CATCHING UP, STRUCTURAL TRANSFORMATION, AND INEQUALITY: LESSONS FROM ASIA

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Bruno Martorano (b.martorano@ids.ac.uk) is research fellow at the Institute of Development Studies. Donghyun Park (dpark@adb.org) is principal economist at the Economic Research and Regional Cooperation Department of the Asian Development Bank. Marco Sanfilippo (marco.sanfilippo@uantwerp.be) is associate professor of Economics at the University of Bari and visiting professor at the Globalization and Development, Institute of Development Policy and Management at the University of Antwerp.

ASIAN DEVELOPMENT BANK

6 ADB Avenue, Mandaluyong City, 1550 Metro Manila, Philippines
Tel +63 2 632 4444; Fax +63 2 636 2444
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ABSTRACT

While structural transformation, driven by technological progress, productivity growth, and capital deepening, has contributed to Asia's sustained rapid growth, its effect on income inequality is uncertain. The central objective of our paper is to empirically examine the effect of structural change on wage inequality in Asia, using industry-level data for three skill groups of workers. Our evidence indicates that structural change, pushed by productivity catch-up with advanced economies, capital deepness, and the shift of the economic structures to more skill-intensive industries, has exacerbated inequality in the region. However, we also find that policy responses, especially investment in education matching the higher demand for skills and competitive exchange rates, can mitigate the increase in inequality.

Keywords: Asia, inequality, productivity, structural change, wage gap

JEL codes: E24, L16

I. INTRODUCTION

Rapid globalization and diffusion of new technologies has brought about extensive structural transformation of economies across the world. While the structural changes improved productivity and bolstered economic growth, more of the gains have accrued to owners of capital than to workers, and to skilled rather than unskilled workers, in both advanced and developing economies (ILO 2014). In addition to globalization and technological progress, other factors such as financial sector expansion and the weakening of labor market institutions have contributed to lower share of labor income, and to wider wage gap between skilled and unskilled workers (Piketty, Saez, and Stantcheva 2014; Jaumotte and Osorio Buitron 2015).

Most Asian economies are clearly part of such global trends. Over the last decade, output growth has consistently exceeded employment, and productivity outgrew wages (especially outside the People's Republic of China [PRC]). At different times and in different ways, most Asian economies have witnessed drastic changes in their economic structures. While structural change facilitated catch-up with advanced economies and contributed to unprecedented poverty reduction, the impact on inequality is uncertain. Zhuang, Kanbur, and Rhee 2014, 3) point out that the drivers of Asia's world-beating growth, i.e. technological change, globalization, and market-oriented reforms, also exacerbated inequality.

Capital accumulation due to the high investment rates, along with skill-biased technological change (SBTC), are the main likely causes of the rise in inequality, especially between skilled and unskilled workers, since they raise the demand for skill (Card and di Nardo 2002; Zhuang, Kanbur, and Rhee 2014). Additional sources of inequality in the region include the rising role of services, which absorb low shares of labor force, and capital account liberalization, which benefits skilled labor.

Still, the experience of Asia brings about several distinguished features. The East Asian growth model was characterized by labor-saving technological progress (World Bank 1993) and high levels of investment in human and physical capital (Aizenman, Lee, and Park 2012). Many Asian economies still specialize in labor-absorbing manufacturing, in contrast to the ongoing "premature de-industrialization" in developing countries described by Rodrik (2015).

McMillan, Rodrik, and Verduzco-Gallo (2014) and Timmer et al. (2014) document that productivity growth in Asia has taken place largely within, rather than between, sectors, i.e. through a more rapid accumulation of technology and capital within a sector rather than as a shift of labor from low- to high-productive sectors. This pattern is consistent with the comparative advantage-following argument recently put forth by proponents of the new structural economics approach (Lin 2011).

In light of the above discussion, we aim to uncover new evidence on the relationship between structural transformation, catch-up, and wage inequality in Asia. We hope to contribute to the existing literature in different ways. First, we perform our empirical analysis at both the country and the industry level. Compared to studies that only examine the country level (e.g. Avalos and Savvides 2006, Bigsten and Munshi 2014), our analysis accounts for heterogeneity across sectors. Furthermore, in contrast to previous industry-level studies, which are confined to a subset of high-technology industries within the manufacturing sector (Martorano and Sanfilippo 2015), we extend the analysis to all the main industries of the economy, fully accounting for both within-sector and between-sectors structural transformation.

Second, we use different variables as a proxy for structural transformation. While we account for the capital intensity of each sector, our key measures of structural transformation considers each industry's productivity gap as well as the overlap in the sectorial structure of the economy, compared to the benchmark of high-income Organisation for Economic Co-operation and Development (OECD) economies. Not only does this allow for looking at both the within- and between-sector dimensions of structural transformation (Timmer et al. 2014), but it also provides a better sense of each country's pattern of economic development and the extent to which catching up affects inequality.

Third, we highlight the role of policies that can mitigate the negative effects of structural transformation on the wage gap between skilled and the unskilled workers. Areas of such policy interventions include exchange rate management, education/human capital formation, trade openness, and labor market institutions.

Finally, thanks to the richness of the data, we are able to examine the effects of our control variables on the relative compensations of high-; medium-; and low-skilled workers separately. This allows us to more clearly disentangle some of the mechanisms through which structural transformation and policies affect inequality.

To do this, we use data from the Socio-Economic Accounts (SEA) of the World Input Output Database (WIOD) project for five Asian economies (the PRC; India; Indonesia; the Republic of Korea; and Taipei,China) over the period 1995–2009. Our results show that the process of economic transformation has contributed to wider wage gaps by increasing the relative share of high-skilled workers' compensation. This is due to both (1) a shift toward more productive—and more intensive in the use of skilled workforce—activities within and between industries and (2) capital deepening. This pattern is difficult to reverse, since it is intrinsically linked to the process of economic development in Asian economies. Therefore, selective policy interventions can partially offset the negative effect of economic upgrading and structural changes on wage inequality.

The remainder of the paper is structured as follows. Section II describes the Asian context of wage inequality, productivity catch-up, and related policies. Section III describes the data and the empirical strategy. Section IV reports and discusses our results, while section V concludes.

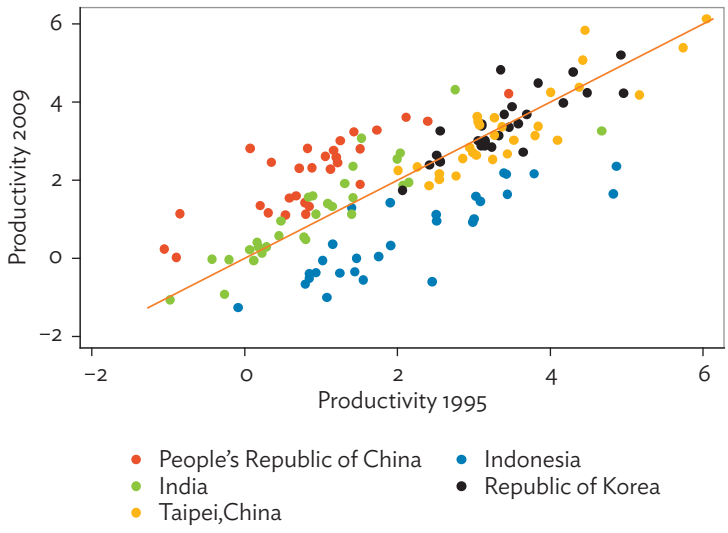
II. CATCH-UP AND WAGE INEQUALITY

In this section, we examine productivity catch-up and wage inequality of Asian economies.

A. Productivity Catch-Up and Structural Transformation

Since the mid-1990s, Asian economies have experienced rapid growth and extensive structural transformation. Growth of labor productivity, constructed as the ratio of real value added on employees, has been uneven across economies and industries. In 1995–2009, the PRC and India enjoyed the highest growth of productivity. The Republic of Korea and Taipei,China managed to keep their productivity levels stable, which is plausible in light of their already high productivity levels (Figure 1). Indonesia, on the other hand, has lost ground. After a rebound in the early 2000s, productivity declined visibly in the manufacturing sector and fell modestly in the service sector, with the exception of some industries such as transport and communications (World Bank 2014b).

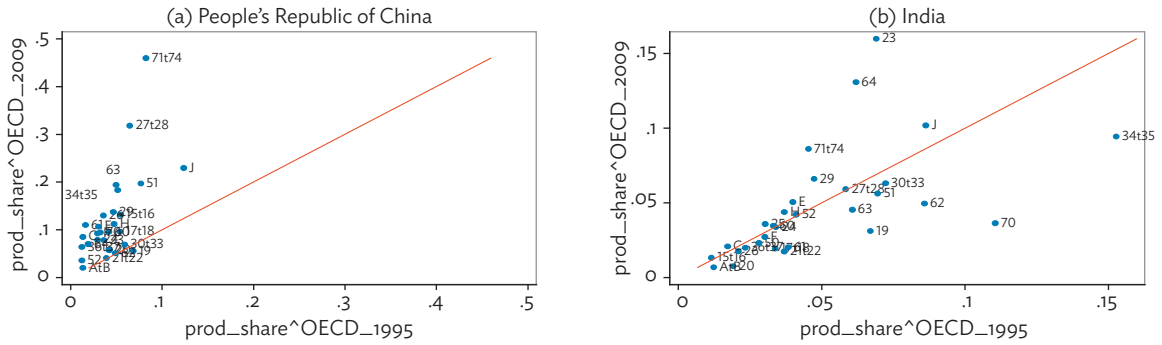
Figure 1: Changes in Productivity Level between 1995 (x-axis) and 2009 (y-axis)



Note: Productivity is measured at the country and industry level as the ratio of deflated value added on employees. See section III for more details on the variables and the deflators used.
Source: Authors' elaboration on Socio-Economic Accounts database.

The overall increases of within-industry productivity observed in absolute terms in Figure 1 have not necessarily led to faster catching up with advanced economies, highlighting interesting differences in the direction of structural change among different economies. Not surprisingly, the PRC stands out as the country with productivity improvements large enough to catch up with advanced countries in practically all sectors of the economy, regardless of labor, capital or knowledge intensity (Figure 2.a). India, on the other hand, has been able to close the gap more modestly and mostly in services, especially knowledge intensive ones such as financial intermediation and business services (Figure 2.b). The drivers of Korean growth are mostly manufacturing industries in which the country had developed a comparative advantage, while in Taipei,China, it has been driven by high-skill services. Finally, our data confirm that the poor Indonesian performance was driven by manufacturing industries (Appendix Figure A.1).

Figure 2: Changes in Productivity Gap with OECD in the People's Republic of China (panel a) and India (panel b) between 1995 (x-axis) and 2009 (y-axis)



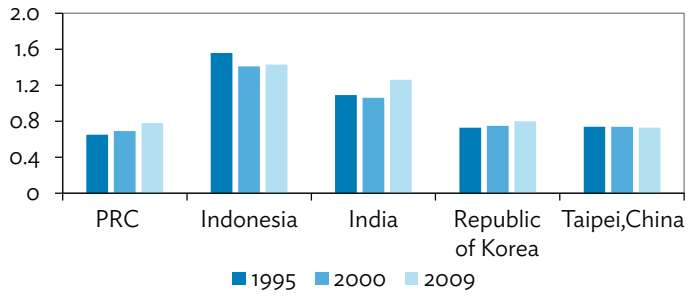
OECD = Organisation for Economic Co-operation and Development.
Notes: The productivity ratio has been constructed comparing levels of productivity by country and industry with the corresponding average levels recorded by high-income OECD countries. More details on the construction of the index are provided in section III.A.
Source: Authors' elaboration on Socio-Economic Accounts data.

B. The Impact of Structural Transformation on Wage Distribution

Following the theoretical literature (see Chusseau and Hellier 2012), our main hypothesis is that productivity changes leading to catching up with advanced economies can result in higher inequality. The underlying assumption is that by reducing the productivity gap with more advanced economies, Asian economies start introducing new, and higher skill-intensive productions that increase the demand for skills (Zhu and Trefler 2005).

Evidence on inequality levels over time shows some differences among our sample of Asian economies. Based on our data, and in line with the existing evidence, the PRC started out with lower levels, but witnessed the most marked widening of wage inequality (Figure 3). Rising disparities between urban and rural areas, as well as growing wage gaps between skilled and unskilled workers within urban areas, have contributed to the worsening wage gap. However, the increase in wage inequality went hand in hand with a stronger increase in overall productivity, suggesting that the PRC's economic growth was largely driven by the absorption of surplus labor.

Figure 3: Average Levels of Wage Gap in Asian Economies, 1995–2009

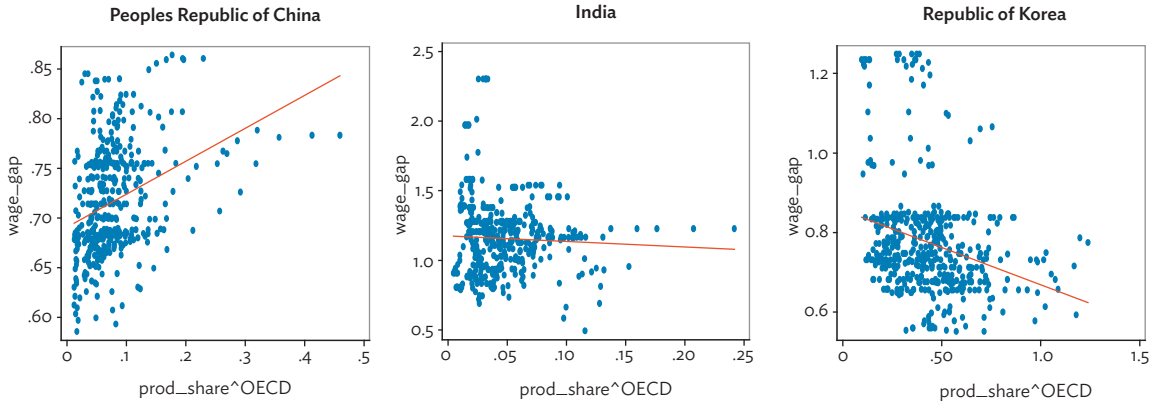


PRC = People's Republic of China.
Note: The wage gap reported in this graph is constructed as the simple average of each industry's wage gaps. More details are provided in section III.A.
Source: Authors' elaboration on Socio-Economic Accounts data.

India and Indonesia have the highest levels of wage inequality. Interestingly, Indonesian wage inequality has remained stable. This seems supported by complementary evidence on the country's overall inequality levels (di Gropiello and Sakellariou 2010). A possible explanation is that the Asian crisis affected urban wages more than rural wages (Jomo 2006). On the other hand, East Asian economies, which enjoyed the positive spillover effects of rapid growth on income distribution during the years of the East Asian Miracle (World Bank 1993), have somewhat better levels of inequality.

Whether and to what extent the process of structural transformation and catching up in productivity are the main drivers of wage inequality is ultimately an empirical question. Observing the actual trends of productivity relative to advanced economies and wage inequality during the last decade gives us a mixed picture about their relationship (Figure 4).

Figure 4: Wage_gap (y-axis) and Productivity Ratio (x-axis), Selected Countries



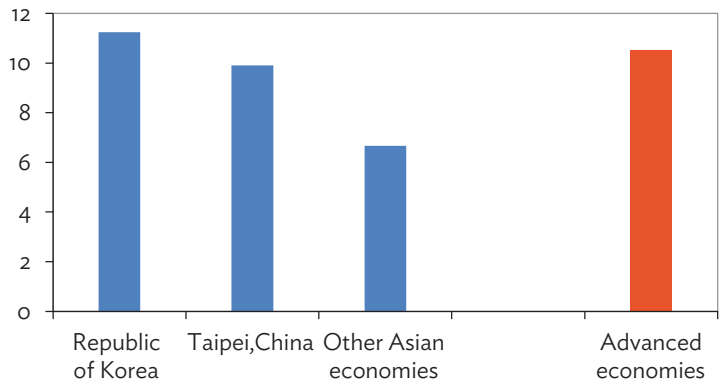
OECD = Organisation for Economic Co-operation and Development.
Source: Authors' elaboration on Socio-Economic Accounts data.

What can be said about the trends observed in the previous graphs? Why did wage inequality increase faster in some countries than others? How were Asian economies able to weaken the link between productivity catch-up and wage inequality?

The experience of the East Asian economies during the Miracle suggests that selective government interventions can improve outcomes in terms of both growth and income distribution (Wade 1990). In particular, previous work confined to the manufacturing sector shows that well-designed education policies and a prudent macroeconomic management restrained the pressure of structural change on wage inequality (Martorano and Sanfilippo 2015).

For instance, a key mechanism to mitigate the growing demand for skills on wage inequality is to adjust the supply of human capital. In this context, in the Republic of Korea and Taipei,China, education policies were able to match the evolution of their economic structures over time (Jankowska, Nagengast, and Perea 2013). As a result, their workforce is now as well educated as the workforce of other advanced economies (Figure 5).

Figure 5: Average Years of Education—Population Aged 25 years, Average Period 1995–2010



Note: Advanced economies include Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, United, and United Kingdom.
Source: Authors' elaboration on data by Barro and Lee (2010).

In contrast to the past, however, emerging Asian economies face the challenge of developing in a context of an open economy. The process of import liberalization, together with a rise in capital inflows, has recently led to significant pressures on wages.

Currency devaluations have been used to promote tradable industries, especially in East Asia (Rodrik 2008). After the crisis of 1997–1998, Asian governments followed different strategies. India adopted an intermediate, while the PRC moved to a pegged regime, while Indonesia; the Republic of Korea; and Taipei,China all opted for a flexible exchange rate. However, painful memories of the crisis and the fear of appreciation led to asymmetric interventions, moving the floating economies toward intermediate exchange rate regimes (Rajan 2012).

In addition, Asian economies introduced measures to manage capital inflows, with the explicit aim of attracting foreign direct investment (FDI) into manufacturing and restricting short term inflows (Gochoco-Bautista, Jongwanich, and Lee 2011). For example, Indonesia introduced capital account

controls to reduce the pressure on real exchange rates in the 2000s. The PRC and India embarked on gradual capital account liberalization to limit their external vulnerability. Taipei,China, too, pursued a strategy of gradual liberalization (Fay 2013).

Some important changes were also implemented in the labor market. Many Asian governments implemented active labor market programs to promote employment. This has been the case in the Republic of Korea (Bacchetta and Jansen 2011), and more recently in India, with the introduction of the National Rural Employment Guarantee Scheme (Dasgupta and Sudarshan 2011). Nevertheless, labor market institutions in the region remain weak. Unemployment insurance is still rare in Asian economies (World Bank 2014a). Lack of effective wage policies, together with the large supply of labor, weakens the bargaining power of less-skilled workers (ILO 2008, ADB 2012). Finally, minimum wage legislations have emerged across the region only recently (ILO 2012), although it did play a positive role during the global financial crisis (ILO 2014).

III. DATA AND EMPIRICAL STRATEGY

In this section, we describe the data and strategy used for our empirical analysis.

A. Data and Main Indicators

Our main data come from the Socio-Economic Accounts (SEA) of the WIOD project (Timmer et al. 2015), which provides information on employment, wages, capital, and output at the industry level for 40 economies over the period 1995–2009.[1] Data on the number of hours worked and their relative compensations, originally sourced from national labor force surveys and censuses, are reported by skills, defined according to the International Standard Classification of Education (ISCED). We can therefore distinguish between low-skilled workers, i.e. those with no education or ISCED levels 1 and 2 (basic education); medium skilled (levels 3 and 4, secondary and postsecondary) and high skilled (levels 5 and 6, tertiary education).[2]

Five Asian economies are available in the original dataset.[3] They include two newly industrialized economies (the Republic of Korea and Taipei,China), a large, middle-income economy from the Association of Southeast Asian Nations (Indonesia), and the PRC and India, two fast-growing giants. Industries cover the three main sectors of the economy, primary, manufacturing and services, and are generally reported—unless where some reaggregation was necessary—with their 2-digit code of the ISIC classification, revision 3 (see Appendix Table A.1 for a list of the industries included).[4]

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[1] Available at http://www.wiod.org/new_site/home.htm

[2] Though to the best of our knowledge, the data are probably more comprehensive sources comparing countries across sectors in such a consistent way, some bias must be taken into account due, for instance, to the lack of reliable information on informal and self-employed workers, whose role might be substantial in some emerging economies such as India. For more information on the way these workers were covered by the data, see the country notes reported in the background paper by Erumban et al. (2012).

[3] While Japan is also included in SEA, we exclude it from our analysis considering its stable presence in the group of high-income OECD countries as well a less recent process of structural transformation.

[4] Nonmarket service industries (from L to P in Table A1) were dropped from the sample due to their potential role of outliers in countries highly exposed to market forces and international integration.

Based on such information, we construct our main dependent variable, the wage gap, as the ratio of the hourly wage of high-skilled workers (*skilled_wage*) to the sum of the wages of medium- and low-skilled workers (*unskilled_wage*). Formally,

$$wage\_gap_{i,j,t} = skilled\_wage_{i,j,t}/unskilled\_wage_{i,j,t} \quad (1)$$

where *i, j,* and *t* identify country, industry and year, respectively.

In the absence of detailed information on technology adoption by industry, we try to capture the skill-biased technological change dimension by combining information about changes in within-sector productivity and information about the distribution of output across sectors, i.e., looking at the pattern of structural transformation over time.

Rather than using absolute values of productivity for each country in our sample, we compare their performance to a benchmark represented by the average value of a group of high-income OECD countries.[5] More specifically, we first construct a within-industry labor productivity as the ratio of value added to the total number of workers in each Asian economy. We then construct our benchmark as the average of the OECD group, and express our variable as the ratio of the two:

$$prod\_ratio^{oecd}{}_{i,j,t} = productivity_{i,j,t}/productivity_{\ OECD,j,t} \quad (2)$$

B. Model and Empirical Specification

In this subsection, we describe the empirical specification and the mitigating role of policies.

1. Baseline specification

Having introduced the main variables of interest, this section presents our baseline specification in more detail. Formally, we define the wage gap as a function of the productivity ratio:

$$wage\_gap_{ijt} = \alpha_0 + \alpha_1 prod\_ratio^{oecd}{}_{i,j,t} + \eta_{ij} + \rho_i + \zeta_t + u_{ijt} \quad (3)$$

We include in our specifications a set of country (ρ_i) and country-industry fixed effects (η_{ij}), to rule out omitted variable bias, while controlling for unobservable factors likely to influence the distribution of wages. We also include a set of year dummies (ζ_t). We thus allow for common shocks among the five Asian economies since they are fairly well integrated, especially via trade.[6]

As discussed in the previous section, productivity growth may affect wage inequality through a number of mechanisms, especially technology diffusion and capital deepening. To rule out the effect of capital deepening, and isolate the technological change component, we refine (3) and control specifically for the capital intensity of each industry, measured as the ratio of investments on fixed assets to total employment (*k_e*):

---

[5] Countries included are: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, the Netherlands, Portugal, Spain, Sweden, the United Kingdom, and the United States.

[6] Over the period considered, one might think of at least three such common shocks. First, the 1997–1998 financial crisis in Thailand; second, the PRC's 2001 entry into the World Trade Organization and the likely spread of global value chains in the region; third, the 2007–2009 global crisis.

$$wage\_gap_{ijt} = \alpha_0 + \alpha_1 prod\_ratio^{oecd}{}_{i,j,t} + \alpha_2 k\_e_{ijt} + \eta_{ij} + \rho_i + \zeta_t + u_{ijt} \quad (4)$$

To account for the relative size of each industry in the economy, and its influence on the wage distribution, we control as well for the share of each industry in total output (*output_share*):

$$wage\_gap_{ijt} = \alpha_0 + \alpha_1 prod\_ratio^{oecd}{}_{i,j,t} + \alpha_2 k\_e_{ijt} + \alpha_3 output\_share_{ijt} + \eta_{ij} + \rho_i + \zeta_t + u_{it} \quad (5)$$

Finally, though we are confident that within-industry productivity change should absorb a large part of the gains in total productivity in our economies (as demonstrated in Table 4 of McMillan, Rodrik, and Verduzco-Gallo 2014, 21), in further specifications, we also try to account for a modified "between" effect. We use the OECD countries as benchmark, and, using the same metric of the export similarity index based on Krugman (1991), calculate a similarity index (Krugman Index of Similarity) by comparing the relative share of each industry's gross output in the economy. The similarity index is transformed to have a range between zero and 1, with values close to zero meaning a stronger similarity with the economic structure of the OECD:

$$KIS_{it} = \frac{1}{2}\sum_{j=1}^{j}\left|output\_share_{ijt} - output\_share\_OECD_{ijt}\right| \quad (6)$$

Overall, we expect that both productivity catch-up and capital intensity worsen the wage gap, in light of the skill bias of technological change they bring about; the complementarity between capital and skilled workers and the shift of production toward high-skill activities they cause. This is at least what we consistently observe in the recent pattern of growth of advanced economies. However, technological change via productivity growth and capital deepening might not necessarily be labor biased, but labor saving (Vivarelli 2012), depending on the characteristics of the countries and industries.

2. The Mitigating Role of Policies

Once we verified the existing relations between our main variables of interests, and identified the effect of productivity catch-up, capital deepening, and structural transformation on wage inequality, we check the consistency of our model by incorporating other control variables.

More specifically, we first control for the level of per capita gross domestic product (*gdp_pc*) in order to account for the different income levels of the five economies. Moreover, we introduce a number of factors under the direct control of policy makers.

First, we construct an indicator of human capital (*hc*), measuring the ratio of working-age population with tertiary education to working-age population with primary, secondary, and no education, using the Barro-Lee data set (Barro and Lee 2010). We expect that an increase in the share of high-skilled workers to reduce wage inequality.

Second, we try to measure the impact of labor market institutions by constructing the ratio of the statutory minimum wage to the median wage (*min_wage*).[7] A higher minimum wage should prevent a race to the bottom among less-skilled workers (Freeman 1996). Empirical evidence provides so far mixed results (Card and Krueger 1995), since the effectiveness of this policy tool is conditioned by a number of

[7] Data on nominal minimum wage were extracted from ILOStat. We construct our measure of minimum wage relative to the median, rather than the mean, earnings since median values provide a better basis for international comparisons, accounting for wage dispersions across countries.

factors. Indeed, it is possible that minimum wage policy is neutral when coverage or level is limited. On the other hand, it might cause a reduction of the demand for unskilled workers when its level is too high or in the presence of a large informal sector (Fields and Kanbur 2005). Using Indian data, Soundararajan (2013) finds positive distributive effects of minimum wage. Fang and Lin (2013) report that minimum wage has negative effects on employment for the most vulnerable groups in the PRC.

Third, we control for the changes in the level of the real exchange rate (*reer*). A stable and competitive exchange rate can promote the growth of the tradable sector by raising the demand for unskilled workers in countries that specialize in labor-intensive activities. Recent studies on developing countries find that competitive exchange rates can protect the manufacturing sector and are positively related to growth-enhancing structural change (McMillan, Rodrik, and Verduzco-Gallo 2014). This, in turn, should promote labor-saving structural change and specialization in labor-intensive activities (Helleiner 2011).

Finally, in a separate specification, we analyze the effects of capital account liberalization on sectoral wage inequality, using the variable developed by Chinn and Ito (2006) (*kaopen*). Theoretically, opening the capital account can push firms to high-tech capital investments that complement and thus raise the demand for more skilled workers and the wage gap. An empirical analysis by Larrain (2014) on a group of European countries confirms this pattern, which is magnified in financially constrained and capital-intensive industries.

3. Further Specifications

So far, we have not directly tackled the impact of trade and financial globalization on wage inequality. A large literature examines the relationship between globalization and wage gap between skilled and unskilled workers (see a recent review by Kurokawa 2014, for an overview of the existing evidence). While trade theory predicts that globalization raises the wages of the abundant factors, some evidence suggests the opposite (Goldberg and Pavnik, 2007). The case of Asia is of special interest, in light of its rapid integration into the world economy, especially through global and regional value chains (Rodrik, 2008). Similarly, large FDI inflows fostered the participation of Asian workers in low value-added phases of global supply chains.

In further specifications of the analysis, we therefore control for openness to trade, including the share of imported intermediate inputs in total inputs used by each industry (*imp_int*). We calculate these shares for each country using complementary Input–Output tables made available from the WIOD project.

Importantly, we are also able to combine, for 2003–2009, our data with sectoral greenfield FDI statistics constructed from the *FDI Markets* database (*fdi*). Although there is a large interest in the effects of FDI on inequality (Basu and Guariglia 2007), to the best of our knowledge, our study is one of the first studies to look at this relation taking into account sectorial heterogeneity.

When not transformed as ratios or indexes, all variables expressed in monetary values, such as gross fixed capital formation, value added, and wages, were deflated using their respective price index (available from the SEA database) and reported in common currency using the same exchange rate adopted to make Input–Output tables consistent across the different countries covered by the WIOD (see Timmer et al. 2015). Summary statistics of the variables are reported in Table 1.

Table 1: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
wage_gap	2,220	0.97	0.43	0.49	7.44
prod_ratio^{oecd}	2,220	0.23	0.28	0.00	2.27
k/e	2,193	8.06	3.89	−4.74	18.51
output_share	2,550	3.01	2.74	0.00	16.86
gdp_pc	2,550	8.95	1.03	7.30	10.46
hc	2,250	0.20	0.20	0.02	0.64
kaopen	2,040	−0.33	1.08	−1.19	2.39
reer	2,550	97.14	14.69	51.11	130.07
min_wage	2,250	37.02	6.79	22.60	55.32
imp_int	2,250	0.10	0.10	0.00	0.75
fdi	1,036	0.33	1.41	0.00	21.71

Source: Authors' elaboration.

IV. RESULTS

In this section, we report and discuss the results of our empirical analysis.

A. Baseline Model

Table 2 reports the main regression results obtained through an ordinary least squares model with fixed effects. The productivity coefficient is positive across all the different specifications. From column 1 we can argue that closing the productivity gap by 10% would result in increasing wage inequality by 2.2%. Similar results are found for the capital intensity and the output share. These findings are in line with the existing literature, and suggest that structural changes resulting in the adoption of more advanced, and more capital-intensive production techniques complements skilled labor. Having so far controlled for within-industry upgrading over time, column (3) also supports "between" structural transformation. Our results suggest that developing economies transforming the structure of their economies pay a price in terms of widening the gap between skilled and unskilled. This is plausible since structural transformation often leads to a shift from labor to capital-intensive industries or to high value-added services, which normally entail a wage *premium* to more educated workers.

Table 2: Main Results
(dependent variable: wage gap)

	(1)	(2)	(3)
prod_ratio^{oecd}	0.223***	0.215***	0.127***
	[0.040]	[0.036]	[0.040]
k_e		0.041***	0.033**
		[0.015]	[0.014]
output_share		0.034***	0.035***
		[0.010]	[0.010]
KIS			−2.976***
			[0.629]
Constant	0.662***	−0.092	0.968***
	[0.022]	[0.228]	[0.271]
Country*Industry effects	Y	Y	Y
Country effects	Y	Y	Y
Year effects	Y	Y	Y
Observations	2,220	2,193	2,193
R-squared	0.581	0.584	0.593

KIS = Krugman Index of Similarity.
Notes: Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.
Source: Authors' calculations.

In columns 1–7 of Table 3 we present the results of our baseline specification augmented by a number of policy-related factors. Interestingly, the size of the coefficients of productivity and, especially, capital decline and they both lose part of their explanatory power. One possible interpretation is that the policy-related variables have an explanatory power on wage inequality and that their effect partly offsets the effect of rising capital intensity.

Indeed, most of the policy-related variables included have a role in explaining wage inequality, as discussed in section II.B. The supply of highly skilled workers can, in principle, reduce wage inequality.[8] To test this, we introduce an interaction term between the productivity ratio and the human capital variables (*prod*hc*). The results, reported in column 3 of Table 3, show that the interaction term is negative and significant, meaning that a greater supply of workers with higher education mitigates the widening of the skill premium caused by productivity catch-up. This was a striking feature of the East Asian Miracle; expansion of skilled labor helped East Asian economies the technological gap vis-à-vis more advanced economies without worsening wage inequality (Stiglitz 1996).

The coefficient of the minimum wages is negative and significant at 1%. Although labor market institutions have been historically weak in Asia, this result highlights their potential contribution to protecting vulnerable workers and reducing the skill premium.

[8] Interestingly, the coefficient is no longer statistically significant— even though it is still negative— after the introduction of the *kaopen* index. One of the explanations could be related to the fact that Taipei,China is excluded from the last regression, the other that the two variables are correlated.

Table 3 shows some interesting results on macroeconomic policies as well. The coefficient of the exchange rate is positive and statistically significant, suggesting that a competitive exchange rate can promote the tradable sector. In countries which specialize in labor-intensive activities, this process contributes to higher demand for unskilled workers, reducing the wage gap. To check this hypothesis further, we interact the coefficient of *reer* with a dummy for the service sector (*reer*serv*, column 5). While the original coefficient remains positive and statistically significant, the interaction term is not. It is possible that a competitive exchange rate regime helps to reduce the wage gap in the overall economy, but not services.

Columns 2 and 4 show that the coefficient of capital account openness is positive and significant. This is in line with both theory and existing evidence. One explanation, in particular, is that firms can now borrow abroad to invest in high-tech equipment that in turn increases the demand of skilled workers (Larrain 2014).

We interact the productivity variable with an indicator of capital account openness based on *kaopen*, which takes a value of 1 if a country's capital account is open to some degree—and zero otherwise. The result in column 4 shows that the coefficient is still positive and significant. Interestingly, the coefficient of the interaction variable is higher than the *kaopen* coefficient, while the coefficient of productivity remains significant. These results are consistent with the predictions of skill-biased technical change theory and suggest that the detrimental effect of the catch-up process on wage inequality is larger under open capital accounts.

Our last set of results (columns 6 and 7, Table 3) adds some information on the role of globalization and openness to trade and international capital flows.[9] The negative and significant coefficient of imported intermediate inputs as a share of total inputs supports theoretical predictions about factor remuneration and some existing cross-country evidence, including on Asia (Wood 1997, Avalos and Savvides 2006). A potential explanation has to do with the heavy involvement of Asian economies in global and regional production chains. Industries with higher share of imported intermediate inputs are likely to have a lower share of domestic value added. The PRC is a classic example. Despite its ongoing technological upgrading, the PRC still imports a large quantity of inputs and assembles them into final goods for export with low domestic value added but a lot of unskilled and medium-skilled labor.

The coefficient of the FDI variable is negative, but not significant. This suggests that opening up to capital might not exacerbate wage inequality, especially if long-term flows are in line with existing comparative advantages (te Velde and Morrisey 2004, Lin 2011).

[9] Due to the potential high correlation, we dropped the exchange rate coeffiecient when running the specifications including imports and inward FDI.

Table 3: Additional Tests
(dependent variable: wage gap)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
prod_ratio^{oecd}	0.107**	0.063	0.303***	0.009	0.090*	0.111**	0.070
	[0.046]	[0.123]	[0.099]	[0.113]	[0.048]	[0.056]	[0.069]
k_e	0.024	0.026	0.024	0.025	0.024	0.032*	0.085*
	[0.017]	[0.019]	[0.017]	[0.019]	[0.017]	[0.017]	[0.048]
output_share	0.034***	0.043***	0.034***	0.043***	0.035***	0.038***	−0.005
	[0.010]	[0.013]	[0.010]	[0.012]	[0.010]	[0.010]	[0.051]
gdp_pc	−0.140	−0.351**	−0.182	−0.321*	−0.135	−0.028	−0.764
	[0.129]	[0.172]	[0.137]	[0.167]	[0.131]	[0.115]	[0.502]
hc	−0.277**	−0.244	−0.071	−0.344*	−0.281**	−0.386***	−1.154
	[0.118]	[0.190]	[0.113]	[0.205]	[0.116]	[0.125]	[1.163]
min_wage	−0.003***	−0.008***	−0.004***	−0.008***	−0.003***	−0.003***	−0.018***
	[0.001]	[0.002]	[0.001]	[0.002]	[0.001]	[0.001]	[0.005]
reer	0.003***	0.002***	0.003***	0.002***	0.004***		
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]		
kaopen		0.072***		0.060**			
		[0.025]		[0.024]			
prod*hc			−0.549***				
			[0.179]				
prod*kaopen				0.120**			
				[0.058]			
reer*serv					−0.002		
					[0.001]		
imp_int						−0.899**	
						[0.352]	
fdi							−0.027
							[0.018]
Constant	1.093	3.083**	1.404	2.832**	0.937	0.357	6.803
	[0.916]	[1.343]	[0.977]	[1.293]	[0.964]	[0.827]	[4.392]
Country*Industry effects	Y	Y	Y	Y	Y	Y	Y
Country effects	Y	Y	Y	Y	Y	Y	Y
Year effects	Y	Y	Y	Y	Y	Y	Y
Observations	2,193	1,744	2,193	1,744	2,193	2,193	1,024
R-squared	0.591	0.566	0.591	0.567	0.591	0.591	0.614

Notes: Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.
Source: Authors' calculations.

B. Seemingly Unrelated Estimator Results

So far, we have analyzed the impact of structural transformation on the wage gap. In this section, we extend our analysis to account for the effects of our main control variables on the relative compensations of high-, medium-, and low-skilled workers separately. To do this, we consider the relative share of labor compensation for each type of workers in total labor compensation.

The three variables are linked to each other since are all part of their common denominator. Therefore, we attempt to address potential simultaneity by running a system of Seemingly Unrelated Regressions (SUR), assuming that the error terms are correlated (Wooldridge 2001).

Model 1 in Table 4 reports the first set of regressions, including only the productivity coefficient and fixed effects. Catching up has a positive effect on the compensation of medium- and high-skilled workers. For high-skilled workers in particular we can see that the rising demand due to productivity catch-up raises their compensation strongly. The resulting increase in wage inequality observed in the previous section can

therefore be explained as the combination of two forces. On one hand, high-skilled workers' wages rise faster than those of medium-skilled workers, who also benefit from reducing the productivity gap with advanced economies, albeit more modestly. On the other hand, convergence in industry's productivity with higher-income countries generally comes at the expenses of low-skilled workers, who lose out from technological upgrading, capital intensification and the likely shift of production toward industries at higher skill content. This last point becomes clearer from the results of Model 2 (Table 4). Controlling for capital intensity and industry size, they show that the relative decline of low-skilled workers wage is mostly due to the efficiency gains associated with productivity growth relative to advanced economies. Though we cannot further disentangle the factors driving productivity growth, skill-biased technical change and structural transformation are certainly the more plausible candidates.

Structural transformation of the economy drains resources from traditional labor-intensive activities toward more sophisticated ones, and benefits high-skilled workers (Model 3, Table 4). The effect is larger for medium-skilled workers than low-skilled workers, in line with existing evidence showing that structural transformation disadvantages workers who specialize in routine tasks (Autor, Katz, and Kearney 2008).

Table 4: Regression Results, Seemingly Unrelated Regressions
(Model 1–3)

	Model 1			Model 2			Model 3		
	High	Medium	Low	High	Medium	Low	High	Medium	Low
prod_ratio^{oecd}	0.515***	0.075***	−0.056***	0.504***	0.075***	−0.055***	0.409***	0.104***	−0.050***
	[0.082]	[0.016]	[0.011]	[0.072]	[0.015]	[0.011]	[0.079]	[0.016]	[0.011]
k_e				0.098***	0.013***	−0.000	0.090***	0.016***	0.000
				[0.023]	[0.003]	[0.002]	[0.022]	[0.003]	[0.002]
output_share				0.057***	0.003	−0.005***	0.059***	0.003	−0.005***
				[0.015]	[0.003]	[0.001]	[0.015]	[0.003]	[0.001]
KIS							−3.225***	0.998***	0.150*
							[0.939]	[0.123]	[0.081]
Constant	1.454***	1.118***	0.977***	−0.233	0.914***	1.007***	0.916**	0.559***	0.954***
	[0.039]	[0.014]	[0.005]	[0.347]	[0.046]	[0.033]	[0.427]	[0.069]	[0.043]
Country*Industry effects	Y	Y	Y	Y	Y	Y	Y	Y	Y
Country effects	Y	Y	Y	Y	Y	Y	Y	Y	Y
Year effects	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	2,220	2,220	2,220	2,193	2,193	2,193	2,193	2,193	2,193

KIS = Krugman Index of Similarity.
Notes: Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.
Sources: Authors' calculations.

Further results, incorporating additional variables, are reported in Table 5. To estimate the effects of human capital, we decompose the indicator of relative endowments by including separately indicators of completion of primary (or no education), secondary, and tertiary education for the three types of workers. Results are inconclusive. The coefficient of the relative supply of medium-educated workers is negative, but becomes positive when we control for the degree of openness of capital account.[10]

[10] This could be explained by the exclusion of Taipei,China, which reduces the average years of education in the sample decreases to 6.9, a value close to the turning point identified by Ram (1990) and Londoño (1996) in the relationship between educational achievement and educational inequality. This means that starting from a low level of education, an increase in the supply of educated workers (and so in the years of education) leads to an increase in the education inequality, which in turn causes an increase in wage inequality. Only beyond a certain threshold—a further increase in the supply of educated workers lead to a reduction in the variance of education and so in the wage dispersion (Checchi 2001).

Table 5: Regression Results, Seemingly Unrelated Regressions
(Model 4–5)

	Model 4			Model 5		
	High	Medium	Low	High	Medium	Low
prod_ratio^{oecd}	0.205**	−0.018	0.006	0.230	0.050	−0.015
	[0.080]	[0.020]	[0.009]	[0.225]	[0.032]	[0.022]
k_e	0.056**	0.005	0.005**	0.057**	0.004	0.004
	[0.026]	[0.003]	[0.002]	[0.029]	[0.004]	[0.003]
output_share	0.056***	0.003	−0.005***	0.070***	0.002	−0.007***
	[0.015]	[0.003]	[0.001]	[0.019]	[0.004]	[0.002]
gdp_pc	0.186	0.278***	−0.100***	0.020	0.340***	−0.093***
	[0.194]	[0.025]	[0.015]	[0.260]	[0.031]	[0.018]
hc (tertiary education)	0.330			−0.282		
	[0.205]			[0.285]		
hc (secondary education)		−0.032**			0.063***	
		[0.014]			[0.017]	
hc (primary or no education)			−0.003			−0.005
			[0.002]			[0.003]
min_wage	−0.005***	0.002***	−0.001***	−0.007**	0.005***	−0.001
	[0.001]	[0.000]	[0.000]	[0.003]	[0.000]	[0.000]
reer	0.006***	−0.001***	−0.000**	0.005***	0.000	−0.000
	[0.001]	[0.000]	[0.000]	[0.001]	[0.000]	[0.000]
kaopen				0.114***	0.007	−0.010***
				[0.038]	[0.006]	[0.003]
Constant	−1.557	−1.181***	1.842***	−0.019	−2.011***	1.777***
	[1.402]	[0.193]	[0.113]	[2.058]	[0.261]	[0.152]
Country*Industry effects	Y	Y	Y	Y	Y	Y
Country effects	Y	Y	Y	Y	Y	Y
Year effects	Y	Y	Y	Y	Y	Y
Observations	2,193	2,193	2,193	1,744	1,744	1,744
R-squared						

Notes: Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.
Source: Authors' calculations.

Turning to labor market policies, higher levels of minimum wage increase the compensation of medium-skilled workers but decrease those of high and low-skilled ones (Table 5, Models 4 and 5). It is possible that medium-skilled workers, more likely to have a formal job, are more effectively protected by labor market regulations, including minimum wage legislation. On the other hand, low-skilled workers are more likely to be in the informal sector, with lower levels of protection and employer compliance (Menon and Rodgers 2015).

The evidence from other studies seems consistent with our findings. Raising the minimum wage has often harmed low-skilled workers, who are laid off by employers facing higher labor costs (see Gindling 2014 for a review). This is what happened in Indonesia in the mid-1990s, when overgenerous minimum wage caused higher unemployment, especially among women (World Bank 1996). Similar evidence can be found for the case of the PRC (Feng and Lin 2013), while the evidence of a beneficial effect in India is limited (Menon and Rodgers 2015).

The results of the coefficient of exchange rate are consistent with the discussion of earlier sections (Table 5 – Model 4). The coefficient of *reer* is in fact significant for both categories of workers, but its sign differs—positive for skilled workers but negative for unskilled workers. This result suggests that competitive exchange rate benefits less-skilled workers, protecting labor-intensive industries, likely to be important in some Asian economies. At the same time, the positive and significant effect on high-skilled workers' wages is consistent with studies showing that exchange rate appreciation could promote more imports of high-tech inputs, which are complementary with higher-skilled workers (Cornia 2005).

Capital openness (see Model 5) raises the demand for skilled workers, and reduces the relative compensation of unskilled workers, in line with the explanations of the literature (Chari, Henry, and Sasson 2012).

V. CONCLUDING OBSERVATIONS

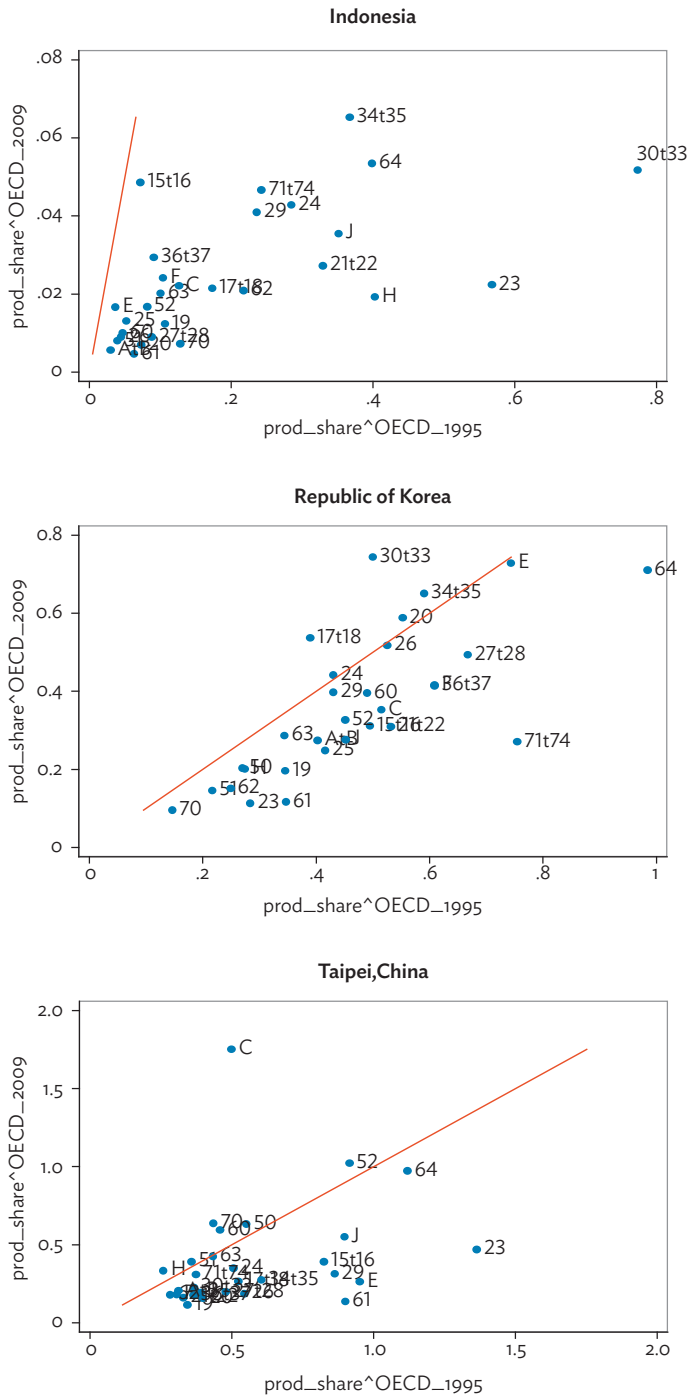
Asia has grown visibly faster than other parts of the world during the past few decades. While extensive structural transformation, driven by technological progress, productivity growth, and capital deepening, contributed to Asia's sustained rapid growth, it may have exacerbated income inequality. This issue is of great interest for the region, where more inclusive growth has emerged as a top strategic priority in light of widening inequality. The central objective of this paper is to empirically investigate the effect of structural change on inequality in Asian economies. To do so, we use data for different industries and skill groups of workers from 1995 to 2009.

Our results confirm that the process of structural change and catch-up with advanced economies has indeed worsened wage inequality in Asian economies. Our evidence further confirms that high-skilled workers have benefited from structural transformation. In line with theory and existing evidence, our findings lend empirical support to the skill bias of technological change, and complementarity between capital and skilled workers, in Asian economies. Therefore, while structural change is vital for Asia's economic dynamism and growth, it may exacerbate inequality in the region.

However, our evidence suggests that a number of policy responses can mitigate the adverse effect of structural transformation on wage inequality in Asian economies. In particular, boosting the supply of high-skilled workers can limit the adverse effect. This result underlines the need for investments in education and human capital. Our results also suggest that competitive exchange rates reduce inequality by promoting the growth of labor-intensive export-oriented manufacturing. Capital account openness seems to widen inequality, but higher international integration through imports and FDI may reduce it. Finally, the minimum wage—our proxy for labor market institutions—plays an important role in reducing the extent of inequality.

APPENDIX

Figure A.1: Changes in Productivity Ratio with OECD Countries, 1995 (x-axis) and 2009 (y-axis)



OECD = Organisation for Economic Co-operation and Development.
Source: Authors' elaboration on Socio-Economic Accounts data.

Table A.1: Industries

Industry Description	Industry Code
Agriculture, hunting, forestry and fishing	AtB
Mning and quarrying	C
Food, beverages and tobacco	15t16
Textiles and textile	17t18
Leather, leather and footwear	19
Wood and wood and cork	20
Pulp, paper, paper, printing and publishing	21t22
Coke, refined petroleum and nuclear fuel	23
Chemicals and chemical	24
Rubber and plastics	25
Other non-metallic mineral	26
Basic metals and fabricated metals	27t28
Machinery, nes	29
Electrical and optical equipment	30t33
Transport equipment	34t35
Manufacturing nec; recycling	36t37
Electricity, gas and water supply	E
Construction	F
Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of fuel	50
Wholesale trade and commission trade, except of motor vehicles and motorcycles	51
Retail trade, except of motor vehicles and motorcycles; repair of household goods	52
Hotels and restaurants	H
Other inland transport	60
Other water transport	61
Other air transport	62
Other supporting and auxiliary transport activities; activities of travel agencies	63
Post and telecommunications	64
Financial intermediation	J
Real estate activities	70
Renting of m&eq and other business activities	71t74
Public admin and defence; compulsory social security	L
Education	M
Health and social work	N
Other community, social and personal services	O
Private households with employed persons	P

Source: Authors' elaboration on Socio-Economic Accounts data.

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Catching Up, Structural Transformation, and Inequality: Lessons from Asia

The authors empirically examine the effect of structural change on wage inequality in Asia, using industry-level data for three skill groups of workers. Their evidence indicates that structural change, pushed by productivity catch-up with advanced economies, capital deepness and the shift of the economic structures to more skill-intensive industries, has exacerbated inequality in the region. However, they also find that policy responses, especially investment in education matching the higher demand for skills and competitive exchange rates, can mitigate the increase in inequality.

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ASIAN DEVELOPMENT BANK
6 ADB Avenue, Mandaluyong City
1550 Metro Manila, Philippines
www.adb.org