45	1.96
US	4.89	0.39	2.64	1.06	0.52	0.79	1.82	1.01	1.41

Table 5a.2: Average TFP Growth by Country/Region 2000-2019 (%)

Country	TFP Traded			TFP Non-Traded			TFP Distribution		
	2000-09	2010-19	Overall	2000-09	2010-19	Overall	2000-09	2010-19	Overall
CHINA	2.07	2.26	2.17	-1.83	-0.35	-1.09	-1.05	-0.15	-0.60
EU	0.36	2.04	1.24	-0.29	0.04	-0.12	0.83	1.32	1.09
INDIA	1.57	1.44	1.51	0.38	1.76	1.07	-0.42	-0.74	-0.58
JAPAN	0.38	2.65	1.51	-0.84	0.46	-0.19	-0.40	0.32	-0.04
UK	2.10	1.21	1.65	0.57	0.56	0.56	0.37	2.01	1.19
US	2.72	0.21	1.47	0.15	0.37	0.26	0.48	0.58	0.53

Table 5a.3: Average Wage Growth by Country/Region 2000-2019 (%)

Country	Wage Traded			Wage Non-Traded			Wage Distribution		
	2000-09	2010-19	Overall	2000-09	2010-19	Overall	2000-09	2010-19	Overall
CHINA	6.82	8.66	7.74	0.22	7.50	3.86	0.55	9.24	4.90
EU	2.63	1.46	2.01	2.32	1.84	2.07	2.62	1.70	2.13
INDIA	9.71	7.93	8.82	8.03	8.99	8.51	9.06	12.51	10.78
JAPAN	-0.39	0.40	0.00	-0.63	0.10	-0.26	-0.64	0.09	-0.27
UK	4.36	2.19	3.27	3.14	2.27	2.71	4.61	2.73	3.67
US	2.97	1.74	2.35	3.51	2.42	2.96	2.91	2.02	2.47

Table 6a.1: Levin, Lin & Chu Unit Root Test

	Level		First Diff.	
	t-Stat	Prob.	t-Stat	Prob.
Real Exchange Rate (CPI)	0.61	0.73	-6.00	0.00
Real Exchange Rate (KLEMS)	-1.25	0.11	-3.94	0.00
TFP Traded	-1.95	0.03	-3.82	0.00
TFP Non-Traded	1.34	0.91	-4.60	0.00
TFP Distribution	-2.10	0.02	-2.21	0.01
TFP Non-Traded (Excluding Distribution)	2.04	0.98	-3.91	0.00
Labour Productivity Traded	0.53	0.70	-3.04	0.00
Labour Productivity Non-Traded	5.32	1.00	-4.84	0.00
Labour Productivity Distribution	5.84	1.00	-5.12	0.00
Labour Productivity Non-Traded (Excluding Distribution)	3.28	1.00	-4.10	0.00
Wage Traded	-0.69	0.24	-2.62	0.00
Wage Non-Traded	0.11	0.54	-3.16	0.00
Wage Distribution	0.55	0.71	-1.66	0.05
Wage Non-Traded (Excluding Distribution)	0.25	0.60	-4.71	0.00
Terms of Trade	-3.74	0.00	-2.85	0.00

Note: H_0: Variable has a unit root.

Table 6a.2: Im, Pesaran and Shin Unit Root Test

	Level		First Diff.	
	t-Stat	Prob.	t-Stat	Prob.
Real Exchange Rate (CPI)	2.09	0.98	-5.33	0.00
Real Exchange Rate (KLEMS)	-0.10	0.46	-3.82	0.00
TFP Traded	-2.92	0.00	-4.69	0.00
TFP Non-Traded	2.72	1.00	-4.75	0.00
TFP Distribution	-1.12	0.13	-1.81	0.03
TFP Non-Traded (Excluding Distribution)	3.74	1.00	-5.78	0.00
Labour Productivity Traded	1.89	0.97	-3.62	0.00
Labour Productivity Non-Traded	6.41	1.00	-5.82	0.00
Labour Productivity Distribution	6.70	1.00	-5.15	0.00
Labour Productivity Non-Traded (Excluding Distribution)	4.90	1.00	-6.16	0.00
Wage Traded	1.00	0.84	-3.53	0.00
Wage Non-Traded	2.98	1.00	-2.86	0.00
Wage Distribution	2.77	1.00	-2.92	0.00
Wage Non-Traded (Excluding Distribution)	2.73	1.00	-3.24	0.00
Terms of Trade	-0.88	0.19	-2.23	0.01

Note: H_0: Variable has a unit root.