Construction Productivity and Income Convergence

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Abstract

This paper examines the implications of heterogeneity in construction productivity on cross-country income disparity. Using a sample of 168 countries, we estimate the 10:1 spread in construction productivity as a factor of 49-fold in 2017. The construction productivity gap falls by 46 percent when production networks are incorporated in the development accounting framework. Based on counterfactual analysis, the elimination of cross-country disparity in construction productivity lowers the 10:1 spread in GDP per capita by 55 percent. Variations in both the intermediates share of construction output and complementarity in intermediate inputs across countries drive the aggregate effects of construction productivity shock.

JEL: O4, O5, O11, E01, E13, L74.

Keywords: Productivity, Construction, Intersectoral network, Income Disparity.

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Introduction

The construction sector plays a crucial role in an economy through a range of public and private infrastructure projects (Moavenzadeh 1978; Kirchberger 2020). In 2020, the construction sector accounted for about 13 percent of the world's GDP – only three percentage points lower than the share of manufacturing sector (McKinsey 2020). Since the early 2000, construction productivity has remained mostly flat or trended downward in advanced countries (Changali et al 2015; Garcia and Molloy 2023; Goolsbee and Syverson 2023), whereas it has increased in low- and middle-income countries.[1] The growth in construction productivity in the Global South has been associated with a gradual shift of construction value chain hubs from advanced to emerging market economies,[2] but also a persistent large gap in construction prices.[3] For instance, the cost of an asphalt overlay of 50 mm for 100 kilometers of road in India (US$ 4.5 million) is almost half of that in Rwanda (US$ 9.1 million) (Collier et al 2016).

We have limited understanding of the aggregate implications of the change in construction productivity gap across countries. An early literature (Stokes 1981; Allen 1985) and some recent studies (Sveikauskas et al 2016; Sveikauskas et al 2018; Garcia and Molloy 2023; Goolsbee and Syverson 2023) have analysed the causes of slow productivity growth in construction and its consequences for aggregate productivity in OECD countries. These effects are likely to be different for low- and middle-income countries, which remains largely unknown. This paper is the first to examine how the change in construction productivity is linked to disparity in income (GDP per capita) across a large sample of 168 countries, predominantly from the Global South.

To formulate the empirical framework, we draw insights from the literatures on sectoral development accounting and propagation of sectoral shock through production networks (input-output flows in the production process of sectoral output). A growing body of research documents that sectoral characterization of productivity differences can account for a large income gap across countries (Herrendorf and Valentinyi 2012; Gollin et al. 2014; Duarte and Restuccia 2020; Inklaar et al 2023). A recent study by Duarte and Restuccia

[1] The labor productivity in construction has increased in 26 out of 38 low- and middle-income countries between 2000 and 2018 (Economic Transformation database, GGDC-UNU-WIDER).

[2] In 2009, the construction sector in China became the seventh largest downstream sector globally from not even making the top 20 list back in 1997 (Frohm and Gunnella 2017). China's prominence in global value chains corresponds to a large property sector securing 30 percent of China's GDP (Rogoff and Yang 2021).

[3] The drivers include a range of factors, including the poor organization (Zhang and Gutman 2015; World Bank 2018), inadequate communication (Changali et al 2015), contractual misunderstanding (Asher et al 2018), and flawed management (Collier, et al 2016; Presbitero 2016) explaining the gap in construction productivity.

(2020) shows that elimination of cross-country differences in productivity in non-traditional services lowers aggregate income disparity by 58 percent. We extend this line of inquiry to the change in the construction productivity gap across countries.

The change in productivity in construction could also be linked to the process through which intermediate inputs are converted into outputs. A higher value-added to gross output ratio in construction indicates greater dependency on value-added components (labor and capital). A shift toward a more value-added-intensive production process, i.e., substituting away intermediates, could result in a lower input spending, As Goolsbee and Syverson (2023) argue, this has been one of the reasons why construction productivity in the US have trended downward. In a model with production networks, the construction Domar weight (the construction sales to GDP ratio) can capture the role of construction in aggregate productivity dynamics following the foundational theorem by Hulten (1978). This is termed as the first order effect showing the aggregate effect of the change in construction productivity through production networks (Baqaee and Farhi 2019). The change in the complementarity in intermediate inputs could produce a redistributive effect, which can be approximated by a second order term. The first and the second order effects summarize a nonlinear aggregate propagation of the change in construction productivity.

Following Duarte and Restuccia (2020), we use a multisectoral development accounting framework with labor as the only factor input and estimate labor productivity in construction.[4] We then incorporate production networks in the model. As development accounting frameworks are silent about the propagation mechanisms, to identify the channel linking the change in construction productivity and aggregate outcomes we adopt a nonlinear propagation channel (Baqaee and Farhi 2019; Bachmann et al. 2022). This allows us to compute the aggregate effect of the change in construction productivity as the sum of the first order effect as the construction Domar weight and the second order effect approximated by the change in the construction Domar weight.

We primarily use the World Bank's International Comparisons Program (ICP) data over three benchmark years (2005, 2011, and 2017), the Africa Supply and Use Tables (Mensah and de Vries 2024) and the World Input-Output Database (Timmer, et al. 2015). We estimate the 10:1 spread in construction productivity as a measure of construction productivity gap using the full ICP sample (168 countries) as a factor of 62-fold in 2005, 50-

[4] Labor productivity in construction exhibits similar broad patterns, as does TFP and intermediate productivity in construction (Goolsbee and Syverson 2023).

fold in 2011, and 49-fold in 2017. Since IO tables are not available for the full ICP sample, we quantify the nonlinear aggregate effect based on its linear approximation (Bachmann et al. 2022).

We also consider a smaller sample (ASUT + WIOD) of 54 countries for which IO tables are available. Using this sample, the 10:1 spread in construction productivity drops to 30-fold and 16-fold in 2005, and 2011, respectively. This gap arises mainly because of the inclusion of many more low-income countries in ICP. Compared to the estimates of Inklaar et al (2023) based on a sample of 84 countries, the construction productivity gap using the ICP sample is larger but using the ASUT+WIOD sample it is smaller. It suggests that the sample size of countries matters for estimating the cross-country gap in sectoral productivity.

Importantly, the 10:1 spread in construction productivity gap lowers, on average, by 46 percent with IO linkages compared to without IO linkages. The correlation between total factor productivity (TFP) (Fadinger et al 2022) and labor productivity in construction with IO (0.54) is twice as large as the correlation between TFP and labor productivity in construction without IO (0.32). This supports the rationale of incorporating production networks in the model. The counterfactual simulation outcomes suggest that elimination of cross-country disparity in construction productivity lowers the 10:1 spread in GDP per capita in 2011 from 55-fold to 31-fold, registering a drop in income gap by 45 percent. Similarly, elimination of heterogeneity in construction productivity decreases the 10:1 spread in GDP per capita in 2017 from 49-fold to 22-fold, i.e., by 55 percent. Our findings are broadly in line with that of Inklaar et al (2023).[5] Finally, the pattern of production networks with construction markedly varies across countries and shows quantitatively large implications for income disparity.

One of the robust outcomes of the empirical growth literature is a strong correlation between investment rates and income (Barro 1991). This large cross-country differences in investment persist as poor countries have low productivity in producing investment goods (Hsieh and Klenow 2007). Construction, on average, accounts for more than two-thirds of investment. The role of construction in the disparity in economic performance across countries remains largely understudied, while a related literature has investigated the relationship between investment machinery and long-run economic growth (de Long and Summers 1993; Temple 1998; Sen 2002; Sen 2007). We bridge this knowledge gap by

[5] Inklaar et al (2023) show that while productivity in the non-traded sector does not systematically vary with the income level, construction has the largest productivity gap among nontraded sectors. Allowing for sectoral differences in marginal productivity of labor can considerably reduce the systematic variation in TFP in the construction industry.

documenting large gap in construction productivity and how it relates to income across countries.

This study also contributes to the literature on sectoral growth accounting. It is well-documented that differences in aggregate TFP accounts for almost half of the cross-country income differences (Hall and Jones 1999; Caselli 2005). Recent studies show that even a larger variation in income is explained by the productivity gap in certain sectors (Herrendorf and Valentinyi 2012; Gollin et al. 2014). Production networks also play a crucial role in cross-country differences in sectoral and aggregate productivity (Jones 2011; Duarte and Restuccia 2020; Fadinger et al 2022). We observe variations in the sources of intermediate inputs in construction and the intermediates share of construction output across countries with potentially large implications for the disparity in construction productivity and income.

Finally, we contribute to a scant literature on the construction sector. Early studies on the economics of construction examined the determinants of long-term fluctuations in construction demand and productivity in advanced industrial economies (Kuznets 1958; Abramovitz 1968; Stokes 1981; Allen 1985). As research interests in construction among economists fell since the early nineties, it became increasingly integrated into the fields of construction engineering and management, and urban studies (Ive and Chang 2007; de Valence and Runeson 2015). There is a renewed interest in understanding the productivity dynamics in construction (Sveikauskas et al 2016; Sveikauskas et al 2018; Garcia and Molloy 2023; Goolsbee and Syverson 2023). While some studies argue that mismeasurements of output and input prices can possibly lead to a construction productivity gap (Garcia and Molloy 2023; Goolsbee and Syverson 2023), we take a slightly different route and demonstrate the effect of modelling production networks on the construction productivity gap across countries.

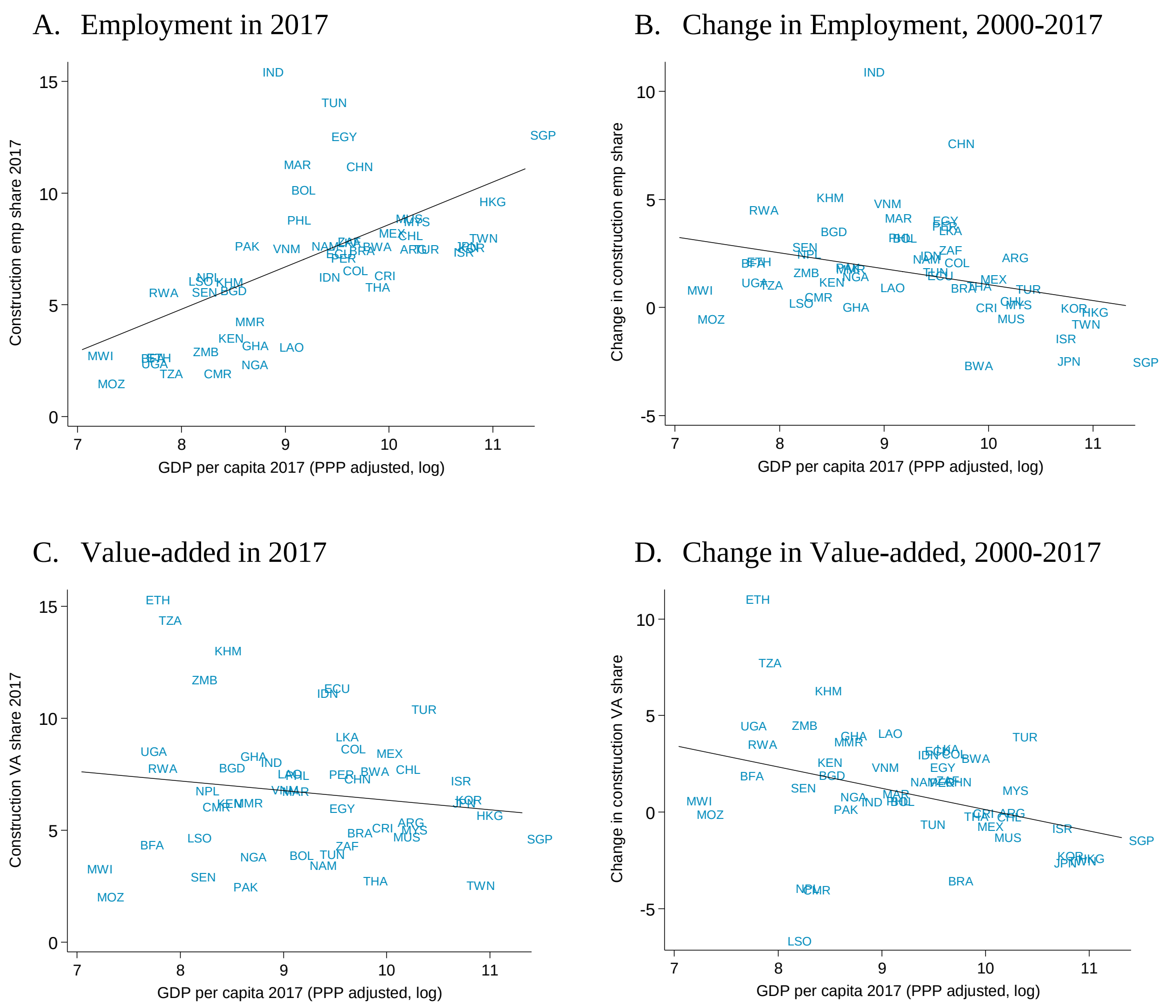
The rest of the paper is organized as follows. In section 2, we describe data sources and some stylized facts. Section 3 presents development accounting outcomes on construction productivity. In section 4, we present the counterfactual outcomes of the change in construction productivity on income disparity. Section 5 provides evidence on the role of production networks. Section 6 concludes.

2. Data and Stylized Facts

2.1. Data

We primarily use sectoral expenditure and prices data from three rounds (2005, 2011 and 2017) of the ICP, World Bank. In Appendix A, we describe all data sources, and the necessary adjustments that we had to make. We consider ICP prices for the comparison of output and expenditure in construction as expenditure-based PPPs can be a good proxy for the production-based PPPs in construction (Inklaar and Timmer 2009). We construct real expenditure share, and relative prices for construction and its subcomponents using the ICP data (see Appendix A for the ICP classification into groups, classes, and basic headings). The IO tables come from the ASUT and WIOD (Timmer et al. 2015). We transform these IO tables into 10-sector IO tables for the purpose of development accounting exercise with production networks (Appendix A shows the mapping). In addition, we use sectoral TFP measures from Fadinger et al (2022) for robustness checks and ETD data for stylized facts.

Figure 1. Construction Employment and Value-added Share, 2000-2017

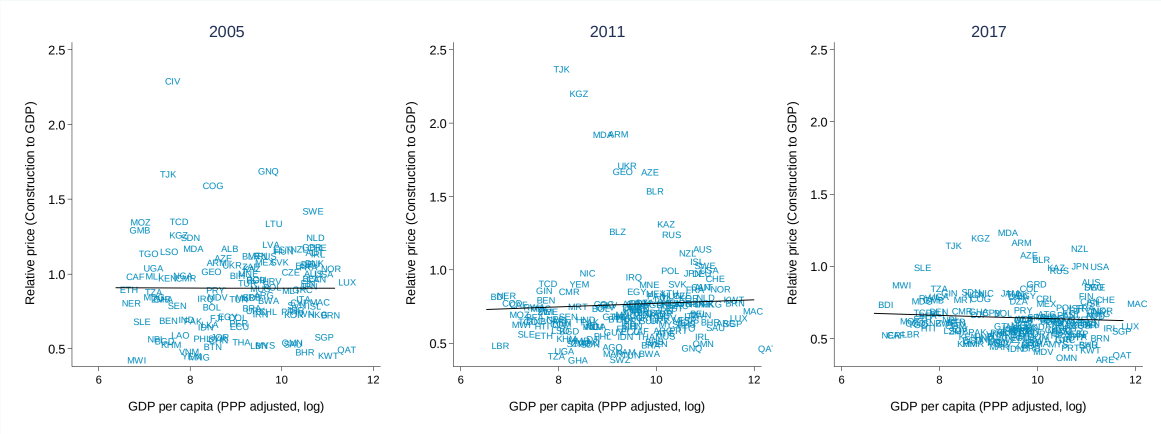


Source: Authors' estimates based on the Economic Transformation database (GGDC-UNU-WIDER).
Note: Graphs include 51 countries. The change in the construction employment (Value-added) share is the percentage points change in construction employment (value-added).

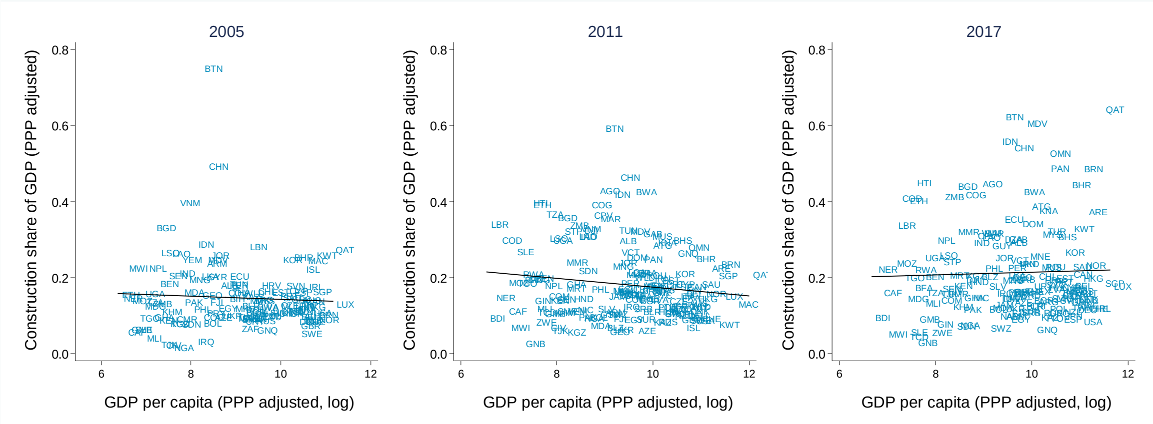
Figure 1 (panel A) shows a positive relationship between the construction employment share and income (GDP per capita in PPP terms) in 2017, which is primarily driven by the middle-income countries. The share of employment in construction increased, on average, for the low- and the middle-income countries (panel B). We do not observe any difference in the average value-added share in construction across the low-and-middle-income and the high-income countries (panel C). The change in the value-added share in construction is, on average, larger in the low-and-middle-income countries relative to the high-income countries (Panel D). Overall, the evidence supports growing activities in construction especially among the low-and-middle-income countries.

Figure 2. Relative Prices and Income: 2005, 2011, and 2017

A. Relative price of construction (Construction to GDP) and GDP per capita



B. Construction share of GDP and Income



Source: Authors' estimates based on data from 2005, 2011, and 2017 rounds of the International Comparisons Program (ICP), World Bank.
Note: 145 countries in 2005, 168 countries in 2011, and 166 countries in 2017.
Relative price of investment = PPP prices of gross fixed capital formation (GFCF) / PPP prices of GDP.
Relative price of construction = PPP price of construction / PPP price of GDP.

2.2. Relative Prices of Construction and Income

Figure 2 (panel A) shows a weak correlation between relative price of construction (in PPP terms) and income. Hsieh and Klenow (2007) show similar results between relative prices of construction and income for the benchmark years, 1980 (61 countries) and 1985 (64 countries).

2.3. Real Investment Rates in Construction and Income

We measure the real investment rate in construction, and subcomponents of construction as the ratio between total expenses in these expenditure categories and GDP (all in PPP terms). In 2005, the linear relationship between investment rate in construction and income is almost a flat line, which becomes slightly negative in 2011; however, the relationship turns out to be slightly positive in 2017 (Figure 2, panel B). Notably, the change in the investment rate in construction between 2005 and 2017 varies across income level. The 10:1 spread in the rate of change in the investment rate in construction is a factor of two-fold, i.e., the construction share of GDP in rich countries is twice the size of that in poor countries.

Recent studies show that examining subsectors within construction can provide a more accurate picture of the productivity growth dynamics (Sveikauskas et al 2018; Goolsbee and Syverson 2023). In Figure A1, we compare the relationship between income elasticity of different subcomponents of construction. The correlation between investment in residential building and income is weakly negative, whereas the expenditure share of non-residential building shows a positive correlation with income in both 2005 and 2011. The income elasticity of civil engineering works is also weakly negative.

Overall, the average rate of investment in construction and its subcomponents do not seem to vary much across different income decile of countries even though there are outliers especially in the middle deciles of the income distribution.

3. Construction Productivity Gap Across Countries

We estimate construction productivity in three steps. We start with a development accounting framework with only labor, then extend the model to include IO. Finally, we compare these findings with construction TFP.

3.1. Development accounting without IO

We consider a development accounting framework to compute labor productivity in construction following Duarte and Restuccia (2020). Output in sector i (y_i) is produced with labor (l_i) following linear technologies, $y_i = A_i l_i$, where A_i is labor productivity in sector i. We assume competitive markets for goods and labor, and free movement of labor between sectors. Assume p_i is the price of output in sector i , and w is the common wage rate across sectors. The profit-maximizing conditions can be derived from the first-order conditions for each sector i as

$$p_i A_i = w. \quad (1)$$

The value of aggregate output in domestic prices can be written as $\sum_i p_i A_i = wl$, where $\sum_i l_i = l$. The nominal wage rate in this simple model is nothing but the per capita aggregate output in nominal price. Denoting the nominal price of GDP as p, and rearranging the terms, we derive

$$log(A_i) = log(GDPpc) - log(\frac{P_i}{P}). \quad (2)$$

Differentiating equation (2) with respect to $log(GDPpc)$, the relationship between income elasticity of sectoral productivity (A_i) and income elasticity of sectoral relative price ($\frac{P_i}{P}$) becomes:

$$\frac{dlog(A_i)}{dlog(GDPpc)} = 1 - \frac{dlog(\frac{P_i}{P})}{dlog(GDPpc)}. \quad (3)$$

Table 1 (panel A) presents the income elasticity of the relative price of construction (in PPP terms) as the slope coefficient of an OLS regression of this variable on log GDP per capita (in PPP terms). The estimated coefficients are 0.01 in 2005 (145 countries), 0.027 in 2011 (168 countries), and -0.018 in 2017 (166 countries), all statistically insignificant at the 5 percent level. A 1% higher GDP per capita leads to 0.99% higher productivity in construction in 2005, 0.97% higher productivity in construction in 2011, and 1.02% higher productivity in construction in 2017. The 10:1 spread in the construction productivity gap becomes a factor of 62-fold in 2005, which drops to 50-fold in 2011, and 49-fold in 2017. The convergence in cross-country construction productivity gap over time is primarily driven by a faster growth in the average construction productivity for countries in the bottom five income deciles relative to countries in the top five income deciles.

Among the subcomponents of construction, the 10:1 spread in the productivity gap in residential buildings becomes a factor of 53-fold in 2005 and 44-fold in 2011. On the other hand, the 10:1 spread in the productivity in non-residential buildings becomes a factor of

51.62-fold in 2005, and 47-fold in 2011. The 10:1 spread in the productivity in civil engineering works is higher than buildings and it becomes a factor of 71-fold in 2005, and 59-fold in 2011. There exists large disparity in construction productivity and the productivity of different components of construction across countries.

Table 1. Development Accounting Outcomes

Panel A. Productivity gap without IO

		Real GDP Per Capita	Relative Price (Construction to GDP)	Relative Price (Residential buildings to GDP)	Relative Price (Non-residential buildings to GDP)	Relative Price (Civil engineering works to GDP)
Decile 10 / Decile 1	2005	64.37	0.92	1.11	1.11	0.88
	2011	55.46	1.14	1.35	1.19	0.89
	2017	45.61	0.95			
Income Elasticity	2005		0.01	0.045**	0.053**	-0.024
			(0.022)	(0.022)	(0.021)	(0.018)
	2011		0.027	0.056***	0.040**	-0.015
			(0.020)	(0.022)	(0.020)	(0.020)
	2017		-0.018			
			(0.016)			

Panel B. Comparison of productivity gap: without IO versus with IO

		Real GDP Per Capita	Intermediate input share in construction output	Construction productivity (without I-O table)	Construction Productivity (with I-O table)
Decile 10 / Decile 1	2005	38.423	0.57	30.31	17.60
	2011	23.481	0.59	15.58	7.67

Source: Authors' estimates based on data from 2005, 2011, and 2017 rounds of the ICP, World Bank and WIOD (Timmer, et al., 2015).
Note: Panel A outcomes with 145 countries in 2005, 168 countries in 2011, and 166 countries in 2017. Countries are ranked according to real GDP per capita (PPP adjusted). Income elasticity is measured as the slope coefficient of an OLS regression of the log of each variable on log real GDP per capita (PPP adjusted) across countries in the sample. Standard errors are in parenthesis. Panel B outcomes are based on 54 countries that are common between ICP and WIOD + WIOT. Construction productivity without IO table is calculated based on equation 2, and construction productivity with IO table is calculated based on equation 4 with 10 sectors.

3.2. Development accounting with IO

We now extend the development accounting framework to incorporate IO linkages a la Duarte and Restuccia (2020). We write the gross output production function as $y_i = B_i {l_i}^{1-\alpha_i} {h_i}^{\alpha_i}$, where B_i is productivity level of gross output in sector i, α_i is the share of produced inputs in each sector. h_i is the composite of intermediate inputs: $h_i = \prod_j \left(\frac{h_{ji}}{\emptyset_{ji}}\right)^{\emptyset_{ji}}$, where h_{ji} is the quantity of intermediate input j used to produce output in sector i, and $\emptyset_{ji}$ is the share of total input *j* in total intermediate input use. Solving for the profit maximization of sectoral output, we derive the following expression for sectoral productivity[6]

$$log(A_i) = log(GDPpc) - log\left(\frac{P_i}{P}\right) - \frac{\alpha_i}{1-\alpha_i}\sum_j \emptyset_{ji}\left[log\left(\frac{P_i}{P}\right) - log\left(\frac{P_j}{P}\right)\right] \qquad (4)$$

Equation (4) shows that the magnitude of the effect of intersectoral linkages on sectoral productivity construction lowers if the share of intermediate inputs in gross output becomes smaller, and/or the share of intermediate inputs from other sectors becomes smaller, and/or the share of intermediate inputs with different relative prices gets smaller. In the development accounting framework with IO linkages, quantitative implications of intersectoral network depends largely on the values of α_i and $\emptyset_{ji}$.

As ICP data does not provide output prices, to minimize the discrepancy arising from the comparison of output and expenditure prices, we construct the output prices for these 10 sectors (agriculture, mining, manufacturing, public utility, construction, wholesale and retail trade, transport, business, public services, and private services) (see Appendix A). To compute the parameters (α_i and $\emptyset_{ji}$), we use 10 industry classification for two benchmark years: 2005 and 2011 using the IO tables from ASUT and WIOD. Figure A2 compares the average intermediate input share of construction across income deciles of countries. We do not find any systematic difference in the average input share of construction output across income deciles.

With production networks, the 10:1 spread in construction productivity gap in 2005 drops to a factor of 18-fold from a factor of 30-fold without production networks (Table 1, panel B). We observe similar outcomes in 2011. The 10:1 spread in construction productivity

[6] See Duarte and Restuccia (2020) for derivation of this expression.

gap with production network lowers to a factor of 8-fold from a factor of 16-fold with production networks. Figure A3 (panel A) compares the average construction productivity between without IO and with IO model across income deciles. The 10:1 spread in construction productivity gap across income deciles declines by 57 percent in 2005, and 50 percent in 2011 if IO linkages are modelled. This effect is largely driven by a substantial (two-to-three-fold) increase in the average construction productivity for countries in the bottom income decile.

Furthermore, a larger productivity gain in construction is also strongly correlated with a higher share of intermediate use of construction output for countries in the bottom income decile. Presumably, the low-and-middle-income countries, on average, require more construction inputs for production in other sectors compared to high-income countries as more buildings, roads, and other infrastructural support are needed owing to their less-developed stage. The demand for construction inputs gradually diminishes as the level of income rises.

3.3. Development accounting with IO and capital – robustness check

As a robustness check, we compare the measures of labor productivity in construction used in our development accounting framework against construction TFP derived using a model with labor, capital, and IO by Fadinger et al (2022). We find a much stronger correlation between construction TFP and construction labor productivity with intersectoral linkages of 0.54 compared to the degree of fit between construction TFP and construction labor productivity without intersectoral linkages (0.32) (Figure A4).

We document a large gap in cross-country construction productivity, and the gap increases with a larger sample with the inclusion of low-income countries. However, the productivity gap in construction lowers with IO linkages.

4. Aggregate Effects of the Change in Construction Productivity

Armed with the developing accounting outcomes, we evaluate the extent of income convergence arising from the change in construction productivity. The first order effect of sectoral productivity shock can be summarized by the Domar weight in construction following Hulten (1978). However, in the presence of redistributive effects due to heterogeneity in the degree of complementarity between intermediate inputs, sectoral Domar weights alone may not explain the aggregate propagation of construction productivity shock.

We approximate the second order effect using nonlinear characterization of the propagation mechanism following Baqaee and Farhi (2019).

We compute the aggregate effect of the change in construction productivity as the sum of the first order and the second order effect, approximated by the change in construction Domar weight (Bachmann et al. 2022):

$$\frac{d\log Y}{d\log A_C} + \frac{d^2\log Y}{d\log {A_C}^2} = D_C + \frac{1}{2}\Delta D_C, \qquad (5)$$

where Y = GDP per capita, A_C = productivity in construction sector, and D_C = construction Domar weight. Simplifying it further, we compute the change in GDP per capita as $d\log Y = d\log A_C\,(D_C + \frac{1}{2}\Delta D_C)$.

Table 2. Income Disparity and the Change in Construction Productivity, ICP

	Ratio of log GDP per capita 2011 decile 10 to decile 1				Ratio of log GDP per capita 2017 decile 10 to decile 1
	Due to change in the labor productivity between 2005 and 2011 in				Due to change in the labor productivity between 2011 and 2017 in construction
	Construction	Residential buildings	Non-residential buildings	Civil engineering works	
Actual change (baseline case)	55.42	56.93	58.34	56.86	48.50
Elimination of productivity gap	30.46	47.79	53.29	48.28	21.89
Twice the actual change in the bottom one-third countries	48.82	54.41	57.19	55.26	46.45
Twice the actual change in the top one-third countries	60.14	58.49	59.90	57.39	50.58

Source: Authors' estimates based on data from 2005, 2011, and 2017 rounds of the International Comparisons Program (ICP), World Bank.
Note: 145 countries in 2005, 168 countries in 2011, and 166 countries in 2017.

4.1. Counterfactual outcomes using the ICP sample

Table 2 presents the counterfactual simulation results for the full ICP sample of countries. We calibrate the cross-country income disparity based on the actual change in construction productivity between 2005 and 2011, and 2011 and 2017. The outcomes for the full ICP sample are shown on the first row. The 10:1 spread in income in 2011 based on the actual change in construction productivity between 2005 and 2011 closely corresponds to the figures presented in Table 1 obtained using development accounting framework.

Elimination of cross-country disparity in construction productivity lowers the 10:1 spread in income in 2011 from 55-fold to 30-fold resulting in a drop in income inequality by almost 45 percent. Figure A5 compares log GDP per capita between the baseline case of the actual change in construction productivity between 2005 and 2011 and the counterfactual case in which construction productivity gap is eliminated over the period 2005-2011. As low-income countries tend to have low productivity in construction (Hsieh and Klenow 2007), elimination of cross-country productivity in construction helps the less-developed countries to catch up with the advanced countries at a faster rate. The drop in income inequality is larger in 2017; the 10:1 spread in income drops from 49-fold to 22-fold, registering a 55 percent decline. We find income inequality to reduce by a smaller margin resulting from an elimination of productivity gap in residential building, non-residential buildings, and civil engineering works than an elimination of productivity gap in construction. A smaller Domar weights for sub-categories of construction compared to construction explains this outcome.

If the bottom one-third countries gain twice the size of actual construction productivity growth, then it helps income convergence (the 10:1 spread drops from 55-fold to 49-fold). If the top one-third countries have construction productivity growth twice the actual size, then it leads to income divergence (the 10:1 spread increases from 55-fold to 60-fold). The results are comparable when we consider similar counterfactual cases for construction productivity gap for the period 2011-2017, and sub-components of construction for the period, 2005-11.

4.2. Counterfactual outcomes using the ASUT + WIOD sample

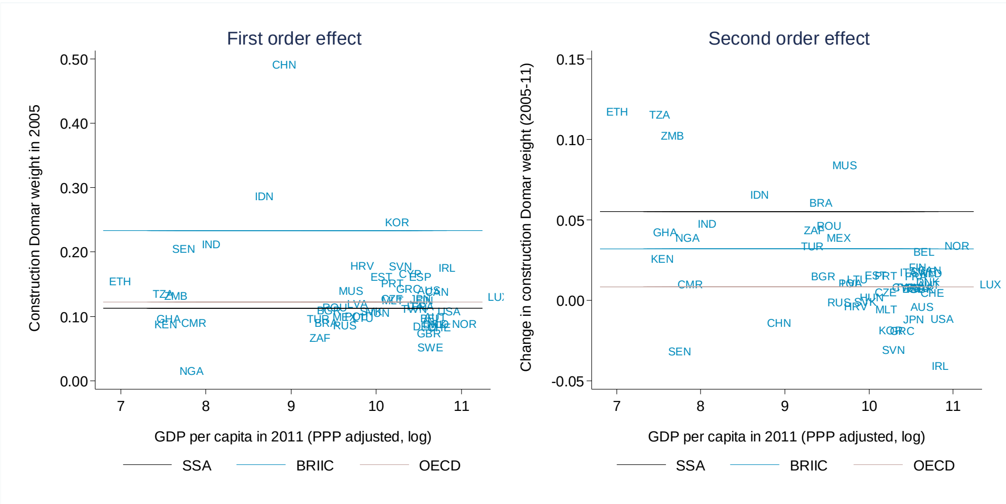
Table A1 presents the counterfactual simulation outcomes for the ASUT + WIOD sample of countries that have IO tables. Elimination of construction productivity gap lowers the 10:1 spread in income by 45 percent (from 34-fold to 19-fold) and 63 percent (27-fold to 10-fold) in 2011 and 2017, respectively. Overall, the relationship between the change in construction productivity and income disparity across countries appears robust across different country sample sizes.

5. The Role of Production Networks

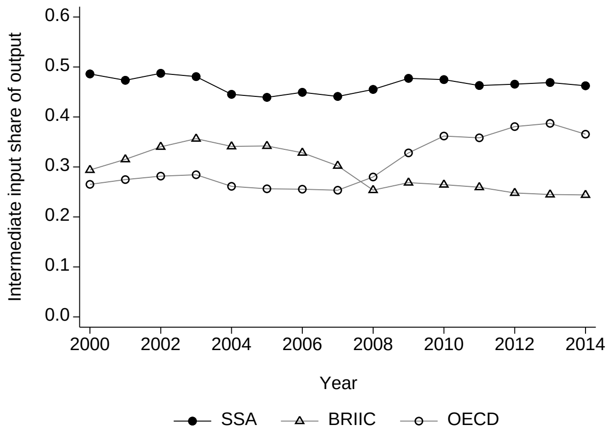
Our discussion so far points to the importance of cross-country differences in construction productivity for income disparity across countries. We now take a closer look at the nonlinear propagation mechanism to understand how production network impinges on this relationship using data on 54 countries for which IO tables are available.

Figure 3. Role of Production Network in Income Disparity Across Countries

A. First and Second order effects of the change in construction productivity



B. Construction Share of Total Intermediate Input



Source: Authors' estimates based on data from 2005 and 2011 rounds of the International Comparisons Program, the Africa Supply and Use Tables (ASUT) and World Input-Output Database (WIOD).
Note: SSA = average of 11 Sub-Saharan African countries in ASUT data. BRIIC = average of Brazil, Russia, India, Indonesia, and China from WIOD. OECD = average of the rest of the 38 countries in WIOD.

The aggregate productivity effect combines the first and the second order effects. Figure 3 (panel A) compares the estimates of the first and second order effects across four groups of countries: SSA (based on 11 countries from SSA), BRIC (5 emerging markets

Brazil, Russia, India Indonesia, and China), and OECD (the rest of 38 countries in WIOD data) averages. Among these groups, OECD is the richest, followed by BRIC and SSA. The first order effect in BRIC is twice the size of that in SSA and OECD, mainly due to China's large construction Domar weight around at 0.5. No systematic relationship exists between the first order effect and income. The second order effect is negatively correlated with income. Elimination of construction prodictivity gap produces a larger increase in construction productivity for low-income compared to high-income countries. Mainly due to the second effect, it leads to income convergence, or a large decline in income disparity as discussed in section 4.1.

Complementarities in intermediate inputs govern the role of production network in the aggregate propagation of construction productivity shock. Baqaee and Farhi (2019) define pseudo elasticity of substitution (ρ_{ji}) as $\frac{1}{\rho_{ji}} = \frac{d\log\frac{f_j}{f_i}}{d\log A_i}$ (where f is a CES aggregator of sectoral outputs, and A is sectoral productivity), and derive an expression for the change in log ratio of sectoral Domar weights with respect to the change in log productivity in sector i (A_i) as $\frac{d\log\frac{D_i}{D_j}}{d\log A_i} = 1 - \frac{1}{\rho_{ji}}$, which determines the magnitude of the second order effect. If intermediate inputs are complementary, i.e., when $\rho_{ji} < 1$, the magnitude of the second order effect becomes smaller. A negative correlation between the second order effect and income suggest that intermediate inputs utilized in the construction sector are more complementary in high-income compared to low-income countries.

The estimation of pseudo elasticities using input-output tables posits econometric hurdles. As the second-best option, we draw insights from the characteristics of intermediate inputs in construction. The construction share of total intermediate input usage averages around 46 percent in SSA - larger than BRIC and OECD, averaging around 30 percent (Figure 3, Panel B). The correlation between the size of the second order effect and the intermediate share of output in construction appears to be positive. Heavy manufacturing and wholesale and retail trade services mainly contribute to the gap between SSA and other regions (Figure A6). On the other hand, the contribution of light manufacturing to the share of the intermediates in construction is larger in BRIC (and OECD) compared to SSA. Overall, large differences in the pattern of production network across countries suggests that the implication of production network for income disparity arising from the change in construction productivity can be quantitatively large.

6. Conclusion

Based on a sample of 168 countries, we document considerable heterogeneity in labor productivity in construction between the top and bottom deciles as a factor of 49-fold in 2017. Elimination of construction productivity gap can lower the 10:1 spread in GDP per capita by 55 percent. Production networks appear quantitatively important. In the presence of production network, the gap in construction productivity declines by 46 percent. We also observe large cross-country variation in the pattern of production networks. Differences in both the intermediates share of construction output and complementarity in intermediate inputs across countries drive the aggregate effects of construction productivity shock.

Our findings provide deeper insights for industrial policy. Wholesale and retail trade services sectors source the bulk of the intermediate inputs in SSA compared to BRIC and OECD. On the other hand, almost 40 percent of the inputs in construction come from light manufacturing in BRIC and OECD, which is merely five percent in SSA. Limited utilization of manufacturing inputs in construction in low-income countries highlights the scope of policy interventions to create a denser production network in the global South.

Finally, this paper touches upon the ongoing debate on the role of nontraded sector in income disparity across countries. In a recent study, Inklaar et al (2023) show that nontraded sectors are invariant to the level of income. Duarte and Restuccia (2020), on the other hand, show that non-traditional services can account for large cross-country income disparity. Our study documents similar evidence for construction. Heterogeneity within the nontraded sector remains a promising area to understand the drivers of global income convergence inequality.

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