American Journal of Multidisciplinary Research & Development (AJMRD)
Volume 3, Issue 04 (April- 2021), PP 07-23
ISSN: 2360-821X
www.ajmrd.com

Research Paper **Open Access**

The impact of global production sharing on employment and wages in the manufacturing industry in Sri Lanka

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Abstract: This paper examines the impact of global production sharing on employment and wages in the manufacturing industry in Sri Lanka. The study models the effects of global production sharing on employment and wages in the manufacturing industry in a labour demand and a wages framework on an integrated panel dataset of trade, labour and manufacturing industries. The impact of global production sharing employment and wages in the manufacturing industry is examined following the predictions of global production sharing models. On the labour demand model, global production sharing is negative and statistically significant on manufacturing employment against theoretical expectations. On the wages model, global production sharing is negative and statistically insignificant on manufacturing wages as opposed to theoretical predictions.

Key words: Trade, Global production sharing, Manufacturing, Employment, Wages
JEL code: F16

I. Introduction

Global production sharing involves the splitting up of the production process and the distribution of the same to partner countries. This has enabled developing economies to cater to international markets in their segment of comparative advantage. In the case of Sri Lanka, the share of exports in global production sharing in total manufacturing exports has continued to decline as a direct result of the trade policies that have been followed since 2000. The share of exports in global production sharing in total manufacturing exports reduced from 58.6 percent in 1997 to 47.1 per cent by 2011. Considering the share of exports in parts and components for 2011, 22.6 percent are concentrated into manufacture of rubber products, followed by exports in electricity distribution and control apparatus (18.4 percent), electric motors (10.9 percent), manufacture of other electrical equipment (10.3 percent). Sri Lanka also imports a variety of parts and components essential for manufacturing. The concentration of imports in parts and components is seen to be steadily increasing in the case of manufacture of wearing apparel (International Standard Industrial Classification (ISIC)-1810, manufacture of rubber products (ISIC-2519), manufacture of plastic products (ISIC-2520), manufacture of cutlery, hand tools and general hardware (ISIC-2893), manufacture of machinery for mining, quarry and construction (ISIC-2924), manufacture of parts and accessories for motor vehicles and engines (ISIC-3430). As an example, the share of imports in parts and components in accessories for motor vehicles has increased from a share of 6.24 percent to 8.21 percent from 1996 to 2011. On the other hand, the import of parts and components in the manufacture of other textiles (ISIC-1729), manufacture of engines and turbines (ISIC-2911), manufacture of other special purpose machinery (ISIC-2929), manufacture of office, accounting and computing machinery (ISIC-3000), manufacture of electric generators, engines and transformers (ISIC-3110) has steadily reduced their share of imports in parts and components from 1996 to 2011. The import of parts and component for office, accounting and computing industry has reduced from a share of 8.0 percent in 1996 to 2.31 percent in 2011. Exports in final assembly are the exports of final commodities that are assembled and exported from Sri Lanka. It is the difference between total exports in global production networks and the export of parts and components following Athukorala (2016). A lion's share of exports in final assembly commodities is concentrated in clothing and clothing accessories (Standard International Trade Classification-SITC-84). The share of final assembly exports from clothing and clothing accessories (SITC 84) was 87.5 percent in 1996. This share gradually increased to a dominant position of 90 percent by 2011. Until 2005, the second and the third highest export contribution was from travel goods (SITC 83) footwear and sport goods (SITC 85). In the post 2005 period, the significance of travel goods and footwear and sport goods declined drastically.

While economic theory offers several explanations for the pattern of trade between developed and developing economies and its consequent effect on employment and wages, global production sharing models mostly explain the link between global production sharing, employment and wages. Hence the main objective of this paper is to examine the impact of global production sharing on employment and wages in the manufacturing industry as postulated by the global production sharing models. As far as the author is aware, this is the only study that empirically examines the impact of global production sharing on manufacturing employment and wages based on a panel dataset, the case of Sri Lanka.

II. Theory and literature

The main objective of this discussion is to lay down the theory of global production sharing, its alternative models, and its predictions on employment and wages together with the available empirical literature.

Literature on global production sharing and its impact on labour market outcomes fits the gambit of new-trade theory (Joanna & Parteka, 2015). Global production sharing involves splitting the production process into separate stages (Athukorala, 2006; Feenstra, 1998; Venables, 1999; Yeats, 2001) and the movement of home-country jobs to other countries (Blinder & Kruger, 2013). Under global production sharing, each country specialises in a specific stage of the production line in contrast to concentrated manufacturing. Therefore, much of global production sharing encompasses trading intermediate products that entail further processing prior to reaching the final consumer (Sanyal & Jones, 1982). It is a form of division of labour along the manufacturing line based on skills differences (Timmer, Erumban, & Los, 2014). Therefore, comparative advantage is no longer determined based on trading a final commodity (Kemeny & Rigby, 2012). Fragmentation is made feasible as a result of reductions in trade barriers, transportation and information costs (Venables, 1999) leading to a spatial separation of consumers and producers (Kemeny & Rigby, 2012). Heckscher-Ohlin and Ricardian trade models are often consulted to explain production fragmentation (Gorg, 2000; Jones, Kierzkowski, & Lurong, 2005). Under these models, the unskilled and labour intensive stages of production are shifted to unskilled labour abundant developing economies, while the more technologically advanced stages of production that requires skilled labour remain with developed economies (Hijzen, Gorg, & Hine, 2005; Kemeny & Rigby, 2012; Timmer et al., 2014; Zang & Markusen, 1999). Hence, the upstream knowledge-intensive jobs are retained by the developed economies, while the downstream production functions of routine nature are allocated to developing economies (Venables, 1999). Splitting up of production gives a country a comparative advantage in commodities where it had no comparative advantage previously (Deardorff, 1998). As a result, southern workers participating in fragmented production are predicted to receive higher wages relative to their counterparts employed in domestic firms (Antras, Garicano, & Hansberg, 2006). However, a frequent criticism is that leading firms that usually control value chains based in industrialised countries tend to take away the profits from global production sharing (Derick, Kraemer, & Linden, 2010, 2011; Gereffi, Humphrey, & Sturgeon, 2005; Gereffi & Korzeniewicz, 1994; Nathan, 2007). Having discussed the mechanism of global production sharing, the reader's attention is shifted to discuss the different models of global production sharing that have evolved in the recent past. Although global production sharing comes in different models, the predictions of these models are standardised. With the shift of unskilled and labour-intensive segments of production to developing economies, it is predicted that the demand for labour and wages in these countries will be positively affected.

Theoretical models that explain the growth of offshoring have proliferated (Kemeny & Rigby, 2012). Ardnt (1997) considers a global production sharing model that consists of capital and labour as two factors of production and two commodities, where one is labour-intensive and the other, capital-intensive. With technological advancement when offshoring becomes possible, the labour-intensive sub stages of production are allocated to countries that have a comparative advantage in labour-intensive production, and the capital-intensive stages of production are allocated to capital-intensive countries. Grossman and Esteban (2008) propose a model of task-trade where reduction in trade costs lead to increased offshoring on routine production operations. Feenstra and Hanson (1995, 1997) proposed a global production-sharing model with a continuum of goods and inputs. A range of activities leading to the final commodity including designing, creation, production, packaging and delivery are identified and ranked in their order of labour intensity. Given two countries, where one has a comparative advantage in skilled labour and the other in unskilled labour, the skilled stages of the production are retained by the skills-intensive country while the stages of production that involve unskilled labour are moved to the unskilled labour-intensive country. In another model, Feenstra and Hanson (1996, 2003) considered a scenario where offshoring is an offshoot of international competition in industries producing heterogeneous inputs subjected to differences in the relative demand for skilled and unskilled labour. Yeaple (2005) introduced a model of heterogeneous firms and workers where international competition spurs more productive firms to enter the export market thus raising the demand for skilled workers. Jones and Kierzkowski (1988, 1990) in their model of global production sharing focus on production blocks and service links. Here, when production is concentrated into one country, a fixed cost is involved. When production is sliced into production blocks, it incurs only service link costs such as communication, transportation, coordination, planning etc. Antras and Helpman (2004) developed a theoretical framework for studying global sourcing strategies. This model predicts that in choosing between a domestic supplier and a foreign supplier for parts and components, trade-off between lower variables costs in the South and the lower fixed costs in the North is of critical importance.

Unlike the literature on factor proportions and technology theory, the available empirical evidence on the impact of global production sharing is sparse. This limitation is more evident in the case of developing economies. In terms of division of labour along value chains, Timmer et al. (2014) states that developed economies are engaged in relocating the unskilled-labour-intensive production activities to developing economies while the high value added activities are retained for their skilled workers. With the shift of unskilled-labour-intensive sectors of the production process to developing economies, workers in these countries are locked into monotonous unskilled assembly type of work. Unskilled work is poorly rewarded and affects the supply of skills of a country on a longer-term basis. In an opposing argument, Broadman (2005) claims economies that take part in global production sharing are increasingly experiencing a shift towards capital-intensive or skilled labour-intensive parts production. Rajan (2003) states that developing economies which had not been able to sell their final products in the export market earlier are now able to access international markets under global production sharing. This is more beneficial for small economies that engage in the production of parts and components of a vertically integrated manufacturing process (Jones et al., 2005). Irrespective of the theoretical predictions, empirical evidence on global production sharing and its impact on employment and wages in the case of developing economies is not so promising. A central theme that emerges from literature in the context of developing economies is that global production sharing has been negative on both employment and wages while its severity is more on unskilled workers. As an example, Kelegama (2009) identifies that the flexibility provided by global production sharing to shift parts and components production from one country to another has had detrimental effects on manufacturing employment in the case of Sri Lanka. Banga (2016) analysed the impact of global production sharing on employment in India using a database of twenty-two manufacturing industries over the period 1998-2011. Results using a fixed effects model indicated backward linkages to have a replacement effect on employment and an insignificant effect on employment in the case of forward linkages. Athukorala and Rajapathirana (2000a, 2000b); Kelegama and Foley (1999); Kelegama and Wignaraja (1991); Knutsen (2003); Lopez and Robertson (2012, 2016) further supports this notion that backward linkages under global production sharing in garments manufacturing are weak, ultimately leading to lower value addition and employment (Athukorala & Santosa, 1997). In the case of Thailand, Athukorala and Kohpaiboon (2013) found global production sharing to have a negative effect on manufacturing wages. Egger and Egger (2002) analysed the impact of international outsourcing on the wages of workers in seven Central and Eastern European countries over the period 1993-1998. They found a negative impact of international outsourcing (export of intermediate goods) on the wages of workers. Egger and Egger (2003) analysed the impact of foreign outsourcing on employment and wages using a panel of twenty Austrian two-digit industrial dataset over the period 1990-1998. They found that outsourcing to Central and Eastern European and the former Soviet Union significantly shifted relative employment in favour of high-skilled labour with a negative effect on the unskilled workers.

In the case of developed economies, international outsourcing has been more promising with regards to labour market outcomes for skilled workers compared to unskilled and less-educated workers. Ebenstein, Harrison, McMillan, and Phillips (2014) analysed the impact of offshoring on workers in the United States using population surveys. They concluded that offshoring had put downward pressure on US wages due to the reallocation of workers away from higher-wage manufacturing jobs. This was mainly due to the outsourcing of most unskilled and routine tasks to developing economies. Similarly, Mullen and Panning (2009) examined the impact of international outsourcing on the employment of skilled workers in the United States using a panel of six-digit manufacturing industries over the period 1997 to 2002. Their results indicated a negative effect of outsourcing on the labour market outcomes for unskilled workers. Using four-digit level data for 450 manufacturing industries over the period 1958-1989, Paul and Seigel (2001) estimated the impact of foreign outsourcing of employment in United States. They found outsourcing to have a relatively negative effect on the demand for workers across all levels of education, with the strongest negative impact on workers with less than a college degree.

McGregor, Stehrer, and deVries (2013) analysed the impact of international outsourcing on the demand for labour using a sample of forty countries covering the period 1995-2009. Results indicated a negative effect of offshoring on all skill levels, and the largest impact on medium skilled workers. For the United Kingdom, Hijzen et al. (2005); Hijzen and Swaim (2007) examined the impact of international outsourcing on the skill structure of labour demand using import-use matrices of input-output tables for manufacturing industries for the period 1982-1996. Their findings indicated that international outsourcing had a strong negative impact on the demand for unskilled workers and a positive impact on skilled workers. Later, in assessing the impact of offshoring on employment in the European Union, Joanna and Parteka (2015) analysed the impact of international outsourcing on employment in twenty-seven European countries across thirteen manufacturing industries over the period 1995-2009. Findings indicated a negative impact of offshoring on domestic employment while the intensity of the negative impact is more severe on unskilled workers.

On wage outcomes of global production sharing, a favourable effect is experienced by workers who are more educated, more skilled and knowledge workers. For Denmark, Munch and Skaksen (2009) examined the impact of outsourcing on wages of skilled and unskilled using a panel of manufacturing workers covering the period 1993-2002. They found that international outsourcing had raised the wages of workers with further education while lowering the wages of workers with basic and vocational education. Similarly, Hummels, Jorgensen, Munch, and Xiang (2014) estimated the effect of offshoring on worker wages in Denmark using a worker-firm-trade integrated database for the period 1995-2006. Findings indicated a positive effect on the wages of skilled workers and a negative effect on the wages of unskilled workers.

III. Methodology

Data

Data for this research is captured from diverse sources. Manufacturing data is drawn from the Annual Survey of Industries conducted by the Department of Census and Statistics. A distinctive feature of this rich manufacturing dataset is the availability of data at the firm-level. This is a sample survey which supplements the industry census conducted once in every 10 years, providing a nationally representative sample of manufacturing industries. The survey takes the previous year as the reference period and includes all industrial establishments with 5 persons or more. The Industry Census frame is used to determine the sample of establishments to be surveyed each year. The Annual Survey of Industry sample includes 3500 to 4500 manufacturing firms each year. The geographical strata contain all 25 administrative districts of Sri Lanka.

Trade data is drawn from the United Nations Commodity Tarde database. This database is maintained by the United Nations Statistical Division. The database records import and exports data using several commodity classification methods. For this study, the Standard Industry Trade Classification method at a 5-digit level was used to extract import and export data for Sri Lanka with the rest of the world. Exports are valued on free-on-board basis and imports are valued on cost-insurance-freight basis. Exports do not include re-exports.

The data on custom duties is captured using the Tariff Analysis Online database. The Tariff Analysis Online database is maintained by the World Trade Organisation. This database maintains customs duties for each commodity based on the Harmonised System of Coding at a 6-digit level. In addition to custom duties, the government of Sri Lanka also charges a variety of tariffs on imports. Since these charges are outside the scope of customs duties specified by the World Trade Organisation, these extra charges are commonly known as para-tariffs or other levies. They include charges such as National Security Levy, Road infrastructure Development Levy, Value Added Tax on imports, Excise duties, Ports Authority Levy etc. The tariff rates of these additional levies are captured from the Tariff Guides prepared by Sri Lanka Customs. Tariff guides by Sri Lanka Customs are maintained using HS Coding at a 6-digit and 8-digit level.

Conceptual framework

How has global production sharing impacted manufacturing employment and wages as predicted by the global production sharing models? This is the research question this paper tries to address. The theoretical basis for empirically testing this research question is provided by the global production sharing models. Classical and the neo-classical trade models based on the exchange of finished commodities fail to capture the fragmentation of commodity production under global production sharing (Kemeny & Rigby, 2012). Moreover, the introduction of trade in parts and components necessitates a fundamental alteration in the classical analysis to reflect the dynamic conditions under which global production sharing takes place (McKenzie, 1954). Under global production sharing, trade in numerous parts and components takes place simultaneously with multiple trading partners (Yeats, 2001). With the splitting-up of the production process into parts and components, developing countries now have an opportunity to engage in the parts and components trade that is predicted to positively influence the demand for labour and wages (Ardnt, 1997; Feenstra, 2004; Feenstra & Hanson, 1995, 1996, 2003). Hence the research question stated above can be formulated into the following hypothesis for empirical examination.

Hypothesis: *Participation in global production sharing has a positive impact on manufacturing employment and wages in developing economies.*

This study is an attempt to model manufacturing labour and wages in response to trade stimulus. Therefore, in the labour demand model, the dependent variable is manufacturing labour *(L)*. Similarly, in the wages model, the dependent variable is average real wages *(W)*. Based on the hypothesis developed, 'global production sharing' is the key independent variable in this instance. 'Global production sharing' is depicted by four proxy variables for robustness of the results [the share of imports in parts and components *(P&C_IM)*, the share of exports in parts and components *(P&C_EX)*, the share of exports in global production sharing *(GPN_EX)* and the share of parts and components in total trade *(P&C_TR)*].

What follows is a brief discussion about the method of measuring global production sharing, followed by the operationalisation of proxy variables. Delineating parts and components from trade data are a critical aspect of measuring global production sharing. Therefore, the method of delineating import and export of parts and components from trade data is initially explained. Secondly, the variables for capturing the impact of global production sharing are explained. Measuring global production sharing is not a straightforward exercise (Blinder & Kruger, 2013; Kemeny & Rigby, 2012). Different methodologies are used to capture the effect of offshoring. Some empirical literature on international outsourcing use two measures to capture its effect following Feenstra and Hanson (1996, 1999). The broad measure is defined as the value of all imported intermediates of an industry. The narrow measure restricts attention to intermediate inputs that are purchased from the same industry as the good being produced. Due to the complexity involved in measuring trade in global production sharing, literature has often used trade in intermediate inputs or trade in parts and components to proxy for global production sharing (Audet, 1996; Campa & Goldberg, 1997; Hummels, Ishii, & Yi, 2001; Yeats, 2001). The main drawback of focusing on intermediates is that it necessarily excludes offshoring assembly activities (Hijzen & Swaim, 2007). Therefore, it is important to capture the effect of the export of parts and components and the import of parts and components in production sharing (Clark, 2010). Therefore, without explicitly modelling for parts and components in trade, an analysis of international trade in global production sharing will be misleading (Athukorala & Menon, 2010; Athukorala & Talgaswatta, 2016) given the importance stressed on service links in global production sharing (Jones & Kierzkowski, 1990). Similarly, trade in parts and components has grown at a faster rate than trade in final goods and trade in parts and components behave differently to trade in final goods (Athukorala, 2013; Athukorala & Yamashita, 2006; Yeats, 2001). A number of studies have also used the input-output technique to measure the degree of manufacturing production and trade of selected countries in global production sharing (Hummels et al., 2001; Hummels, Rapoport, & Yi, 1998; Johnson & Noguera, 2012). On the other hand, empirical literature has also used trade flows between US multinational enterprises and their foreign affiliates (Hanson, Mataloni, & Slaughter, 2005) while engaging the Dictionary of Occupational Titles for identifying the routine and non-routine tasks structure of activities in measuring the extent of global production sharing (Kemeny & Rigby, 2012). Given the availability of data and empirical limitations, global production sharing in the context of this thesis is modelled after trade in parts and components. Regardless of its downward bias, trade in parts and components is the only measure of fragmented trade (Athukorala & Yamashita, 2006).

Trade in global production sharing involves trade in parts and components and trade in final assembly goods. It is important to note the distinction between trade in 'part and components' and 'intermediate commodities' at the outset since these two terms are used interchangeably in literature vis-à-vis global production sharing. Parts and components are a subset of intermediate goods and are inputs further along the production chain. Unlike intermediate inputs, parts and components do not have a reference price, and are not sold on exchanges, demanded under a contractual environment and most importantly do not have a commercial life of their own (Nunn, 2007). Trade in intermediate inputs has often been used in literature to capture the effects of offshoring (Foster, Stehrer, & deVries, 2013; Muller & Panning, 2009). However, the main drawback of focusing on intermediate inputs is that it excludes the offshoring of assembly activities (Hijzen & Swaim, 2007). Therefore, an essential element in analysing trade in global production networks is to systematically delineate items of trade in parts and components and trade in final assembly from trade records (Yeats, 2001). One of the main reasons for the dearth of research on the impact of global production sharing is due to the lack of clarity as to which trade can be categorised as trade under global production networks and how to measure it (Banga, 2014). SITC revision 1 made it impossible to delineate parts and components in international trade. SITC revision 2 adopted a more detailed classification of parts and components, although to a limited extent (Athukorala & Yamashita, 2006). With the introduction of SITC revision 3, these difficulties have been countered, allowing one to approximate trade in global production sharing (Yeats, 2001).

Given the importance and the emphasis on the need to separate parts and components from trade flows, the analysis on trade in parts and components is based on a list meticulously prepared by Athukorala and Talgaswatta (2016) using SITC revision-3. This list identifies three hundred and fifty-five items of parts and components traded under global production sharing. Having identified the commodities that are traded as parts and components under global production sharing, Athukorala (2016) follows a simple method to identify trade in final assembly. As Krugman (2008) points out, there is no hard and fast rule to make a distinction between trade in parts and components and trade in final assembly products. The only feasible method available to delineate parts and components from final assembly products is to concentrate on the specific product categories in which network trade is concentrated. Based on the literature, Athukorala (2016) identifies fourteen product categories in which global production sharing is highly prevalent. Once these product categories are identified, a reasonable assumption is made that these product categories contain virtually no product that is produced from the start to its end in a given country. Therefore, the difference between the value of total exports and the export value of parts and components within these product categories is treated as the export value of final assembly goods.

Athukorala (2016) identifies the following product categories where trade in global production sharing mostly takes place. They include, power generating machinery (SITC-71), specialised industrial machines (SITC-72), metal working machines (SITC-73), general industrial machinery (SITC-74), office machines and automatic data processing machines (SITC-75), telecommunication and sound recording equipment (SITC-76), electrical machinery (SITC-77), road vehicles (SITC-78), other transport equipment (SITC-79), travel goods (SITC-83), clothing and clothing accessories (SITC-84), footwear and sport goods (SITC-85), professional and scientific equipment (SITC-87), and photographic apparatus (SITC-88). Of these SITC categories, 83, 84 and 85 are identified as buyer–driven production networks, while the remaining are producer-driven production networks. Once items traded as parts and components have been identified, these items have to be traced to their respective industry categories using a concordance prepared by the European Commission. This concordance matches all trade items in SITC coding to their respective industries based on ISIC revision 3.1. Delineation of parts and components enables us to construct the required regressors to capture the effects of Global Production Sharing. However, when moving forward in the modelling exercise, the regressor that is theoretically sound and with statistical power will be selected based on the principal of parsimony(Harvey, 1990).

Modelling

Following Hine and Wright (1998) and Greenaway, Hine, and Wright (1999) Milner and Wright (1998), this paper uses the Cobb-Douglas production function of the following form, which serves as the core model in this analysis;

$$Q_{it} = A^{\gamma} K_{it}^{A} L_{it}^{\beta} \quad \text{……………………..(1)}$$

where for the representative firm in industry *i* in period *t*; *Q* = real output; *K* = capital stock; *L*= units of labour utilised; *A* = technology and α, β represent the factor share coefficients while γ allows for factors changing the efficiency of the production process. Based on this, the following standard labour demand model equation (2) is derived, where *Lit* is total employment, *Wit* is average real wages, *Q*it is the real output and *K*it is real capital intensity in industry '*i*' at time '*t*' and *X*it is a vector of variables which affect the efficiency of production, so it is related to A^{γ}. The vector of variables includes the key independent variable and other control variables that impacts manufacturing employment. The *θ0* is the overall intercept and *θ1, θ2, θ3* and *θ4* are unknown slope parameters to be estimated and the error term u*it*. A profit maximising firm employs labour where the marginal revenue product of labour equals the wage (*W*).

$$\ln L_{it} = \theta_0 + \theta_1 \ln W_{it} + \theta_2 \ln Q_{it} + \theta_3 \ln K_{it} + \theta_4 \ln X_{it} + u_{it} \quad \text{……………(2)}$$

Similarly, wages are determined by numerous factors, and following Greenaway et al. (1999); Hine and Wright (1998); Milner and Wright (1998), and the following wages equation is derived (3), where *Wit* is average real wages, *Lit* is total employment, *Q*it is the real output and *K*it is real capital intensity in industry '*i*' at time '*t*'. *Xit* represents a vector of variables that are engaged in the wage setting process and includes the key independent variable and other control variables that impacts wages. The *β0* is the overall intercept and *β1, β2, β3* and *β4* are unknown slope parameters to be estimated and the error term εit.

$$\ln W_{it} = \beta_0 + \beta_1 \ln L_{it} + \beta_2 \ln Q_{it} + \beta_3 \ln K_{it} + \beta_4 \ln X_{it} + \varepsilon_{it} \quad \text{…………..(3)}$$

Variables

In the labour demand model, manufacturing labour is the main outcome variable. In the wages model, the main outcome variable is manufacturing wages. The research question is about analysing the impact of global production sharing on manufacturing employment and wages. Based on the hypothesis developed, 'global production sharing' is the key independent variable in this instance. 'Global production sharing' is depicted by four proxy variables for robustness of the results [the share of imports in parts and components *(P&C_IM)*, the share of exports in parts and components *(P&C_EX)*, the share of exports in global production sharing *(GPN_EX)* and the share of parts and components in total trade *(P&C_TR)*]. The study alternates between several proxy measures of global-production sharing in ensuring the model's sensitivity and the robustness of the empirical findings. The share of imports in parts and components (*P&C_IM*) is estimated as the value of real imports in parts and components expressed as a percentage of total real imports following Kohpaiboon and Jongwanich (2013, 2014). It indicates the extent to which an industry is engaged in global production sharing. The higher the import share, the more the industry is involved in global production sharing. The share of exports in parts and components (*P&C_EX*) is estimated as the value of real exports in parts and components expressed as a percentage of total real exports. The share of exports in global production sharing (*GPN_EX*) is estimated as the value of real exports in global production networks expressed as a percentage of total real exports. Exports in global production sharing include exports in parts and components and exports in final assembly. The share of parts and components in total trade (*P&C_TR*) is estimated as the value of total real exports and imports in parts and components expressed as a percentage of total real manufacturing imports and exports following Kohpaiboon and Jongwanich (2013, 2014). Firms might be engaged in global production sharing as parts and components suppliers and therefore the focus on the import of parts and components alone might be misleading. Therefore, trade instead of imports is used to mitigate such a problem.

We also use few control variables in the analysis; manufacturing output *(Q)*, capital intensity *(KI)*, skills intensity *(SKI)*, marginal efficiencies of production *(MEP)*, import penetration ratio *(IP)*, custom duties (CD) and para tariffs *(PT).*

The operational definitions of the variable are presented accordingly in table 1.

Table 1: Variable definition

Variable	Definition
L	Labour is expressed in its natural logarithmic form. This includes all type of manufacturing labour.
Q	Real output is expressed in its natural logarithmic form.
W	Average real wages are expressed in its natural logarithmic form.
K	Capital intensity is the real output divided by real value of machinery, expressed in its natural logarithmic form.
EI	Export-intensity is the value of real exports expressed as a percentage of real output
IP	Import penetration is measured as the value of real imports expressed as a percentage of real consumption
SKI	Skills-intensity is estimated by expressing the share of skilled factory operatives as a percentage of total manufacturing workers
MEP	Marginal efficiency of production is measured as the average plant size of the top fifty percent of firms expressed as a percentage of total output
CD	Industry structure variables Custom duties is estimated using the simple average tariff of all tariff lines for each four-digit manufacturing industry.
PT	Para-tariffs is estimated using the simple average of all para-tariff lines at each four-digit manufacturing industry level.
RDI	Research and development intensity is measured as the share of technicians in total manufacturing employment
P&C_IM	The share of imports in parts and components is estimated as the value of real imports in parts and components expressed as a percentage of total real imports
P&C_EX	The share of exports in parts and components is estimated as the value of real exports in parts and components expressed as a percentage of total real exports.
GPN_EX	The share of exports in global production sharing is estimated as the value of real exports in global production networks expressed as a percentage of total real exports. Exports in global production sharing include exports in parts and components and exports in final assembly.
P&C_TR	The share of parts and components in total trade is estimated as the value of total real exports and imports in parts and components expressed as a percentage of total real manufacturing imports and exports

Analytical technique

Given that the research question is theory testing and the data is quantitative in nature, a quantitative method of analysis is adopted. Therefore, a multiple regression analysis technique is engaged to empirically analyse the impact of global production sharing on employment and wages in the manufacturing industry. This study is based on a trade and industry panel data set covering the period 1994 to 2011. Given that the dataset is a panel, a panel data technique should be employed in the analysis of data. Initially, a pooled ordinary least squares regression was conducted. Accordingly, a Breusch-Pagan Lagrangian multiplier test was conducted to determine whether the pooled regression was consistent or not. The estimated test results were significant, implying that pooled regression is not an appropriate method in this case. Given this, researchers often use a fixed effects model or a random effects model in analysing panel data. Following the Hausman (1978), the fixed effect estimation model is engaged.

Regression diagnostics
A preference for economic theory over method was followed as recommended strongly by Studenmund (2001) for selecting variables to the model. To complement, several alternative formal model specification tests were performed. This study is based on a trade and industry panel data set covering the period 1994 to 2011 and is an unbalanced panel dataset with gaps. To avoid inflation leading to spurious correlation, all nominal values have been adjusted for inflation to be comparable across different time points. Spurious correlation is caused by nonstationary time series. Accordingly, both the Augmented Dickey Fuller test and the Phillips-Perron unit-root tests were conducted. The null hypothesis was rejected at less than 1 percent level of statistical significance. Several tests for multicollinearity such as the correlation matrix and the sensitivity of the model when adding and deleting independent variables were checked. When tested for multicollinearity, the variance of inflation factor was less than 1.5 except in the case of two variables yet, well below the standard. Models were also tested for heteroscedasticity. Since the dataset we have is a panel that is unbalanced and with gaps, there is no robust mechanism that tests for heteroscedasticity, when using a fixed effects model. Given the limited options, heteroscedasticity is tested using a graphical method of detection (Gujarati, 1998). The models were also tested for serial correlation. The DW statistics for both the labour demand and the wages model converges to 2, thereby indicating no serial correlation. Having conducted different tests and precautions in modelling for labour demand and wages, their robustness is also investigated. The estimated labour demand model is robust in conventional statistical terms. Drawing attention to the final labour demand model, the model is statistically significant at less than one percent as indicated by the F-statistics. It possesses a high level of explanatory power as indicated by the adjusted R-squared (0.8431). On the wages model, according to the conventional statistical measures, the estimated model is robust. The wages model is statistically significant at less than one percent as indicated by the F-statistics. It possesses a satisfactory level of explanatory power as indicated by the adjusted R-squared (0.4846).

IV. Results and discussion

The results of the labour demand model are presented in table 2 below.
Labour demand model

Table 2: Labour demand model-Impact of global production sharing on manufacturing employment

	1	2	3	4
Q	0.7106a	0.7101a	0.7104a	0.7115a
	[61.66]	[61.33]	[61.63]	[61.62]
W	-0.5307a	-0.5313a	-0.530a	-0.5309a
	[-16.20]	[-16.19]	[-16.19]	[-16.21]
K	-0.0758a	-0.0754a	-0.0758a	-0.0766a
	[-6.95]	[-6.91]	[-6.95]	[-7.02]
EI	0.00001a	0.00001a	0.00001a	0.00001a
	[2.56]	[2.55]	[2.55]	[2.63]
IP	0.00004b	0.00004b	0.00004b	0.00004c
	[1.99]	[2.02]	[1.99]	[1.87]
SKI	0.0033a	0.0033a	0.0033a	0.0033a
	[3.65]	[3.64]	[3.66]	[3.63]
MEP	-0.0038a	-0.0039a	-0.0038a	-0.0038a
	[-7.06]	[-7.12]	[-7.06]	[-7.04]
PT	-0.0052a	-0.0052a	-0.0053a	-0.0052a
	[-5.23]	[-5.30]	[-5.33]	[-5.24]
RDI	-0.0060c	-0.0061c	-0.0061c	-0.0060c
	[-1.88]	[-1.91]	[-1.92]	[-1.89]

P&C_IM	-0.0027 [-1.45]			
P&C_EX		-0.0004 [-0.37]		
GPN_EX			-0.0018 [-1.20]	
P&C_TR				-0.0034c [-1.80]
Constant	-1.0201a [-3.14]	-1.0344a [-3.18]	-1.0006a [-3.07]	-1.0256a [-3.16]
N	1327	1327	1327	1327
R2	0.8437	0.8479	0.8422	0.8431
F	16.04a	15.95a	15.91a	16.07a

t-values in parentheses. a Significance at 1 percent, b at 5 percent, c at 10 percent

The coefficient on the share of imports in parts and components is negative on manufacturing employment, although statistically insignificant. Similarly, the coefficient on the share of exports in parts and components is also negative and statistically insignificant on manufacturing employment. In the same manner, the coefficient on the share of exports in global production exports is also negative and statistically insignificant on manufacturing employment. However, the coefficient of the share of parts and components in total trade is negative and statistically significant on manufacturing employment. Therefore, all the regressors that capture the effects of global production sharing are negative on manufacturing employment and are in the same direction. Therefore, based on theoretical soundness and the statistical power of the regressor on the share of parts and components in total trade, this variable is selected to represent global production sharing in the final model. Given that the coefficient on the share of parts and components in total trade is negative and statistically significant on manufacturing employment, the empirical findings are against theoretical predictions. Theoretically, developing economies are predicted to gain on employment and wages by engaging in global production sharing. However, empirical findings adamantly contradict the theoretical predictions. Although the findings are against the theoretical expectations, similar results from developed and developing economies are reported following Banga (2016); Joanna and Parteka (2015); Mullen and Panning (2009); Paul and Seigel (2001). However, there are empirical findings that have reported a positive effect of global production sharing on manufacturing employment following Egger and Egger (2003); Hijzen and Swaim (2007).

The empirical findings discussed above on the impact of global production sharing on manufacturing employment are against theoretical expectations. As opposed to the conventional trading along final commodities, trade along the lines of global production sharing forges fewer domestic linkages to achieve growth in employment. Hence, low value addition criterion under global production sharing create less scope for employment creation. On the other hand, the share of exports in global production sharing is on a declining trend as a reaction to the less conducive macroeconomic conditions that in turn affect manufacturing employment negatively. Similarly, global production sharing in Sri Lanka is highly concentrated into a single labour-intensive and low technology product in which the demand is on a declining trend with detrimental effects due to competition posed by new market entrants. Moreover, the labour-intensive segments of production that are transferred to developing economies are often capital-intensive in nature for these developing economies. In turn, these capital-intensive foreign technologies have a negative impact on manufacturing employment. What follows is a more elaborative discussion on few of the possible reasons for the negative effect of global production sharing on manufacturing employment in Sri Lanka.

Poor backward linkages and low value addition

The effect of backward linkages in a global production environment could be multi-fold. When parts and component imports are complementary to existing domestic resources, a positive effect on employment could be expected. A negative effect is expected when parts and component imports are substitutes of domestic production (Davis & Prachi, 2007). Import liberalisation in Sri Lanka displaced labour from import-substitution industries, while numerous industries that had the potential to be vertically linked were wiped out (Kelegama & Wignaraja, 1991) as manufacturing exports from Sri Lanka are highly import-intensive it leads to fewer backward linkages to other sectors of the economy (Athukorala & Rajapathirana, 2000a, 2000b). As an example, textile and wearing apparel industry that is highly linked to global production sharing imports an estimated 80-90 percent of its inputs- even items such as fabric, buttons, zippers, studs, eyelets, buckles, interlining, padding and corrugated cartons which can be procured by the local suppliers (Lopez & Robertson, 2012). This makes the garment industry the lowest in terms of value addition (Kelegama & Foley, 1999). Low value addition, leads to low employment opportunities. On the other hand, according to Athukorala and Santosa (1997), forging domestic linkages to achieve growth in employment is not possible in an era of global production sharing. They argue that the conventional value addition criteria cannot be applied when sourcing inputs under global production sharing as it is determined as a part of an overall process of international procurement (Athukorala & Santosa, 1997). For example, garment manufacturers have to follow instructions on where to purchase their fabrics, inputs and machinery to ensure the right quality and uniformity of the product. Therefore, local producers of intermediate supplies are easily by-passed under global production sharing leading to their ultimate displacement (Knutsen, 2003) as export-oriented firms are poorly linked to domestic market oriented firms (Kelegama & Foley, 1999). Moreover, under global production networks, it is the lead firms in industrialised economies that perform most of the value added activities (Cardero, Mantey, & Mendoza, 2006) while the less-value added activities are outsourced to developing economies (Lopez & Robertson, 2016). Therefore, in a global production environment, the relevance of the conventional domestic value addition criteria in generating economic growth and employment opportunities in a developing country context such as Sri Lanka is doubtful.

Declining share of exports in global production sharing

Trade under global production sharing is sensitive compared to trade in final commodities in a traditional manufacturing environment. Due to its segmented nature, manufacturers practicing global production sharing are in a flexible position to shift production from one country to another. For example, Sri Lanka was an attraction to quota hopping manufacturers under the Multi-Fibre Agreement. These opportunistic investors came to Sri Lanka to take advantage of the unmet quota allocations when they had exhausted the quota's in East Asia (Kelegama, 2009). Once these investors recouped their investments, coupled with rising wages, removal of tax incentives, abolition of the Multi-Fibre Agreement, and the suspension of the Generalised System of Preferences, these manufactures shifted production to other low-cost destinations. In Sri Lanka, the share of exports in global production sharing as a percentage of total exports has continued to decline from 33.0 percent from 2001 onwards. Similarly, the share of exports in global production sharing as percentage of manufacturing exports has continued to shrink from 56.7 percent from 2000 onwards. In terms of GDP, exports in global production networks in GDP has continued to erode from a share of 10.8 percent in 2000 to 5.0 percent by 2014. In the case of exports in parts and components, the share of exports in parts and components in manufacturing exports has reduced from 10.25 percent from 2001 onwards [Table 3]. Since the demand for labour is a derived demand, the declining share of exports in global production exports has negatively affected manufacturing employment.

Table 3: Manufacturing exports in global production sharing

	Exports in global production networks as a percentage of manufacturing exports	Exports in global production networks as a percentage of total exports	Buyer driven exports in global production sharing as a percentage of manufacturing exports	Share of buyer driven exports in global production sharing in total exports in global production exports	Share of producer-driven exports in global production sharing in total exports in global production sharing	Share of exports in global production sharing as a percentage of GDP	Share of parts and component exports as a percentage of manufacturing exports
1994	47.15	26.8	42.71	90.58	9.42	7.3	4.73
1995	56.08	33.9	50.83	90.64	9.36	9.9	5.82
1996	56.10	33.8	49.62	88.44	11.56	10.0	6.97
1997	58.63	36.1	50.82	86.67	13.33	11.1	8.09
1998	57.50	35.9	50.22	87.35	12.65	10.9	7.75
1999	57.19	31.7	50.39	88.11	11.89	9.3	7.05

2000	56.73	32.3	48.30	85.14	14.86	10.8	9.00
2001	57.10	33.0	47.43	83.06	16.94	10.1	10.25
2002	51.57	29.1	44.08	85.48	14.52	8.2	7.83
2003	50.03	26.2	42.80	85.54	14.46	7.4	8.21
2004	50.83	27.6	40.74	80.14	19.86	7.9	11.33
2005	46.06	26.9	38.76	84.16	15.84	7.0	8.04
2006	47.12	27.9	38.33	81.35	18.65	6.8	9.46
2007	46.88	26.9	37.02	78.96	21.04	6.4	10.32
2008	46.31	28.4	38.53	83.19	16.81	5.7	7.91
2009	49.07	28.4	43.33	88.30	11.70	4.8	5.44
2010	47.22	26.5	39.35	83.33	16.67	4.6	6.50
2011	47.12	28.6	39.28	83.37	16.63	5.1	6.37
2012	49.17	29.6	40.97	83.33	16.67	4.9	6.77
2014	59.19	29.1	40.12	83.35	16.65	5.0	6.57

Source: Computed by the author based on UN Comtrade database

Global production sharing concentrated into few industries

Global production sharing is not substantial enough to warrant a significant impact on employment and wages in developing economies (Hijzen et al., 2005). More than 80 percent of exports in global production exports in Sri Lanka are concentrated into buyer-driven exports [Table 4]. When even buyer-driven exports in global production sharing are analysed, an excessive concentration on one specific manufacturing industry is observable. This is a major cause for the negligible effect of global production sharing on manufacturing employment and wages. Of the buyer-driven exports in global production, the share of exports in global production networks in wearing apparel accounted for 78.8 percent followed by exports in luggage, handbags, items like saddlery (7.5 per cent) and exports in other rubber products (6.4 per cent) in 1996. By 2011, exports in wearing apparel had consolidated into a lion's share of buyer-driven exports in global production sharing (90.8 per cent). Therefore, although wearing apparel industry is linked to global production networks, other manufacturing industries are poorly linked to global production networks thus exerting a minimal impact on manufacturing employment.

Table 4: Buyer-driven exports in global production sharing by year and manufacturing industry

ISIC	Description	1996	1999	2002	2005	2008	2011
1730	Manufacturing of knitted, crocheted fabrics	2.9	2.2	2.1	1.8	0.9	0.9
1810	Manufacturing of wearing apparel	78.8	77.7	84.9	88.7	90.8	90.8
1820	Dressing, dying of fur	0.0	0.0	0.0	0.0	0.0	0.0
1912	Manufacture of luggage, handbags	7.5	10.0	4.8	1.4	0.3	0.1
1920	Manufacturing of footwear	3.8	5.3	1.5	0.9	1.2	0.6
2519	Manufacturing of other rubber products	6.4	4.4	5.7	6.6	6.4	7.4
2520	Manufacturing of plastic products	0.2	0.5	0.9	0.7	0.4	0.2
		100.0	100.0	100.0	100.0	100.0	100.0

Source: Computed by author based on UN Comtrade database

Capital-intensive [labour-saving] nature of activities outsourced

The impact of global production sharing on employment depends on the relative factor intensity of the stage of production allocated (Helleiner, 1973; Venables, 1999). Developed countries transfer the labour-intensive segments of production to developing countries abundant in labour. These labour-intensive segments are relatively capital-intensive and labour-saving in nature for developing countries (Cardero et al., 2006; Feenstra, 1998; Feenstra & Hanson, 1995, 2003; Lopez & Robertson, 2016). These capital-intensive production segments require skilled labour. Therefore, a shift from unskilled to skilled labour could be observed in developing economies (Cardero et al., 2006; Devadason, 2007). This phenomenon is also evidenced in Sri Lanka. With global production sharing, a radical shift from unskilled labour to skilled labour is evidenced. By 2014, more than 75 percent of the factory operatives were skilled workers and a minority were unskilled operatives, confirming that the work outsourced to Sri Lanka is skilled and capital-intensive in nature.

Wages model

'How has global production sharing impacted manufacturing wages as predicted by the global production sharing models?'. This is the next research question of this paper. Drawing on this, the conceptual framework hypothesized that 'participation of global production sharing has a positive impact on manufacturing employment and wages in developing economies'. In this section, the focus is on ascertaining the impact of global production sharing on 'manufacturing wages'. Following the hypothesis drawn, the key independent variable is 'global production sharing' depicted by four proxy variables [the share of imports in parts and components *(P&C_IM)*, the share of exports in parts and components *(P&C_EX)*, the share of exports in global production sharing *(GPN_EX)* and the share of parts and components in total trade *(P&C_TR)*]. The dependent variable in the analysis is average real wages *(W)*, while the analysis controls for other factors that influence manufacturing wages.

Table 5: Wages Model- Impact of global production sharing on manufacturing wages

	1	2	3	4
Q	0.3547a	0.3550a	0.3544a	0.3553a
	[22.74]	[22.80]	[22.74]	[22.74]
L	-0.3307a	-0.3300 a	-0.3304a	-0.3311a
	[-15.99]	[-15.98]	[-15.98]	[-16.00]
K	-0.0172b	-0.0169b	-0.0172b	-0.0176b
	[-1.94]	[-1.92]	[-1.94]	[-1.98]
EI	0.00001c	0.00001c	0.00001c	0.00001c
	[1.67]	[1.73]	[1.66]	[1.70]
IP	0.00002	0.00002	0.00002	0.00002
	[1.44]	[1.35]	[1.44]	[1.38]
SKI	0.0023a	0.0023a	0.0023a	0.0023a
	[3.19]	[3.19]	[3.19]	[3.18]
MEP	-0.0005	-0.0005	-0.0005	-0.0005
	[-1.16]	[-1.19]	[-1.15]	[-1.15]
CD	0.0028a	0.0028b	0.0029b	0.0028b
	[2.28]	[2.22]	[2.27]	[2.26]
RDI	0.0108a	0.0108a	0.0108a	0.0108a
	[4.28]	[4.29]	[4.27]	[4.28]
P&C_IM	-0.0009			
	[-0.62]			
P&C_EX		-0.0011		
		[-1.27]		
GPN_EX			-0.0006	
			[-0.48]	
P&C_TR				-0.0013
				[-0.85]
Constant	5.6296a	5.6215a	5.6357a	5.6261a
	[27.75]	[27.73]	[27.67]	[27.75]
N	1327	1327	1327	1327
R2	0.4873	0.4878	0.4806	0.4846
F	7.18a	7.24a	6.78a	7.20a

t-values in parentheses. a Significance at 1 percent, b at 5 percent, c at 10 percent

The coefficient on the share of imports in parts and components is negative and statistically insignificant on manufacturing wages. The coefficient on the share of exports in parts and components is negative and statistically insignificant on manufacturing wages. Similarly, the coefficient on the share of exports in global production sharing on wages is negative and statistically insignificant. Finally, the coefficient on the share of parts and components in total trade is also negative and statistically not significant on manufacturing wages. Given that all four regressors are statistically insignificant, there is no conclusive evidence on the impact of global production sharing on manufacturing wages. Empirical evidence from other countries on the impact of global production sharing on wages has been in both directions; either positive or negative. Global production sharing is found negative on wages following Egger and Egger (2002); Hummels et al. (2014); Kohpaiboon and Jongwanich (2013); Mullen and Panning (2009), while it is reported to have a positive effect on wages following Autor, Katz, and Kruger (1998); Hanson and Harrison (1999); Kohpaiboon and Jongwanich (2014).

All regressors on global production sharing were adamantly negative on wages, although statistically insignificant. Therefore, the impact of global production sharing on manufacturing wages in Sri Lanka is inconclusive. The discussion below is centred around to the question of why manufacturing wages in most instances does not react to global production sharing in a developing country context as theoretically predicted. Producers controlling production chains do not always share the principal profits from global production sharing among workers in developing economies (Gereffi & Korzeniewicz, 1994). Power relations along production chains determine what activity is to be allocated to which production node (Gereffi et al., 2005). In other words, the lead firm decides on the chain surpluses, its appropriation, how much of the surplus will be reinvested in which node and what nodes will cover adjustment costs when surpluses are low (Knutsen, 2003). Usually, lead firms in developed countries extract surpluses from the periphery by coordinating and controlling the links (Gereffi & Korzeniewicz, 1994). On the other hand, the peripheral countries are only engaged as platforms to export low technology, labour-intensive goods made using low-waged labour (Lopez & Robertson, 2016). Retaining wage growth in the periphery is possible as multinational corporations have the ability to shift production from one destination to another due to the nature of global production sharing. These threats of production shifting are powerful enough to slow the real wage growth in developing economies (Athukorala & Kohpaiboon, 2013). As a result, the generated profits are taken away by transnational companies based in developed countries that are in control of the entire value chain of designing, marketing, and retailing activities (Derick et al., 2011). This impedes reinvestments in technological upgrading making suppliers more vulnerable to competition in the longer term which would have negative effect on employment and wages (Knutsen, 2003). Case studies from China show that for the Apple iPod, only 4 USDs are attributed to the producers located in China out of the 150 USD, while the rest of the value accrues to Japan, South Korea, and the US (Derick et al., 2010). Since capital is mobile across countries and labour is easily substitutable (in the case of unskilled labour-intensive manufacturing), the dominant firms that control these supply chains intimidate small producers with the threat of exit or the relocation of capital elsewhere (Nathan, 2007). Such threats result in squeezing both wages paid to workers and prices paid to small producers (Kaplinsky, 2005).

V. Conclusion

Recasting on whether the final research objective was achieved, the aim was to empirically examine the impact of global production sharing on employment and wages in the manufacturing industry. The theoretical basis for this empirical examination was drawn from the Global production sharing models. Considering the impact on manufacturing employment using labour demand model, the impact of global production sharing is negative and statistically significant on manufacturing employment against theoretical expectations. On the other hand, on the impact on wages using the wages model, all proxy explanatory variables on global production sharing display signs against the theoretical expectation, while the results are statistically not significant. Therefore, the results on the impact of global production sharing on manufacturing wages is inconclusive.

Acknowledgement

I am grateful to Ms Anjalin Balalingham for doing an excellent job in proofreading this paper.

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