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Structural transformation and inequality: Does trade openness matter?

Wannaphong Durongkaveroj *

Abstract

The purpose of this paper is to examine how trade openness impacts on income inequality in the process of economic transformation. The paper begins with an analytical framework drawing on Kuznets (1955) to set the stage for the empirical analysis. It then examines the role of trade openness in the structural transformation-income inequality nexus using a multi-country panel data analysis covering 48 countries for the period from 1960 to 2010. The results suggest that an increase in the share of employment in manufacturing reduces inequality, irrespective of the stages of structural transformation, and the impact on income inequality is larger for countries with higher degree of trade openness. The findings withstand controlling for the other relevant explanatory variables and the use of different estimators.

Keywords: structural change, inequality, trade openness, inequality

JEL codes: O10, O24, O53

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1. Introduction

The relationship between economic growth and income inequality is a key focus of the development policy debate. The empirical studies on this subject are centred on the hypothesis derived from Kuznets (1955) that income inequality first increases and then tends to decrease in the process of economic growth, resulting in an inverted U-shaped relationship between economic growth and income inequality (the Kuznets hypothesis).

In this seminal paper, Kuznets postulates this relationship as driven by a progressive structural shift in labour at the early stage of economic advancement from the traditional sector (predominantly agriculture), where the productivity is low and income is more equally distributed, to the modern sector with high productivity but more unequal distribution of income. The Kuznets hypothesis receives several critiques. At theoretical level, in addition to the migration process, the reduction in income inequality in the rich countries before 1950 has little to do with intersectoral mobility, and Kuznets' analysis on the evolution of inequality ignores political and institutional factors (Piketty, 2006, 2014).[1] Milanovic (2016) introduces the idea of the so-called Kuznets' wave (successive periods of rising and falling of inequality) and argues that Kuznets overlooks some malign forces (e.g., wars and disasters) that equalises income inequality. In addition, the empirical results from the vast literature attempting to test for this hypothesis are inconclusive. The traditional empirical literature[2] has tested the Kuznets hypothesis by focussing on the relationship between GDP per capita and

[1] However, Kanbur (2017) argues that these factors proposed by Piketty (2006, 2014) are well discussed in Kuznets (1955).

[2] For survey of this vast literature, see Fields (2002), Galor & Tsiddon (1996), Voitchovsky (2009).

income inequality (commonly measured by the Gini coefficient), ignoring the underlying 'Kuznets process' (*a la* Anand & Kanbur (1993a, 1993b)). The findings of the multi-country studies of testing the hypothesis, both cross-country and panel data analyses, are rather mixed presumably because the nature and timing of the process of structural shift in labour deployment and policy regimes that impact on the process vary among countries (Alvaredo and Gasparini, 2015; Deininger and Squire, 1988; Gallup, 2012). Kanbur (2019) notes that this body of literature has ignored the mechanisms that gives rise to the relationship through a shift of population from low productivity sectors to high productivity sectors.

The recent papers by Angeles (2010) and Baymul and Sen (2019, 2020) deserve attention as attempts to examine the growth-inequality nexus departing from this traditional approach. They have focussed on shifts in sectoral employment, a superior manifestation of structural transformation on inequality in line with the Kuznets hypothesis. Angeles (2010) examines the impact of shifts in labour from agriculture to non-agricultural portion (measured by the non-agricultural share in total employment) on income inequality through both panel estimation and intertemporal analysis of selected countries. The results are mixed presumably because the non-agricultural sector as defined in this study lumps together a diverse mix of manufacturing and services activities. Baymul and Sen (2019, 2020) examine the structural transition and income inequality relationship by disaggregating the non-agricultural sector into three sub-sectors: manufacturing, non-manufacturing industry[3] and services. This paper comes up with two interesting findings: (a) the movement of workers to manufacturing unambiguously decreases income inequality, irrespective of the stage of structural transformation of a country, and (b) the movement of workers into services has a positive impact on inequality across of countries at an early stage of structural transformation and a

[3] Mining, utilities, and construction.

negative effect at a later stage, suggesting that the Kuznets postulate of increase in inequality in the process of structural transformation may apply more for services-driven structural transformation than manufacturing-driven structural transformation. The first inference is particularly relevant for the contemporary policy debate on the role of manufacturing in achieving growth with equity in developing countries.

The purpose of this paper is to add an important dimension to this fledging literature on structural change and income inequality, namely the impact of openness to trade on the postulated patterns of labour reallocation among sectors. International trade is one of the key factors that drives the speed and direction of structural transformation on an economy (Betts, Giri, & Verma, 2017; Johnston & Nielsen, 1966; McMillan, Rodrik, & Verduzco-Gallo, 2014; Teignier, 2018; Whang, 2017). The standard trade theory predicts that the structure of production in an open economy is associated with the level and composition of international trade (Syrquin, 1988). Since developing countries are typically endowed with low-skilled labour, trade can benefit developing countries by creating the demand for low-skilled workers. This trade-led structural transformation could therefore reinforce a movement of workers out of agriculture. This postulate is consistent with the available evidence on policy regime shifts from import-substitution industrialisation (ISI) to export-oriented industrialisation (EOI) in developing countries, in particular the experiences of the high-performing economies in East Asia (Fei & Ranis, 1964; Krueger, 1978; Manning & Posso, 2010; World Bank, 1993). However, the role of trade has not received attention in the recent literature on structural transformation and inequality.

The Kuznets hypothesis implicitly assumes a closed economy. In this paper, I develop an analytical framework to link the Kuznets process of structural transformation to openness to trade and apply it to a multi-country panel dataset put together with scattered sources covering 48 countries from 1960 to 2010. Trade openness is measured by two indicators: the

trade-to-GDP ratio and the price convergence index (PCI). The PCI captures convergence of prices of tradable goods among countries, drawing on research by Jeffrey Williamson and other studies on relative price movement of traded goods in the context of economic globalisation.

The results suggest that the movement of workers to manufacturing unambiguously reduces income inequality, regardless of the stages of structural transformation. Using the price convergence index as a measure of trade openness, the results support the hypothesis that the inequality-reducing impact of manufacturing-led structural transformation is significantly larger for countries with more open trade regimes. However, this findings only hold when African countries are excluded from the country coverage. The results are robust to different measures of income inequality, different estimation methods, and an inclusion of other relevant explanatory variables such as government expenditure and human capital. The findings support the view that, at the initial stage of development, a country has the potential to achieve the twin objectives of growth and income equality through the export-oriented industrialisation strategy.

The paper is structured as follows: Section 2 examines the role of trade openness in structural transformation and its implication for income inequality. Section 3 discusses the econometric methodology and data. Section 4 presents the results. Section 5 summarises the key findings with suggestions for further research.

2. Structural transformation, trade openness, and inequality

2.1 The Kuznets hypothesis

Kuznets (1955) postulates an inverted U-shaped relationship between economic growth and inequality, with inequality first increasing and then decreasing. The underlying mechanism is ‘structural transformation’ in the process of economic growth, which is defined as the shift of

the labour force from the traditional sector (predominantly agriculture) to the modern sector (manufacturing and related activities).

The behaviour of inequality during the course of structural transformation (the 'Kuznets process', as Anand and Kanbur (1993b) have dubbed it) can be understood by decomposing income inequality in the economy into within- and between-sector inequality. *Between-sector of inequality* here is the value of inequality measure when everyone in a sector receives the mean income of that sector. By definition, between-sector inequality is zero when everyone is in the same sector since there is no difference in mean income. It is positive when workers start working in various sectors, for example, when they move from agriculture to non-agriculture.

Let us define *within-sector inequality* as the difference between total inequality and between-sector inequality as defined above. The value of this measure depends on the assumption one makes on within-sector inequality. The movement of workers from a sector with low within-sector inequality to a sector with high within-sector inequality increases total inequality.

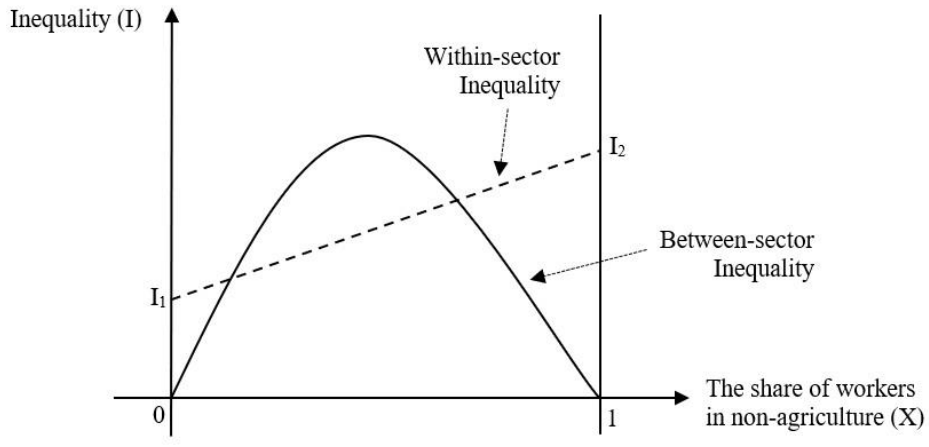

Figure 1: The Kuznets process
Source: Anand & Kanbur (1993b)

Figure 1 illustrates the Kuznets process. The economy comprises two sectors: agriculture and non-agriculture (the modern sector). The share of workers in the non-agricultural sector, x, is shown on the horizontal axis and the degree of inequality on the vertical axis. The solid line indicates the between-sector component of inequality and the dashed line the within-sector component of inequality.

Kuznets (1955) assumes that per capita income of non-agriculture is always higher than that of agriculture and income is more equitably distributed within agriculture compared to that in non-agriculture. With these assumptions, when workers move from agriculture to non-agriculture, the between-sector component of inequality first rises and then falls with an increase in x. This is because, at the early phase of structural transformation, only a small share of workers receives higher wage in the non-agricultural sector. The between-sector component of inequality declines at the later stage of structural transformation when a larger proportion of workers move to the non-agricultural sector. Therefore, between-sector inequality follows a hump-shaped curve. In contrast, the within-sector component of inequality rises continually with an increase in x. This is because the weight of the more unequal distribution (the non-agricultural sector) in total inequality of the economy keeps increasing in the process of structural transformation. Thus, within-sector inequality has a positive slope.

Total inequality depends on these two components of inequality. At the beginning of structural transformation, both the between- and the within-sector components of inequality increase. At a later stage of structural transformation, as the within-sector component of inequality still increases, whether total inequality keeps increasing or starts declining depends on how much the between-sector component of inequality declines. As Kuznets (1955, p. 17) writes: ‘the major offset to the widening of income inequality…must have been a rise in the income share of the lower groups within the non-agricultural sector of the population.’

The Kuznets hypothesis has spawned a voluminous empirical literature. As data required for directly examining the Kuznets process are not available, the relationship between GDP per capita and income inequality (commonly measured by the Gini coefficient) has been tested using a variety of approaches in search of evidence supporting the Kuznets hypothesis. Early studies examined the relationship using multi-country cross-section regression approach. The results of these studies are mixed. Some of these studies find support for the hypothesis (Ahluwalia, 1976a, 1976b; Kravis, 1960; Paukert, 1973). The cross-section approach has also come under criticisms mainly because this approach does not take into account the evolution of income inequality within country that is central to the Kuznets hypothesis (Anand & Kanbur, 1993a; Bowman, 1997; Saith, 1983). Some of the subsequent studies using panel data have confirmed the validity of the inverted U-shaped relationship between development and inequality such as Barro (2000, 2008) and Chambers (2007). However, there is a large number of studies that has failed to find the robust results to support the hypothesis regardless of their choice of cross-sectional or panel data approaches (Anand & Kanbur, 1993b; Deininger & Squire, 1998; Huang, Lin, & Yeh, 2012; Matyas, Konya, & Macquarie, 1998; Papanek & Kyn, 1986). Kanbur (2019) describes that "scepticism about the Kuznets inverse-U became the norm, even using more comprehensive data compilations."

The recent papers by Angeles (2010) and Baymul and Sen (2019, 2020) test the validity of the Kuznets hypothesis using a different approach. Instead of focussing on the relationship between GDP per capita and inequality, they focus on the movement of workers out of agriculture, which is the underlying process in line with the Kuznets hypothesis. Angeles (2010) investigates the impact of the shift of population outside agriculture (defined as one minus the percentage of the labour force employed in the agricultural sector) on income inequality through both panel estimation and intertemporal analysis of selected

countries (separate regression for each country). The share of the population living in urban areas is used as an alternative measure. This paper does not find support for Kuznets' hypothesis in country by country regression. The results are mixed presumably because a diverse mix of activities are aggregated together under non-agriculture and because of countries fixed effects (e.g., institution and production mix).

Baymul and Sen (2019, 2020) examine the structural transformation and income inequality relationship by disaggregating the non-agricultural sector into three sub-sectors, namely, manufacturing, non-manufacturing industry, and services. They find some evidence of heterogeneity in the within-sector component of inequality between manufacturing and services. Manufacturing tends to have lower within-sector inequality compared to services. This is because the manufacturing sector is more labour-intensive and hence return to labour accounts for the sufficiently large proportion of income distribution. In addition, manufacturing activities generally take place within the formal sector compared to services; therefore, wages are presumably compressed by minimum wages and other labour regulations. This suggests that the movement of workers from agriculture to manufacturing tends to squeeze the within-sector component of inequality while the movement of workers to services tends to exacerbate it.

The study has come up with two interesting findings. First, the movement of workers to manufacturing unambiguously decreases income inequality, regardless of the stage of structural transformation. Second, the movement of workers into services increases inequality at an early stage of structural transformation and reduces inequality at a later stage. The results indicate that the Kuznets postulate of increase in inequality in the process of structural transformation may apply more for services-driven structural transformation, and countries have the potential to bypass the stage of increasing income inequality through industrialisation even at the early stage of economic development.

2.2 The role of trade openness in structural transformation

The Kuznets hypothesis implicitly assumes a closed economy. This assumption, however, is not consistent with the experiences of developing countries in the past few decades that have increasingly participated into the world economy. Cross-country regression studies on the structural transformation-inequality nexus have also failed to systematically address the questions of how trade openness can impact on this relationship.[4]

Trade openness can affect *total* inequality in two ways. On the one hand, trade openness can reduce inequality through employment generation in export-oriented industrialisation (EOI). The findings of a series of in-depth comparative country studies in the 1970s and 1980s, which sets the stage for the subsequent ideological shift from import-substitution to EOI strategy, suggest that redressing policy bias against exporting promotes greater efficiency in the use of resources and generates higher levels of employment, and paving the way for later growth with equitable distribution of income (Balassa, 1982; Little, Scitovsky, & Scott, 1970; Papageorgiou, Choksi, & Michaely, 1990). One of the most striking finding of this study is that 'employment growth is more rapid under… *liberalised regimes*.' (Krueger, 1978, p. 257, emphasis added). This development strategy is more capable of absorbing labour at a faster rate compared to the import-substitution industrialisation (ISI) (Krueger, 1983; Lal & Myint, 1996; Panagariya, 2019).

Developing countries that first began to reorient their trade regimes towards export orientation were Taiwan, Singapore, and South Korea. All these countries undertook periodic

[4] Anderson and Ponnusamy (2019) have also pointed out this research gap.

attempts to liberalise their economies by eliminating bias against export and abolishing multiple exchange rate systems. Alongside them, Hong Kong had long pursued open trade and investment policies. The results of such a regime shift among East Asian economies were spectacular. These newly industrialised economies (NIEs), or the so-called 'four Asian tigers', achieved rapid economic growth throughout the following decades and eventually joined the club of high-income countries. More importantly, fast economic growth was not accompanied by a rise in income inequality as postulated by the Kuznets hypothesis (Kuznets, 1955). This was because of their fairly equal income distribution at the beginning of the reform and the very nature of export-propelled economic growth in labour-surplus economies that lifted living standard through employment generation in rapidly expanding labour-intensive manufacturing (Little, Scitovsky, & Scott, 1970; Ranis, 1995; Perkins, 2013). In addition, at the early stage of structural transformation, manufacturing wages do not necessarily increase because the modern sector can hire unskilled workers at a fixed wage rate (Lewis, 1954). This hypothesis is well supported by the experiences of the NIEs in East Asia in the 1960s and 1970s in achieving growth with equity through labour-intensive manufacturing exports.

On the other hand, higher manufacturing wages, after passing the 'Lewisian turning point' (that is after the surplus labour pool is depleted), can counterbalance this inequality-reducing effect. Trade openness reinforces this mechanism. Numerous studies suggest that exporting firms pay higher wages than non-exporting firms (Bernard & Jensen, 1997; McCaig, 2011; Schank, Schnabel, & Wagner, 2007; Verhoogen, 2008). This is because of productivity gains from trade at both firm and industry levels (Bernard, Jensen, & Schott, 2006; Miroudot, Sauvage, & Shepherd, 2012; Pavcnik, 2002). The productivity advantage of exporting firms can lead to higher within-sector inequality. In the meantime, a sector (as a whole) that is exposed more to global trade can see an increase in sectoral productivity—this

enlarges the productivity differentials and between-sector inequality. Thus, *total* inequality can increase at later stage of development when manufacturing wage begins to rise.

The effect of trade-led structural transformation on total inequality can be shown by considering changes in between- and within-sector inequality. Start with within-sector inequality. Figure 2 shows the behaviour of the within-sector component of inequality in the context of an open economy, holding the between-sector component of inequality constant. Key assumption of this idea is that an increase in productivity among exporting firms within a sector does not significantly push manufacturing wage up.

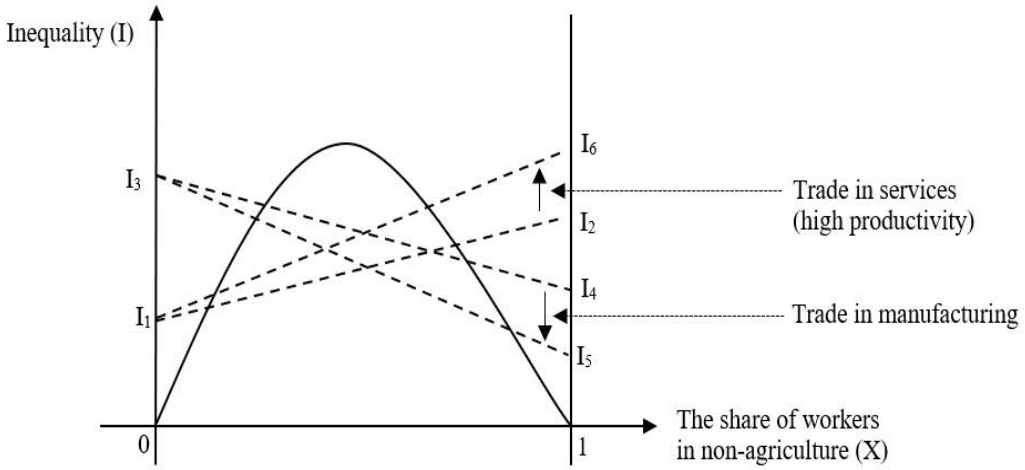

Figure 2: Changes in within-sector inequality in the context of an open economy
Source: Adapted from Anand & Kanbur (1993b) and Baymul & Sen (2020)

In Figure 2, both horizontal and vertical axes are similar to those illustrated in Figure 1. Drawing on Baymul and Sen (2019, 2020), assume that an economy comprises agriculture, manufacturing, and services, and mean income of agriculture is lower than that of manufacturing and services. In general, the within-sector component of inequality falls with the movement of workers from agriculture to manufacturing (see the dashed line I_3I_4). This is because manufacturing is characterised by low within-sector inequality. Wages in

manufacturing tend to be compressed by minimum wages and other labour regulations. In contrast, the within-sector component of inequality increases with the movement of workers from agriculture to services since the weight on the more unequal distribution increases (see the dashed line I_1I_2). Given the heterogeneity in terms of activities, informality, skills, and payment in services, the effect of economic liberalisation tends to be limited to few services activities such as telecommunications, finance, distribution, and transport.

Trade openness affects within-sector inequality in two ways. First, the process of population shift reinforced by trade openness can affect within-sector inequality. If trade openness speeds up the shift towards manufacturing, it can reduce within-sector inequality by increasing the share of manufacturing at each point in time. However, if trade openness speeds up the shift towards services which is characterised by high with-sector inequality, within-sector inequality can increase as a result of an increase in the share of high within-sector inequality at each point in time.

Second, trade openness can affect within-sector inequality associated with a given value of employment share. Manufacturing trade is expected to lower within-sector inequality for a given manufacturing employment share (see the dash lined I_3I_5). With relatively low within-sector inequality, engaging in the world market benefits firm directly through higher trade volume (bigger market) and indirectly through efficiency gained in production process. With the role of labour union and labour market regulations, such gains are likely to well distributed among workers. This may narrow wage differentials among manufacturing workers. The within-sector inequality effect of manufacturing-led structural transformation is expected to be larger for countries with more open trade regimes. However, since services sector is diverse, service trade may further enlarge wages differentials for a given services employment share (see the dashed line I_1I_6). This is due to its high within-sector inequality.

The inequality-increasing effect of services-led structural transformation is therefore expected to be larger in an open economy.

Figure 3 illustrates the behaviour of the between-sector component of inequality in the context of an open economy, holding the within-sector component of inequality constant. In this figure, both horizontal and vertical axes are similar to those shown in the previous figure. Here, assume that an economy comprises the agricultural sector and the non-agricultural sector (manufacturing and services), and mean income of the agricultural sector is lower than that of the non-agricultural sector. In addition, key assumption of this idea is that an increase in productivity in a relatively open sector does not significantly push wages in non-agricultural sector up.

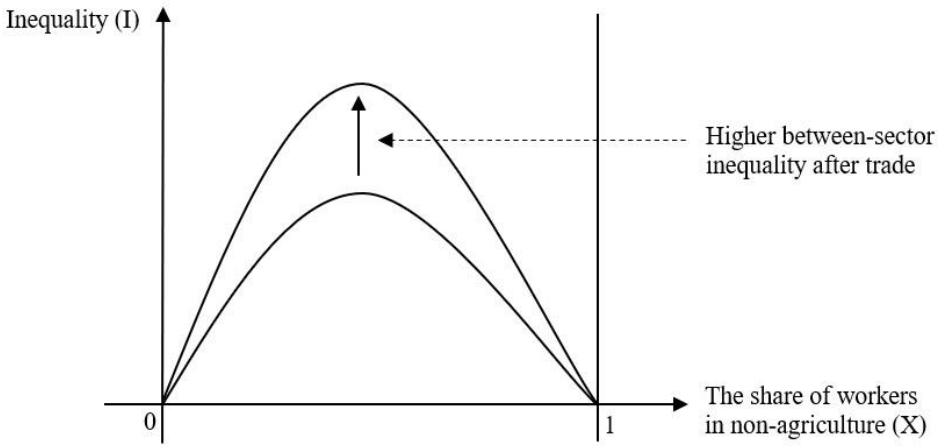

Figure 3: Changes in between-sector inequality in the context of an open economy
Source: Adapted from Anand & Kanbur (1993b)

In the context of developing countries where unskilled labour are relatively abundant, trade openness promotes labour-intensive production, resulting in an increase in the demand for unskilled labour. Openness to trade thus accelerates the process of population shift to the non-agricultural sector (Dessy, Mbiekop, & Pallage, 2010; McMillan et al., 2014; Teignier, 2018). This process enlarges the difference in mean income (productivity) between sectors. Therefore, openness to trade shifts the curve depicting between-sector inequality upward.

Total inequality increases when workers move from agriculture to non-agriculture in the context of an open economy.

To summarise the key message of this discussion, trade openness affects *total* inequality in several ways. First, manufacturing-led trade openness lowers within-sector inequality associated with a given value of the share of manufacturing (Figure 2). Second, openness reinforces the process of population shift into manufacturing (that can absorb surplus labour) which has relatively low within-sector inequality. This will result in an increase in the share of worker in low within-sector inequality, resulting in a decrease in the between-sector inequality at later stage of structural transformation. Third, trade openness widens the income gap between agricultural and non-agricultural sector, resulting in higher between-sector inequality (Figure 3). Therefore, whether manufacturing-led structural transformation in the context of open economy has total inequality-reducing effect is an empirical issue.

3. A new measure of openness

The use of the trade-to-GDP ratio as an indicator of trade openness is highly debatable. Changes in trade ratio can capture an increase in imports and/or exports driven by other factors such as the country size, geography, population, capital accumulation, technological change, and change in terms of trade, all of which have little to do with more liberal trade policies (Berg & Krueger, 2003; O'Rourke & Williamson, 2002; Williamson, 2014). Dollar and Kraay (2004) argue that the change rather than the level of trade-to-GDP ratio is not contaminated by geography, nor by other unobserved country characteristics. However, this reasoning is valid only if all unobservable country characteristics remain unchanged over time (Birdsall & Hamoudi, 2002). For instance, change in the terms of trade can impact on trade share regardless of the openness of the trade regime. Moreover, since policy makers

cannot control the level of trade driven by the ongoing process of global economic integration, trade share may have little to do with trade policy. In addition, there is strong empirical evidence that changes in trade-to-GDP ratio is significantly driven by changes in GDP *per se* (Fuji, 2019).

Finally, the trade share is susceptible to a country's engagement in global production sharing (GPS), the cross-border dispersion of production processes within vertically integrated global industries. This process, which has been the prime mover of the rapid growth of manufacturing exports in a number of developing countries in recent years (Antràs, 2016; Athukorala, 2014; Timmer et al., 2014), naturally involves spreading of total value addition of a given product among a number of countries. This implies that the value added share of recorded exports from a given country tends to decline with the deepening of its involvement in global production networks. While GDP is measured in value added terms, trade is measured in gross terms, thus resulting in inflated trade values relative to GDP.[5] When the manufacturing sector of a country is well integrated within global production networks, the trade-to-GDP ratio can be artificially high even though export production involves adding small amounts of value to imported inputs (Krugman, 1995).[6]

[5] There are also several countries that have embarked on liberalisations reforms only recently, but with trade-to-GDP ratio greater than one (e.g., Botswana, Lesotho, Mauritius, and Namibia). This is presumably because of two reasons: First, these countries are engaged in export processing activities with low value added ratio, and second, and perhaps more importantly, at the initial stages of economic growth significant share of national production takes place in the informal sector (predominantly subsistence farming) which escapes that national data gathering system, whereas national accounts have a better coverage of foreign trade.

[6] As Krugman (1995) has noted, the rise of GPS has led to the emergence of 'supertrading economies' such as Singapore, Hong Kong and Malaysia, which have the trade-to-GDP ratio of well over 100.

Mindful of the limitations of the traditional measure of trade openness, I construct a new index to measure trade openness based on changes in the relative prices of traded goods. The idea for constructing this index comes from the work of Jeffrey Williamson and his research associates (Williamson, 2000, 2002, 2014; O'Rourke & Williamson, 1999, 2002). As they point out, price convergence is a better indicator of openness compared to the trade-to-GDP ratio. It is important to note that most of these historical studies have focused on trade in primary products (e.g., sugar, spice, and coffee). However, as noted by O'Rourke & Williamson (1994, p. 899), the concept of price convergence generally applies to tradable manufactured goods, not just primary products. Rodrik (2002, p. 10) also gives credence to the case for using price convergence as a superior measure alternative to the standard trade-to-GDP ratio: 'from an economic standpoint, what matters most is not the volume of trade as much as the degree of price convergence across national markers.'

The concept of convergence of prices of traded goods in the process of global economic integration is closely related to the law of one price (LOP), which postulates that, in the absence of transport costs and trade restrictions, each traded good is uniformly priced throughout the world by perfect commodity arbitrage (Isard, 1977, p.942). Despite mixed evidence, the key inference from the empirical literature is that the 'relative' version of the LOP (changes in relative prices) holds even though its absolute version (absolute price difference) does not hold. As convincingly argued in these studies, if international markets are integrated, *the rate of change* in prices at home and abroad should converge, given that there is no trade friction such as transportation cost and tariffs. At a given point in time, prices of a given product can of course be different across countries due to differences in consumer purchasing power (which depends on the stage of economic advancement), transportation costs, and other fixed costs. However, over time, openness to trade should manifest in a convergence of *changes* in relative prices of traded goods. In other words, even

though price levels are naturally different, *the rates of change in prices* are, on average, synchronised among countries (Cecchetti, Mark, & Sonora, 2002; Engel & Rogers, 2001; Goldberg & Verboven, 2005; Hufbauer, Wada, & Warren, 2002). Therefore, an index that captures the convergence of prices of traded goods across countries is a superior measure of openness to trade compared to the standard trade-to-GDP ratio. It captures the impact of both tariff and non-tariff restriction (border barriers) and behind-the-border barriers impacting on a country's engagement in foreign trade. At the same time, unlike the trade-to-GDP ratio, this index is less susceptible to other non-trade related factors, in particular country size and GPN participation.

In this study, I construct a 'price convergence index' (PCI) that captures changes over times in the price of traded goods in a given country relative to that of the world price. To construct the index[7], manufacturing price is measured by the implicit price deflator (with 1970 as the base year) derived from national accounts of individual countries while treating the implicit price deflator for the U.S. as the proxy indicator of the world price. Individual country price indices are adjusted for changes in the exchange rate with the U.S. dollar and then expressed as a ratio of the U.S. price index to obtain the relative manufacturing price indices.[8] The PCI is then constructed as the absolute deviation of relative price from the base value (1970 = 100).

I use manufacturing price index to measure traded goods price due to the relatively high degree of tradability of manufactured goods. The GDP deflator is not appropriate

[7] See Appendix A for more details on the PCI.

[8] Variations in the nominal exchange rate are mostly driven by financial and monetary shocks and preclude international arbitrage to equate market prices of internationally traded goods. Therefore, it is important to adjust exchange rate changes in order to measure price divergence/convergence (Rogoff, 1986).

because it captures both tradable and non-tradable prices. Agricultural products are traded goods, but some agricultural products are quasi-nontradables (e.g., vegetables and some other food items). More importantly, agricultural prices are influenced by changes in global commodity price cycles. The U.S. manufacturing price is taken as the reference price because the U.S. is the largest trading nation in the world during the period under study with a highly open trade regime, particularly for manufactured goods.

Data for manufacturing value added deflators for all countries other than China are taken from obtained from FAO database (www.fao.org/statistics). Data for China were compiled from the data extracted from the World Bank World Development Indicator Database (www.datatopics.worldbank.org/world-development-indicators). Note that only data for industry (mining, construction, utilities, and manufacturing) are available for China for the entire period under this study. However, comparison done for a recent period (from 2000 to 2015) for which disaggregated data are available suggests that the manufacturing deflator closely follows the patterns of the deflator for industrial production.

Figures 4 and 5 depicts the trade-to-GDP ratio and the PCI for four countries, China, India, Indonesia, and South Korea, over the period 1970-2017. These four countries have experienced trade regime policy shifts during the period of study.

It is clear from Figure 4 that, regardless of policy changes, the trade-to-GDP ratio has increased successively during the past few decades. This increasing trend did not reverse even during the 1997 Asian Financial Crisis. A fall in trade share after the 2008 Global Financial Crisis was because of the slowdown in world trade, not changes in countries' trade policy. Using the traditional measure of openness, before 2000, Indonesia and South Korea were relatively open compared to China and India. After that, South Korea's degree of openness has outpaced other three countries. However, as shown in Figure 5, there are more

variations in the relative prices, and some episodes of this movement are associated with policy changes.

Despite the liberalisation reforms initiated in 1978, China was considered ‘close economic system’ until the late 1990s (Wacziarg & Welch, 2008). From around 2001, China has had a relatively open trade regime after its accession to the WTO, resulting in significant reductions in tariffs, gradual elimination of quotas and license, and a commitment to international standards in the protection of intellectual property. China’s trade-to-GDP ratio has increased gradually over time, with an astronomical increase in trade share after the early 2000s. However, the relative price movement shown in Figure 5 indicates that China’s trade regime is relatively close throughout the 1980s and 1990s. This is consistent with evidence that trading rights, import license, canalisation and exclusive import rights are more liberalised only in the late 1990s (Panagariya, 2019). After an accession to WTO in 2001, China’s price movement has begun to be more in line with that of the U.S.

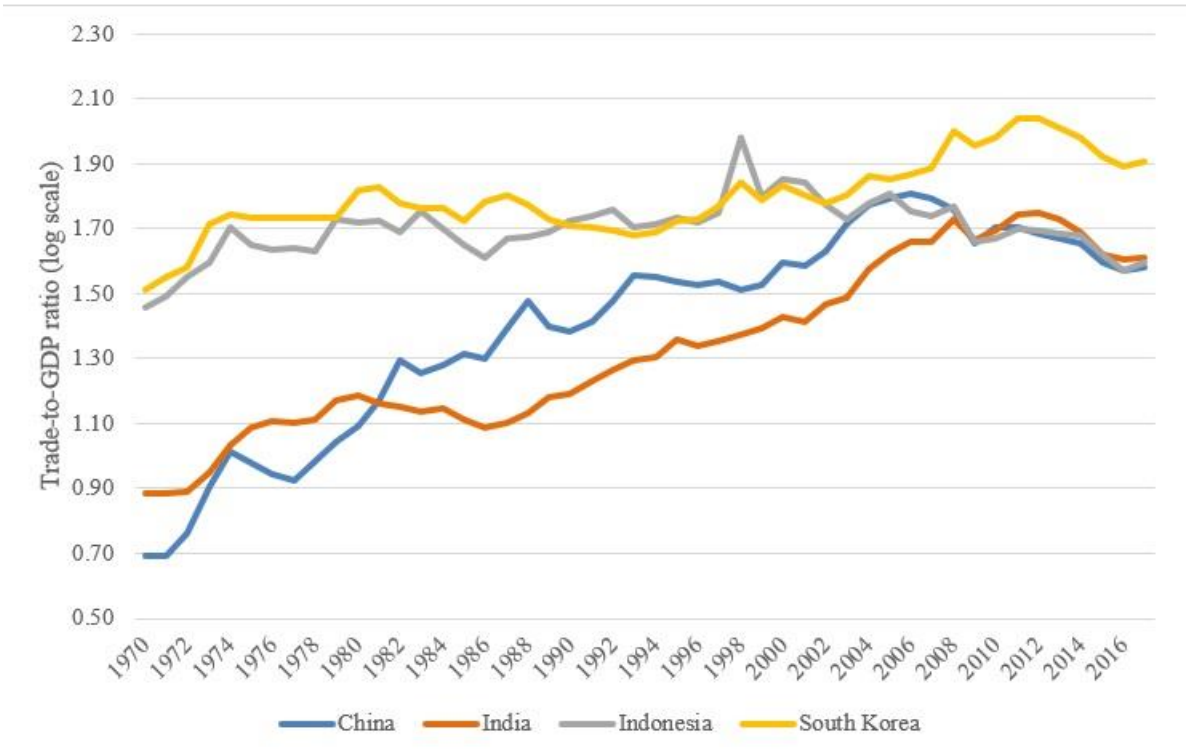

Figure 4: Trade-to-GDP ratio between 1970 and 2017 (log scale)
Source: World Bank (2020)

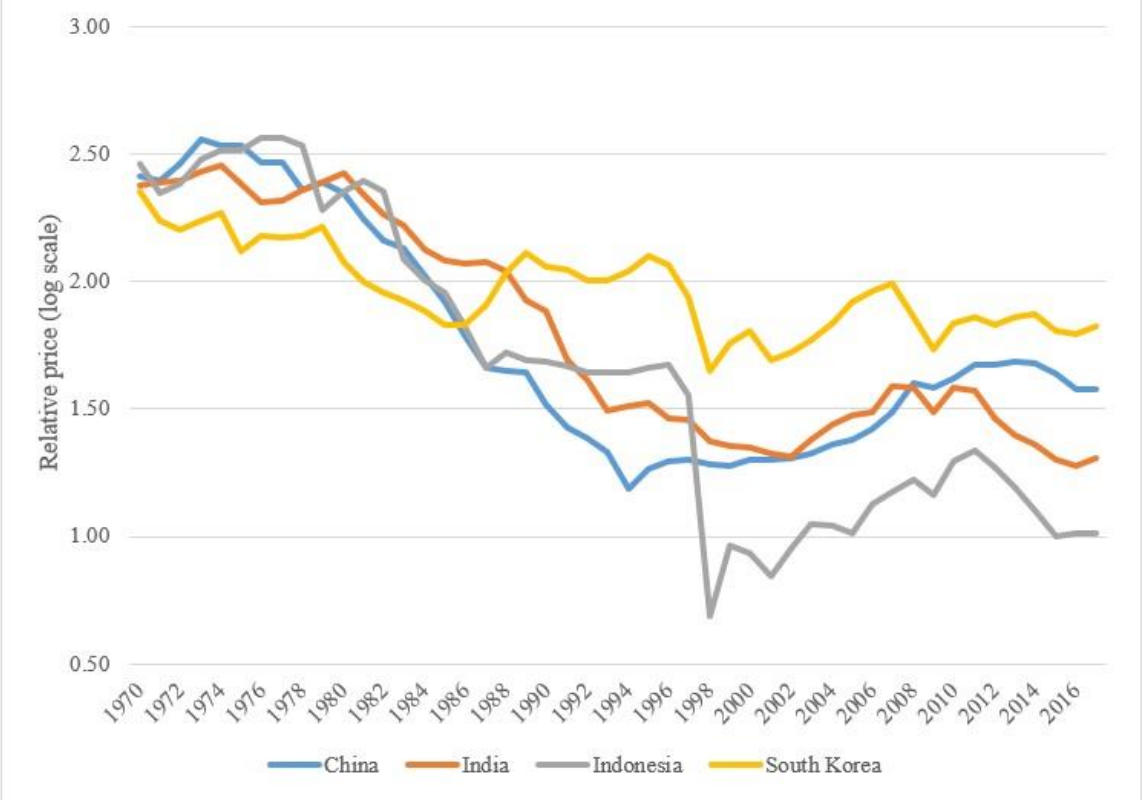

Figure 5: Price convergence index between 1970 and 2017 (log scale)
Source: Author's calculation

India seems to share a similar trend with China. India gradually opened its economy to trade and investment after 1991, followed by some minor liberalisation efforts during the 1980s (Panagariya, 2005; Pursell, 1992). This is illustrated by a relative high degree of openness during the 1980s as shown in Figure 5. However, average manufacturing price movement in the 1990s suggests that protection in India remained high. Chad and Towar (2011) suggest that India offsets the effect of reduced tariffs through use of antidumping and safeguard protection, especially after the late 1990s. An increase in the relative price after 2000 indicates that the Indian economy has become less open during this period. For the last five years, such price movement has significantly diverged from the U.S. This is the period in which the Modi government launched 'Make in India' program in 2014, which was

accompanied by some targeted tariff protection and government subsidies to specific industries (Athukorala, 2020). Overall, India is still less open when compared with South Korea and China.

Indonesia began to become relatively open from about the early 1980s with some episodes of protectionism (Fane & Condon, 1992; Marks & Rahardja, 2012). Yet, as shown in Figure 5, relative price movement suggests that Indonesia has experienced some policy reversals. During the 1970s and the early 1980s, Indonesia followed some forms of import substitution industrialisation with use of tariff, export ban, and import license (Pangestu, Rahardja, & Ing, 2015). From the late 1980s to the mid-1990s when Indonesia implemented deregulation and export promotion, relative price movement during this period was relatively stable. Price divergence took place again after the 1997 AFC. However, Indonesia has seen the return of protectionism in recent years, especially in the form of non-tariff barriers (Basri & Patunru, 2012; Patunru, 2018; Soesastro & Basri, 2005). This has been clearly observed in the divergence of Indonesia's relative price movement since 2000.

As shown by both the trade-to-GDP ratio and the PCI, South Korea remained relatively open throughout the period of study. Even though the trade-to-GDP ratio has risen steadily, relative price movement indicates that there are some fluctuations in this trade regime. During 1960s, the expansion in labour-intensive exports contributed to rapid economic growth. Nonetheless, South Korea launched a targeted promotion of heavy and chemical industry (HCI) in 1973 with HCI-firms enjoying protection by high tariff. Several incentives were also provided to HCI-firms such as directed bank credit at low (on the average, negative) real interest rate and special tax treatment and trade policy concessions (Adelman, 2007; Graham, 2003; Yoo, 1997). While the trade-to-GDP ratio during this period increased, its average manufacturing price in 1970s diverged from the world price. Relatively more liberal trade policy stance of the South Korean government is reflected in more

convergence in prices changes during the 1980s when the economy returned to a neutral regime (Panagariya, 2019, p. 229). An example of liberalisation efforts can be seen in the establishment of the Tariff Reform Committee in 1983. Average tariff rate declined to 11% in 1990 from 24% in 1983. After this, South Korea's trade policy regime has remained relatively open, albeit with some divergences in price movement during the AFC and the GFC.

4. Methodology

4.1 The model

The model used in this paper to investigate the impact of trade-led structural transformation on income inequality is specified drawing on the previous empirical literature (Angeles, 2010; Baymul & Sen, 2020). The novelty of the model is the incorporation of trade openness as a factor that conditions the relationship between structural transformation and inequality. The model takes the following form:

$$INQ_{it} = \alpha + \beta_1 MFG_{it} + \beta_2 MFG_{it}^2 + \beta_3 NMFG_{it} + \beta_4 SERV_{it} + \beta_5 SERV_{it}^2 + \beta_6 OPEN_{it} + \beta_7 (MFG_{it} \times OPEN_{it}) + \beta_8 (NMFG_{it} \times OPEN_{it}) + \beta_9 (SERV_{it} \times OPEN_{it}) + \beta_{10} (MFG_{it}^2 \times OPEN_{it}) + \beta_{11} (SERV_{it}^2 \times OPEN_{it}) + \beta_{12} LGDP_{it} + \beta_{13} GEX_{it} + \beta_{14} HCP_{it} + \mu_i + v_t + \varepsilon_{it} \quad (1)$$

where INQ is income inequality, the subscripts i and t refer to country and year. The explanatory variables are listed below, with the postulated sign of the regression coefficient for the explanatory variables in parenthesis.

$MFG\ (-)$ The employment share in manufacturing

$NMFG\ (-)$	The employment share in non-manufacturing industry
$SERV\ (+)$	The employment share in services
$OPEN\ (\pm)$	Trade openness
$LGDP\ (\pm)$	Real GDP per capita
$GEX\ (-)$	Government expenditure
$HCP\ (\pm)$	Human capital
α	A constant term
μ	Country fixed effects
v	Year fixed effects
ε	An error term

The dependent variable is income inequality measured by the Gini coefficient. To investigate structural transformation from agriculture, non-agricultural activities are divided into three sectors: manufacturing (MFG), non-manufacturing industry (mining, utilities, and construction) $(NMFG)$, and services $(SERV)$. A squared term of each sectoral employment share is added to test nonlinearity of the postulated relationship (the Kuznets hypothesis). Trade openness $(OPEN)$ is alternatively measured using two indicators: the trade-to-GDP ratio and the price convergence index (PCI). The PCI captures a convergence of changes in relative prices of traded goods at home and abroad. After allowing for transportation costs and other fixed costs, convergence of the relative prices of traded goods across countries demonstrates greater economic integration. Therefore, the PCI is my preferred indicator of trade openness. However, for the purpose of comparison, the results based on the trade-to-GDP ratio are reported in the Appendix.

To test whether the relationship between structural transformation and inequality is conditioned by trade openness, sectoral employment share variables and their quadratic terms

are interacted with $OPEN$. I hypothesise that the interaction term between openness and manufacturing employment share is negative because manufacturing goods is more labour-intensive in nature and within-sector inequality in manufacturing is relatively small. Given the level of employment share in manufacturing, inequality is expected to be lower in a country with greater degree of trade openness. However, the same result may not hold for services-led structural change because within-sector inequality in services tends to be higher than that in manufacturing. The expected sign of the interaction term between services employment share and openness measure is thus positive.

Among the control variables, GDP per capita $(LGDP)$ is included to capture possible effect of economic development on inequality over and above the Kuznets process. Country with higher GDP per capita may have more resources for redistribution (i.e., larger income tax base and better tax administration). At the same time, during the process of economic growth, the benefits of growth may not trickle down to the poor. The expected sign is thus ambiguous. In addition, government expenditure (GEX) is included to capture the role of government spending. Country with higher level of government spending is likely to have more equal distribution of income because more resources are allocated to, for instance, basic infrastructure, health, and education. This variable is also indicative of government welfare program that may predominantly benefits the poor. The expected sign is thus positive. Lastly, Human capital (HCP) is included to capture the overall level of human capital. More education allows people to do better, higher-paying jobs. This will reduce inequality. Meanwhile, inequality can increase as well since highly educated worker can concentrate in service sector which has high within-sector inequality. The expected sign is thus ambiguous.

4.2 Data

The model is estimated for a sample of 48 countries covering the period from 1960 to 2010. Table 1 summarises the definitions of variables and the data sources. The data on sectoral employment share come from the GGDC database (Timmer, de Vries, & de Vries, 2015). The data on the Gini coefficient come from the World Income Inequality Database (WIID) of the World Institute for Development Economics Research (WIDER).[9] Tables A3.1 and A3.2 in the Appendix provides details on economic sector and country coverage.

Five-year averaged data are used because data on income inequality are available only for intermittent years. This means that five-year averages of sectoral employment share data (which are available annually) are matched with inequality data for a year or the average for the year for which data are available within that five-year period. In addition, there are gaps in the data on inequality for the given time period for a number of countries. For example, data on inequality for the year 1980 are missing for Bolivia, Indonesia, Mexico, and the Philippines. Drawing on the standard practice in previous literature, these gaps are filled with the averages of the data point below and above it. Note that the regression results still hold when the model is estimated using the dataset with gaps.

Table 1: Definitions of variables and data sources

Label	Definition	Data source
INQ	Income inequality is measured by net Gini coefficient (net of tax and transfer).	World Income Inequality Database (WIID)

[9] Provided by Professor Kunal Sen, the Director of UNU-WIDER.

Label	Definition	Data source
MFG	Manufacturing employment share (% of total employment) based on the International Standard Industry Classification (ISIC) Rev 3.1.	Groningen Growth and Development Centre (GGDC)
SER	Services employment share (% of total employment). Services comprise trade, transportation, business, government, and personal services.	Groningen Growth and Development Centre (GGDC)
$NMFG$	Non-manufacturing employment share (% of total employment). Nonmanufacturing comprises utility, mining, and construction.	Groningen Growth and Development Centre (GGDC)
$OPEN$	There are two alternative measures of trade openness: the trade-to-GDP ratio $(TGDP)$ and Price Convergence Index (PCI). As in Paper 2, the inverse of the PCI is used to make the sign of the regression coefficient consistent with that of the trade-to-GDP ratio.	World Development Indicator (World Bank) and FAO database
$LGDP$	(log of) Gross Domestic Product (GDP) per capita at chained PPPs in 2011 US Dollar.	Penn World Table 9.0
GEX	Government expenditure is government expenditure as share of GDP.	Penn World Table 9.0
HCP	Human capital index is calculated based on the average years of schooling and an assumed rate of return to education.	Penn World Table 9.0

Figure 6 shows the allocation of workers in four economic sectors from 1960 to 2010 in both developed and developing countries (based on the UN country classification). During this period, the share of employment in services continually increased in both developed and developing countries. This feature is more striking in developed countries as the share of employment in services increased from about 50% in the 1960s to almost 80% since 2010.

Over the same period, the share of employment in manufacturing moderately declined in developed countries, illustrating the experience of the so-called 'de-industrialisation.' Developing countries seem to follow the similar trend. However, the share of employment in manufacturing was rather stable, with the share increased from 13% in 1960 to 15% in 1980, before falling to 12% in 2010.

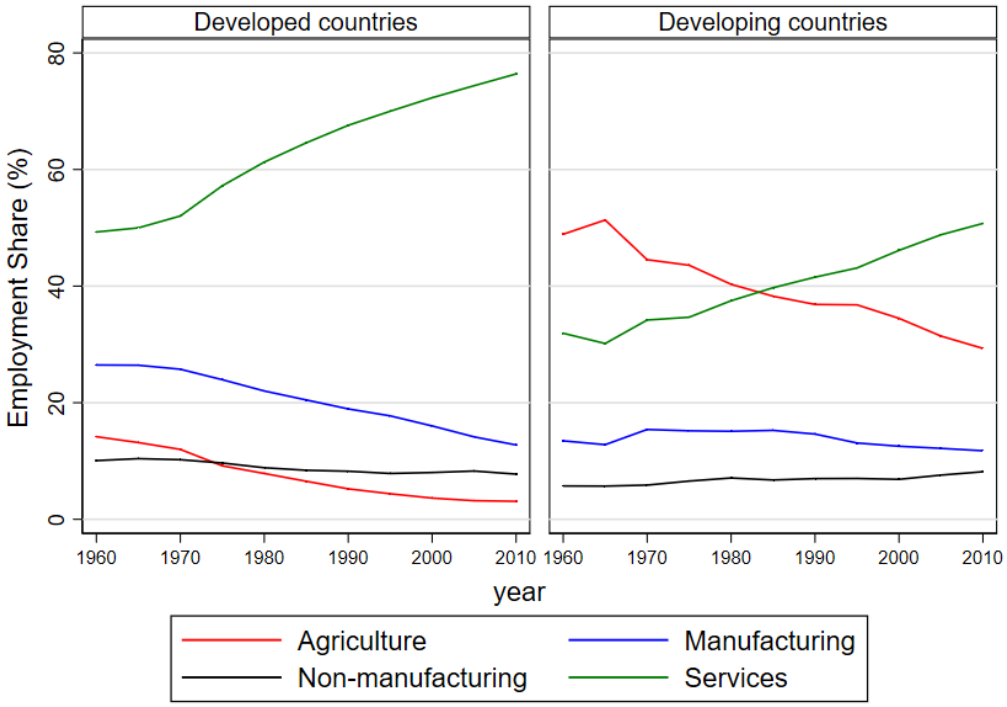

Figure 6: Sectoral employment share, 1960 to 2010
Note: In percentages of total employment, unweighted averages
Source: GGDC database

Two assumptions of the Kuznets' model can be supported by the data from the GGDC database: (a) the agricultural sector has lower productivity than that in the non-agricultural sector and (b) the non-agriculture sector has higher within-sector inequality. For the first assumption, it is found that labour productivity (measured by real value added per worker) in agriculture is relatively low compared to other sectors (Table 2). For the second assumption, within-sector inequality in manufacturing and services can be shown by mean income by sub-

sector. Unfortunately, the GGDC database only publishes the disaggregated data on services at the sub-sectoral level. Baymul and Sen (2020) argue that within-sector inequality in manufacturing is low due to labour market regulations and the role of minimum wage. For within-sector inequality in service, productivity is used as a proxy for sectoral mean income. Figure 7 plots relative productivity within the services sector from 1960 to 2010. As is clear from this figure, there is a large difference in productivity across services activities, suggesting that within-sector inequality in services tends to be high.

Table 2: Productivity by economic sector, 1960 to 2010

	1960	1970	1980	1990	2000	2010
Agriculture	14.42	40.41	134.44	371.69	915.63	1,818.11
Manufacturing	57.06	141.34	460.76	1,192.02	3,957.08	8,630.59
Non-manufacturing	41.72	149.47	630.47	1,532.65	4,854.41	14,351.13
Services	43.72	115.32	355.23	902.95	2,319.00	5,103.37

Note: Productivity is defined as the ratio of real value added and total employment in the sector. Non-manufacturing covers mining, utilities, and construction.
Source: GGDC database

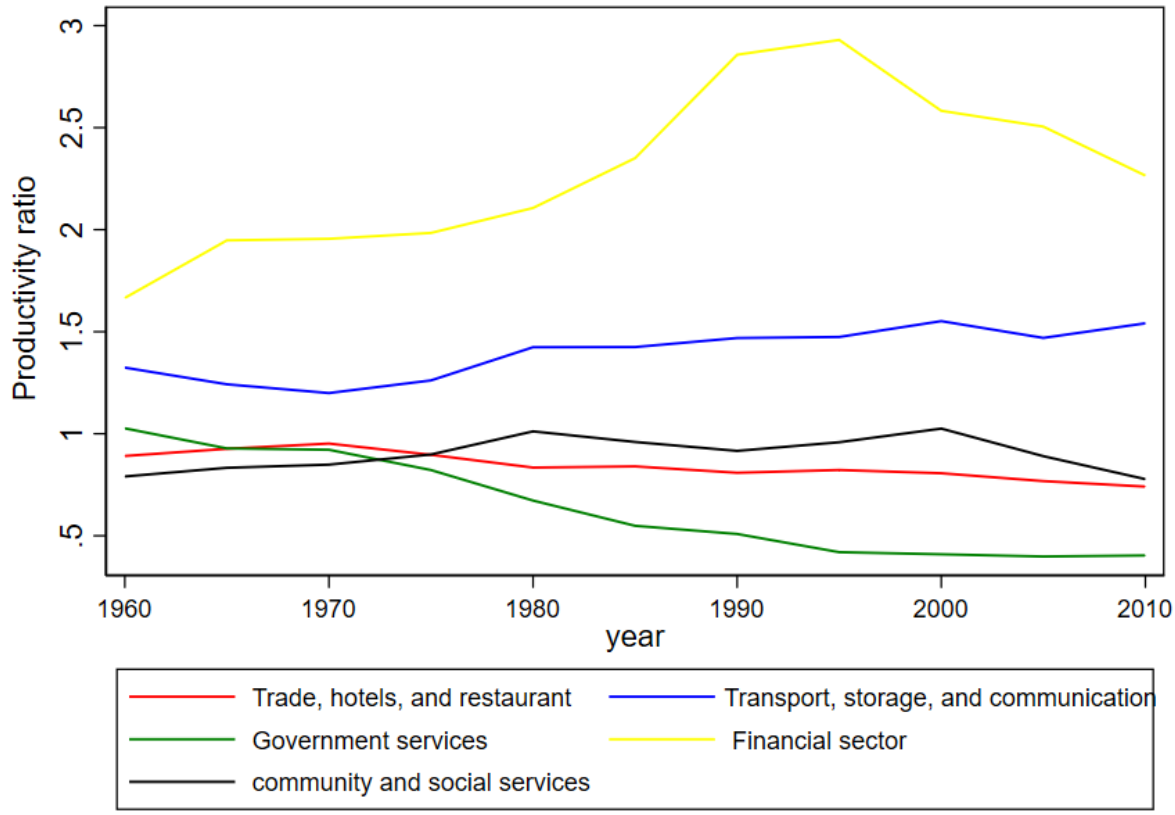

Figure 7: Relative productivity within services sector, 1960 to 2010
Note: Relative productivity of a given sector is the ratio of productivity of that sector and the average productivity of services.
Source: GGDC database

The WIID provides the data on inequality measures for developed as well as developing countries for relatively long time periods and is commonly used in the literature (Castelló-Climent, 2010; Jäntti, Pirttilä, & Rönkkö, 2020; Knowles, 2005; Roope, Niño-Zarazúa, & Tarp, 2018). I report the regression result using the net per capita Gini coefficient, the level of income inequality net of taxes and transfers. Since there is no theoretical reasoning for using net Gini coefficient over gross Gini coefficient (before taxes and transfers), the results based on the net per capita Gini coefficient are presented. Table 3 reports summary statistics.

Table 3: Summary statistics

	Observation	Mean	Standard Deviation	Min	Max

Gini (net)	435	45.32	10.80	22.69	79.81
Manufacturing employment share	435	13.70	7.94	0.87	44.09
Non-manufacturing employment share	435	7.01	3.47	0.32	15.95
Services employment share	435	42.80	1975	4.76	87.51
Ln per capita GDP	435	8.65	1.16	6.21	10.93
Government expenditure as a percentage of GDP	435	17.88	9.25	3.81	63.49
Human capital index	435	2.10	0.65	1.03	3.70
Trade as a percentage of GDP	403	63.68	60.65	5.46	422.39
Price convergence index	370	6.32	24.59	0.00	100

4.3 Estimation method

Equation (1) is estimated using an unbalanced panel dataset. The result from the Hausman suggests that the error term is correlated with the explanatory variables, favouring the Fixed Effects (FE) estimator over the random effects (RE) estimator. The FE estimator controls for time-invariant country characteristics (such as factor endowment, geography, and policy regime shifts) that may impact on both dependent and independent variables. Furthermore, heteroscedasticity-consistent robust standard error is used to address the concern about heteroscedasticity. Period dummies are included to control for period (time) fixed effects or common shocks that may affect structural transformation and income inequality.

Regarding the endogeneity problem, reverse causality may exist because higher inequality may lead to smaller market for manufacturing and high value-added services. This may slow down the process of structural change and affects manufacturing and services employment share. In this study, it is difficult to find a credible set of six instruments (sectoral employment shares and their quadratic terms) to address this concern. However, this concern is more legitimate in closed economies because a country that engages in international trade can expand the market size through trade. To see whether this is the case for relatively closed economies, I limit the sample to cases where trade-to-GDP ratio is less than its median value in the full sample. The results are largely consistent. In addition, the model is re-estimated with GDP with a one-period lag to check on possible reverse causality problem, and the results do not significantly change. To address measurement error, I use alternative measures of inequality (net and gross Gini coefficient) and trade openness (the trade-to-GDP ratio, export-to-GDP ratio, and the PCI). In regard to the omitted variables bias, besides the country fixed effects, I later include other relevant explanatory variables to test the sensitivity of the results such as productivity and foreign direct investment. The results withstand the inclusion of these additional control variables.

The results for all countries as a group could possibly hide different paths of economic development among developed and developing countries. In particular, there is strong empirical evidence from many studies that African economic performance is distinctive partly because of geographic disadvantages, ethno-linguistic diversity, historical conflict, and impediments to trade resulting from geography (in particular, 'landlockedness') (see Besley & Reynal-Querol, 2014; Collier & Gunning, 1999; McKay & Perge, 2015). The later consideration is particularly relevant for most African countries included in the sample (Limão & Venables, 2001; Faye, McArthur, Sachs, & Snow, 2004). African countries dummies can partially take into account this issue; however, it is also possible that the slope representing the relationship between manufacturing employment share and income inequality for African countries is different from other regions. To investigate this possibility, the model is also estimated for the full sample excluding 20 African countries.

5. Results

The results for the total sample (48 countries) are reported in Table 4.

Column 1 presents the estimate of Equation (1) with only the sectoral employment shares and their quadratic terms as explanatory variables (the 'base' regression). It is found that the coefficient on manufacturing employment share is negative and statistically significant at the 5% level. It indicates that a one percentage point increase in manufacturing employment share is significantly associated with a 0.70 percentage point decrease in the Gini coefficient. The coefficient on the squared manufacturing variable is positive but not statistically significant. This suggests that there is no U-shaped relationship between manufacturing employment share and inequality. In addition, the coefficient on the share of employment in services is positive but not statistically significant even at the 10% level. The quadratic term on services is negative and statistically significant at the 5% level.

Table 4: Sectoral employment share and income inequality: Full sample and full sample excluding African countries

	Full sample			Full sample exclude Africa		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Manufacturing *(MFG)*	-0.699**	-1.817*	-2.017**	-1.299**	-2.983**	-2.927**
	(0.338)	(0.907)	(0.817)	(0.481)	(1.096)	(1.081)
Manufacturing^2 *(MFG^2)*	0.008	0.027	0.029	0.017*	0.048*	0.047*
	(0.007)	(0.020)	(0.018)	(0.008)	(0.024)	(0.024)
Non-manufacturing industry *(NMFG)*	0.621	-1.217	-0.982	3.197***	-0.474	-0.702
	(1.020)	(1.887)	(1.986)	(0.940)	(2.371)	(2.598)
Non-manufacturing^2 *($NMFG^2$)*	-0.025	0.037	0.017	-0.136**	0.016	0.038
	(0.054)	(0.099)	(0.103)	(0.055)	(0.137)	(0.144)
Services *(SERV)*	0.364	1.282**	1.356**	0.386	1.573***	1.366***
	(0.259)	(0.553)	(0.528)	(0.447)	(0.552)	(0.479)
Services^2 *($SERV^2$)*	-0.005**	-0.013**	-0.015***	-0.006	-0.017***	-0.015***
	(0.003)	(0.005)	(0.005)	(0.004)	(0.006)	(0.005)
Ln per capita GDP *(LGDP)*			0.796			2.002
			(1.974)			(2.196)
Government expenditure *(GEX)*			0.058			0.091
			(0.059)			(0.071)
Human capital *(HCP)*			3.983			-6.117*
			(4.405)			(3.373)
Price convergence index (PCI)		-0.730	-1.014		2.604	3.419
		(1.142)	(1.154)		(2.278)	(2.460)
$MFG \times PCI$		-0.233	-0.198		-0.350*	-0.362*
		(0.151)	(0.138)		(0.202)	(0.204)
$NMFG \times PCI$		-0.371	-0.270		-0.946**	-0.906*
		(0.297)	(0.284)		(0.454)	(0.496)
$SERV\ X\ PCI$		0.192*	0.176*		0.212**	0.166*
		(0.097)	(0.091)		(0.087)	(0.089)
$MFG^2 \times PCI$		0.005	0.004		0.007	0.007
		(0.004)	(0.003)		(0.005)	(0.005)
$NMFG^2 \times PCI$		0.014	0.009		0.046*	0.045*
		(0.015)	(0.014)		(0.024)	(0.026)
$SERV^2 \times PCI$		-0.002*	-0.001*		-0.002**	-0.001
		(0.001)	(0.001)		(0.001)	(0.001)
Constant	47.273***	44.551***	32.166**	41.679***	48.687***	45.889***
	(4.900)	(6.616)	(15.778)	(7.700)	(11.843)	(15.465)
No. of obs.	435	370	370	285	232	232
Adjusted R-squared	0.145	0.182	0.204	0.333	0.385	0.413

Notes: Robust standard errors clustered at country level are in parentheses; ***, **, * indicate significance level at 1%, 5%, and 10%, respectively.

As the main purpose of this study is to test whether the effect of sectoral employment share on income inequality is conditioned by trade openness, the interaction term between sectoral employment share and trade openness is thus included. The results are presented in Columns 2 and 3 of Table 4. The coefficient on the share of employment in manufacturing is negative and statistically significant. The quadratic term on manufacturing is not statistically significant even at the 10% level, however. This finding indicates that an increase in the share of workers in manufacturing unambiguously reduces inequality. There is also a quadratic Kuznets-type relationship between services employment share and inequality, with inequality first rising and then falling with the movement of workers into services. Note that other explanatory variables (government expenditure, human capital index, and GDP per capita) have no discernible effect on income inequality. The coefficient on the PCI itself is negative but not statistically significant.

Even though the coefficient on the interaction term between the share of workers in manufacturing and the PCI is negative as expected, the coefficient is not statistically significant even at the 10% level.[10] Note however that the t-ratio is 1.54. Additionally, the interaction term between the share of employment in services and the PCI is positive and statistically significant at the 10% level. This indicates that the inequality-increasing effect of services employment share is larger for countries with more open trade regimes.

Columns 4-6 of Table 4 present the results for the full sample excluding African countries. The findings are largely consistent, with larger magnitude of the coefficient on manufacturing employment share. Moreover, there exists a U-shaped relationship between manufacturing employment share and income inequality.

[10] The coefficient on the interaction term between manufacturing employment share and the PCI is negative and statistically significant at the 10% level when standard error is estimated without adjusting for autocorrelation and heteroskedasticity.

Interestingly, the coefficient on the interaction term between manufacturing employment share and the PCI is negative and statistically significant at the 5% level (Columns 5 and 6 of Table 4). This finding supports the hypothesis that the inequality-reducing effect of the movement of workers to manufacturing is larger for countries with more open trade regimes. In addition, the coefficient on the interaction term between the share of employment in services and the PCI is positive and statistically significant at the 5% level (Column 5). The magnitude of the coefficient is larger than that reported in Column 2. This supports the notion that the inequality-increasing effect of service-led structural transformation is greater for countries with more open trade regimes.

Putting together developing and developing countries in a multi-country regression to test the Kuznets hypothesis can be fundamentally flawed because the present position of developed countries may not reflect the future position of developing countries (Saith, 1983; Kuznets, 1954). Therefore, the model is re-estimated for the sample of developing countries. Table 5 reports the results. It is found that the coefficient on manufacturing employment share is negative as expected but it becomes statistically significant at the 10% level only when other control variables are included (Column 3). A one percentage point increase in the share of workers is associated with a 1.77 percentage point decrease in the Gini coefficient. Also, the coefficient on services employment share is positive and statistically significant at the 5% level. The statistical significance of its quadratic term suggests a quadratic Kuznets-type relationship between the share of employment in services and income inequality.

The coefficient on the interaction term between manufacturing employment share and the PCI has the expected sign but not statistically significant. Yet, its t-ratio is greater than 1. In addition, the findings suggest that the inequality-increasing effect of services-led structural transformation is larger for developing countries with more open trade regimes.

Table 5: Sectoral employment share and income inequality: Developing countries and developing countries excluding African countries

	Developing countries			Developing countries exclude Africa		
	1	**2**	**3**	**4**	**5**	**6**
Manufacturing *(MFG)*	-0.493 (0.344)	-1.603 (1.008)	-1.770* (0.902)	-0.947* (0.524)	-4.671*** (1.620)	-4.418*** (1.509)
Manufacturing^2 *(MFG^2)*	0.002 (0.006)	0.023 (0.022)	0.023 (0.020)	0.010 (0.009)	0.076** (0.031)	0.073** (0.031)
Non-manufacturing industry *(NMFG)*	0.083 (1.153)	-1.906 (2.070)	-1.752 (2.187)	2.951** (1.171)	-2.510 (3.079)	-1.946 (3.455)
Non-manufacturing^2 *($NMFG^2$)*	-0.019 (0.059)	0.057 (0.103)	0.039 (0.108)	-0.167** (0.076)	0.217 (0.216)	0.158 (0.233)
Services *(SERV)*	0.298 (0.302)	1.329** (0.593)	1.309** (0.556)	0.274 (0.636)	1.917*** (0.460)	1.569*** (0.381)
Services^2 *($SERV^2$)*	-0.004 (0.003)	-0.014** (0.005)	-0.014** (0.005)	-0.004 (0.006)	-0.021*** (0.005)	-0.017*** (0.004)
Ln per capita GDP *(LGDP)*			1.736 (2.167)			2.469 (2.149)
Government expenditure *(GEX)*			0.054 (0.062)			0.026 (0.086)
Human capital *(HCP)*			1.466 (5.092)			-9.421* (4.818)
Price convergence index (PCI)		-0.747 (1.233)	-0.856 (1.242)		5.710 (3.833)	5.744 (3.542)
$MFG \times PCI$		-0.206 (0.175)	-0.167 (0.157)		-0.825** (0.366)	-0.825** (0.344)
$NMFG \times PCI$		-0.478 (0.339)	-0.348 (0.327)		-1.343* (0.688)	-0.948 (0.784)
$SERV\ X\ PCI$		0.220** (0.099)	0.182* (0.093)		0.317** (0.113)	0.247** (0.096)
$MFG^2 \times PCI$		0.004 (0.004)	0.003 (0.004)		0.016* (0.008)	0.016** (0.007)
$NMFG^2 \times PCI$		0.018 (0.017)	0.011 (0.017)		0.099** (0.047)	0.070 (0.051)
$SERV^2 \times PCI$		-0.002** (0.001)	-0.001 (0.001)		-0.003** (0.001)	-0.002** (0.001)
Constant	49.155*** (5.249)	46.335*** (6.823)	31.987* (15.789)	43.337*** (10.734)	65.014*** (14.920)	63.677*** (15.696)
No. of obs.	339	298	298	200	169	169
Adjusted R-squared	0.164	0.218	0.242	0.311	0.471	0.509

Notes: Robust standard errors clustered at country level are in parentheses; ***, **, * indicate significance level at 1%, 5%, and 10%, respectively.

The results for the sample of developing countries excluding African countries are presented in Columns 5-6 of Table 5. The coefficient on the share of employment in manufacturing is negative and statistically significant at the 1% level. The magnitude of the

coefficient is bigger than that reported in the previous table. The finding suggests that a 1-percentage point increase in the share of employment in manufacturing is significantly associated with almost a 5-percentage point drop in the Gini coefficient. In addition, the coefficient on the squared manufacturing variable is positive and statistically significant at the 5% level. Therefore, there is a U-shaped relationship between manufacturing employment share and income inequality. Therefore, the estimates are consistent when the model is estimated for the full sample excluding African countries (see Columns 5-6 of Table 4).

As shown in Columns 5-6 of Table 5, the interaction term between manufacturing employment share and the PCI is negative as expected and statistically significant at the 5% level. The size of the coefficient on this interaction term is larger than that reported in Table 4. The inequality-reducing impact for a given share of workers in manufacturing is almost 1 percentage point larger in more open economies. Moreover, the coefficient on the interaction term between services employment share and the PCI is positive and statistically significant at the 5% level. These findings for the sample of developing countries excluding African countries are robust to the inclusion of additional control variables (e.g., democracy and regime repressiveness), the use of the RE estimator, and the use of gross Gini coefficient as the dependent variable (the results are not reported).

As discussed in Baymul and Sen (2020), there is a possibility of reverse causality in the model because a country with higher level of income inequality may have a smaller domestic market for manufactured goods and sophisticated services. This leads to a lower share of employment in manufacturing and services. This is a particular concern among closed economies since the market size is limited. I limit my sample to relatively closed economy (where trade-to-GDP ratio is less than median value in the sample). It is found that the results are largely consistent with what reported in Tables 4 and 5. The coefficient on the interaction term between manufacturing employment share and the PCI is statistically

significant at the 5% level after excluding African countries from the sample. The findings are therefore robust to concerns of reverse causality.

Many studies suggest that a series of policy intervention (e.g., minimum wage) can contain a rise of income inequality (Li, Kanbur, & Lin, 2019; Lin & Yun, 2016). Checchi and Garcia-Penalosa (2010) find that labour market institutions play an important role in curbing income inequality through several channels including stronger labour unions and higher minimum wage. However, adding the minimum wage variable changes the finding on the presence of significance of the coefficient on sectoral employment share. The coefficient on the minimum wage itself is not statistically significant. This is presumably due to smaller time and country coverage. In addition, the difference in the minimum wage may be captured through country fixed effect which is cleared away when estimating the model using the FE estimator.

Tables A3.3 in the Appendix report the results when trade openness is measured by the trade-to-GDP ratio. The coefficients on sectoral employment share variables and their quadratic terms are largely consistent with the results reported in Tables 3.5 and 3.6. The coefficient on the interaction term between manufacturing employment share and the trade-to-GDP ratio is positive and statistically significant. The magnitude of the coefficient on this interaction term is very small. The results on sectoral employment share and its square hold when trade openness is measured using export-to-GDP ratio (the results are not shown). Note however that this coefficient is not different from zero when the 'super trading economies' (Botswana, Hong Kong, Lesotho, Malaysia, Mauritius, Namibia, Netherlands, Singapore, Thailand) are deleted from the sample. More importantly, these results, which are not consistent with the hypothesis of this paper, are presumably due to the limitations of the trade-to-GDP ratio as a measure of trade openness.

In summary, when trade openness is measured by the price convergence index, the results from the sample excluding African countries support the hypothesis that the inequality-reducing effect of manufacturing-led structural transformation is greater for countries with more open trade regimes. In addition, the findings also suggest that the inequality-increasing effect of services-led structural transformation is larger for countries with more open trade regimes.

6. Conclusion

After the publication of Kuznets (1955), the relationship between economic growth and income inequality has been pushed to the forefront of development policy debate. The Kuznets hypothesis—that is, income inequality first rises and then tends to fall in the process of economic growth—has inspired a generation of economists to test this relationship. Recent studies have focused on the underlying process of the Kuznets hypothesis, the movement of workers from agriculture to non-agriculture. However, the literature on the structural transformation-income inequality nexus has largely ignored trade dimension, a prime driver of economic dynamism among developing countries in the last half-century.

This paper has examined the implications of openness to trade in the structural transformation-inequality relationship using a panel dataset covering 48 countries from 1960 to 2010. The results suggest that an increase in the share of employment in manufacturing reduces inequality, irrespective of the stages of structural transformation. The impact is significant greater for countries with more open trade regimes when the African countries are excluded for the country coverage. The results are robust to alternate specifications and estimation methods.

These findings call for further attempts to develop an analytical framework in analysing structural transformation by incorporating the dimension of trade. Also, given the

limitations of cross-country regression analysis, further research could extend to in-depth case studies to supplement multi-country econometric studies. Structural equation modelling is an alternative methodology that can be used to see the impacts of the population shift process reinforced by trade openness.

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Appendix

Appendix A

Price Convergence Index

The price convergence index (PCI) is defined as changes over times in the price of traded goods in a given country relative to that of the world price.

The PCI is constructed as follow:

Step 1: Collect data on world and individual-country manufacturing price. Manufacturing price of the U.S., measured by the implicit deflator derived from the U.S. national accounts, is used as the proxy for the world price. Manufacturing price of the countries under study are also measured by the implicit manufacturing deflator derived from national accounts (available in local currency unit). The base year for the price indices is 1970.

Step 2: Adjust individual country price indices for changes in the exchange rate with the U.S. dollar by multiplying price index by the domestic currency – US$ exchange rate index (1970 = 100).

Step 3: Divide each country's exchange rate adjusted price index by the U.S. price index.

Step 4: Calculate the absolute deviation of relative price from the base value (1970=100).

Manufacturing prices, rather than prices of all traded goods, is used to calculate the PCI because, at the level of standard national account disaggregation, it is not possible to precisely delineate prices of other traded goods. In addition, most of the agricultural products

are quasi non-tradables. Agricultural prices are also influenced by changes in global commodity price cycles. Moreover, prices of mineral products are susceptible to commodity booms and busts. Manufacturing price of the U.S. is used as a proxy for world price because the U.S. is the major trading nation in the world during the period under study with an open trade regime, particularly in manufacturing trade.

The concept of the PCI is closely related to the law of one price: the rate of change in prices of traded goods at home and abroad should converge when a country becomes increasingly integrated into the world economy, given that there is no trade friction (such as transportation cost and tariffs). It is important to note that prices of individual product may not be identical across countries even though all trade barriers are eliminated, and domestic market is freely competitive. This is because prices are determined by other factors, for instance, transportation cost, storage costs, tax, in addition to differences in product composition. These costs are country-specific and vary enormously across countries; reduction in trade barriers alone should bring about price convergence for tradable goods but may not achieve the law of one price. Therefore, at a given point of time, the levels of price of a given product can be different across countries due to transportation costs, other fixed costs, and differences in the commodity mix. However, over time, openness to trade should manifest in convergence of changes in relative prices of traded goods (Cecchetti et al., 2002; Engel & Rogers, 2001; Hufbauer et al., 2002).

Table A1: Economic sectors

Economic sectors	Description
Agriculture	Agriculture, hunting, and forestry, fishing
Mining	Mining and quarrying
Manufacturing	Manufacturing
Utilities	Electricity, gas, and water supply
Construction	Construction
Trade services	Wholesale and retail trade; repair of motor vehicles, motorcycles, and personal and household goods; hotels and restaurants
Transport services	Transport, storage, and communications
Business services	Financial intermediation, renting and business activities (excluding owner-occupied rents)
Government services	Public administration and defence, education, health, and social work
Personal services	Other community, social and personal service activities, activities of private households

Table A2: countries coverage (based on GGDC database)

Country	Employment by sector
Africa	
Botswana	1964-2010
Ethiopia	1961-2010
Ghana	1960-2010
Kenya	1969-2010
Malawi	1966-2010
Mauritius	1970-2010
Nigeria	1960-2011
Senegal	1970-2010
South Africa	1960-2010
Tanzania	1960-2010
Zambia	1965-2010
Egypt	1960-2012
Morocco	1960-2012
Asia	
China	1952-2011
Hong Kong	1974-2011
India	1960-2010
Indonesia	1961-2012
Japan	1953-2012
South Korea	1963-2011
Malaysia	1975-2011
Philippines	1971-2012
Singapore	1970-2011
Taiwan	1963-2012
Thailand	1960-2011
Latin America	
Argentina	1950-2011
Bolivia	1950-2010
Brazil	1950-2011
Chile	1950-2012
Colombia	1950-2010
Costa Rica	1950-2011
Mexico	1950-2012
Peru	1960-2011
Venezuela	1950-2011
North America	
United States of America	1950-2010
Europe	
West Germany	1950-1991
Denmark	1948-2011
Spain	1950-2011
France	1950-2011
United Kingdom	1948-2011
Italy	1951-2011
The Netherlands	1950-2011
Sweden	1950-2011

Table A3.2: Sectoral employment share and income inequality (the trade-to-GDP ratio as a measure of trade openness)

	Full sample	**Full sample exclude Africa**	**Developing countries**	**Developing countries exclude Africa**
	1	**2**	**3**	**4**
Manufacturing *(MFG)*	-1.688**	-2.010***	-0.981	-1.671**
	(0.651)	(0.633)	(0.755)	(0.699)
Manufacturing^2 *(MFG^2)*	0.027*	0.031**	0.005	0.025
	(0.015)	(0.014)	(0.018)	(0.017)
Non-manufacturing industry *(NMFG)*	0.968	1.328	1.243	2.977
	(1.927)	(1.760)	(2.110)	(2.535)
Non-manufacturing^2 *($NMFG^2$)*	-0.044	-0.047	-0.086	-0.172
	(0.108)	(0.094)	(0.116)	(0.138)
Services *(SERV)*	1.125**	1.307***	0.850	1.099*
	(0.445)	(0.404)	(0.566)	(0.620)
Services^2 *($SERV^2$)*	-0.013***	-0.013***	-0.010*	-0.010
	(0.004)	(0.004)	(0.005)	(0.006)
Ln per capita GDP *(LGDP)*	0.172	0.043	1.675	0.239
	(1.763)	(1.957)	(1.928)	(1.890)
Government expenditure *(GEX)*	0.045	-0.007	0.032	0.005
	(0.047)	(0.080)	(0.047)	(0.089)
Human capital *(HCP)*	1.928	-1.172	-1.485	-5.078
	(4.156)	(3.494)	(5.214)	(4.364)
Trade to GDP ratio *(TGDP)*	0.172	0.043	1.675	0.239
	(1.763)	(1.957)	(1.928)	(1.890)
$MFG \times TGDP$	-0.013**	0.017***	0.010	0.020***
	(0.005)	(0.004)	(0.008)	(0.006)
$NMFG \times TGDP$	-0.014	0.031	-0.039*	-0.030
	(0.020)	(0.028)	(0.021)	(0.030)
$SERV\ X\ TGDP$	-0.014*	-0.026***	-0.012	-0.025***
	(0.008)	(0.006)	(0.009)	(0.008)
$MFG^2 \times TGDP$	-0.000*	-0.000***	-0.000	-0.000**
	(0.000)	(0.000)	(0.000)	(0.000)
$NMFG^2 \times TGDP$	0.001	-0.001	0.002*	0.002
	(0.001)	(0.001)	(0.001)	(0.002)
$SERV^2 \times TGDP$	0.000*	0.000***	0.000	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
Constant	34.842***	36.393***	28.754**	36.265***
	(12.553)	(12.250)	(12.363)	(10.319)
No. of obs.	403	275	307	190
Adjusted R-squared	0.225	0.459	0.271	0.505

Notes: Robust standard errors clustered at country level are in parentheses; ***, **, * indicate significance level at 1%, 5%, and 10%, respectively.