IMF Economic Review (2023) 71:439–473
https://doi.org/10.1057/s41308-022-00183-7

RESEARCH ARTICLE

A Manufacturing (Re)Naissance? Industrialization in the Developing World

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Published online: 15 August 2022

Abstract
This paper examines industrialization in developing countries. It introduces the GGDC/UNU-WIDER Economic Transformation Database, which provides consistent annual data of employment, real and nominal value added by 12 sectors in 51 economies for the period 1990–2018. Regressions that control for income and population indicate a manufacturing renaissance in several middle-income countries since the 2000s. We observe industrialization in many low-income Asian and sub-Saharan African countries. The industrial naissance in sub-Saharan Africa appears characterized by unregistered firms that expand employment.

JEL Classification N10 · O14 · O47

1 Introduction

Historically, the reallocation of workers from craft to modern activities has driven sustained improvements in living standards. It was the industrial revolution that initiated a long period of economic growth in Europe and the USA (Mokyr 1990). More recently, industrialization has been central to the success stories of Asian economies

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catching up and converging to income levels in the West (Herrendorf et al. 2014; McMillan and Rodrik 2011; Rodrik 2013). Indeed, a dynamic modern sector that absorbs workers is crucial for economic development and poverty reduction.

However, nowadays the phenomenon of "premature de-industrialization" appears prevalent among middle-income countries, who experience declines in manufacturing at lower peak levels of industrialization and per capita GDP compared to the past (Atolia et al. 2020; Felipe et al. 2019; IMF 2018; Rodrik 2016). On the other hand, low-income countries appear to have opportunities for industrialization, especially since labor costs are rising in China and it is moving to more sophisticated manufactures (Hanson 2021).[1]

This paper introduces the open access GGDC/UNU-WIDER Economic Transformation Database (ETD), which provides consistent time series of employment, real and nominal value added by 12 sectors in 51 economies annually from 1990 to 2018. The ETD includes 20 Asian, 9 Latin American, 4 Middle-East and North African (MENA), and 18 sub-Saharan African (SSA) economies at varying levels of economic development. The ETD has been constructed from an in-depth investigation of the availability and reliability of statistical sources on a country-by-country basis.

We use the ETD to examine trends in the manufacturing employment share. We find that the share has been increasing for many low-income countries in Asia and SSA, which suggests an industrial naissance is taking place. In addition, several developing countries that had seen peak industrialization in the 1970s or 1980s, such as Ghana and Nigeria, are experiencing a manufacturing renaissance since the 2000s. Manufacturing employment in SSA increased from 6 million to more than 20 million from 2000 to 2018, raising the share of employment in manufacturing from 7.2 to 8.4%. The significance of these trends are confirmed in regressions which control for income and demographics as well as country fixed effects. For SSA, the coefficient estimates suggest a recovery of the manufacturing employment share by more than half the downward shift during the period 1960–2011 found by Rodrik (2016). The regressions also reveal substantial cross-country heterogeneity in industrialization, indicating that regional findings cannot be generalized to all countries within the region.

We explore whether industrialization involves the expansion of modern activities, which we approximate using data on registered firms in industrial surveys. For Asian economies we find that industrialization does not appear to be dominantly driven by employment expansion in either registered or unregistered firms. In contrast, for SSA the findings suggest an absorption of workers by unregistered firms, which confirms recent evidence for Ethiopia and Tanzania by Diao et al. (2021). Hence, the industrial naissance in SSA appears characterized by unregistered firms that expand employment to meet local demand for basic manufactures (Gollin et al.

[1] See also Diao et al. (2017), Haraguchi et al. (2017), Lopes and te Velde (2021), Mensah (2020), Naudé (2019), Nguimkeu and Zeufack (2019), and Sen (2019). McMillan and Zeufack (2022) discuss various other opportunities to expand employment in manufacturing sectors in SSA.

2016; Pahl et al. 2019). Lewis (1979) noted that such an expansion of small-scale activity in manufacturing could be an initial phase in the development process.[2]

This paper is related to the literature on industrialization and economic development (Herrendorf et al. 2014), in particular the empirical research on (de-)industrialization (Felipe et al. 2019; Rodrik 2016).[3] Our analysis centers on employment industrialization, because the expansion of manufacturing jobs is a strong predictor for higher levels of economic development (Felipe et al. 2019). We contribute to the literature with new data and findings that challenge the notion that de-industrialization trends are a generalizable phenomenon in developing countries.

The paper also relates to an emerging literature that theorizes lower peak levels of industrialization. This includes the technology gap model by Fujiwara and Matsuyama (2020), the closed economy model by Huneeus and Rogerson (2020) and the dynamic open economy model by Sposi et al. (2021). These models emphasize the role of sectoral productivity gaps, differences in technological progress across sectors and trade integration in driving industrialization. The ETD may prove useful to calibrate structural models and thereby help to link driving forces to structural change outcomes.

The remainder of the paper is structured as follows. Section 2 presents the content and main characteristics of the ETD. Section 3 documents trends in manufacturing output and employment shares. Section 4 examines the significance of industrialization conditional on income and demographics. Section 5 examines cross-country heterogeneity in industrialization. Section 6 explores employment expansion in registered versus unregistered firms. Section 7 provides concluding remarks.

2 The GGDC/UNU-WIDER Economic Transformation Database

The ETD is built using primary data sources. It is not an update of time series from an existing sectoral dataset. In contrast to the widely used GGDC 10-sector database (Timmer et al. 2015), the ETD (1) has better coverage of low-income developing countries, (2) distinguishes 12 sectors in the International Standard Industrial Classification (ISIC) revision 4 and (3) has time series that run until 2018.

The ETD consists of 51 developing economies: fourteen in developing Asia, six in developed Asia, nine in Latin America, four in the MENA region and eighteen in SSA.[4] These economies account for a major part of output in each region, namely

[2] For example, in Viet Nam industrialization was at first characterized by a large share of employment in unregistered firms and these grew in importance during the initial stage (McMillan and Zeufack, 2022).

[3] See also Haraguchi et al. 2017 and Palma, 2005.

[4] Developing Asia corresponds to the IMF (2020) country grouping "Emerging and Developing Asia." Developing Asia: Bangladesh, Cambodia, China, India, Indonesia, Laos, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Sri Lanka, Thailand and Viet Nam. Developed Asia: Hong Kong (China), Israel, Japan, Korea (Rep. of), Singapore and Taiwan. Latin America: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, Mexico and Peru. The MENA region: Egypt, Morocco, Tunisia and Turkey. SSA: Botswana, Burkina Faso, Cameroon, Ethiopia, Ghana, Kenya, Lesotho, Malawi, Mauritius, Mozambique, Namibia, Nigeria, Rwanda, Senegal, South Africa, Tanzania, Uganda and Zambia.

98%, 82%, 36% and 73% of GDP in Asia, Latin America, MENA and SSA, respectively, in 2018.[5] Overall, they account for 55% of global real manufacturing value added (VA) and 42% of global GDP.[6]

For these economies, the ETD includes annual data on gross VA at both real and nominal prices in national currencies for the period 1990–2018. Data on employment is also included such that trends in labor productivity (VA per worker) can be derived. The database covers the 12 main sectors of the economy (in ISIC rev. 4), namely agriculture (ISIC rev. 4 code A), mining (B), manufacturing (C), public utilities (D + E), construction (F), trade (G + I), transport (H), business services (J + M + N), finance (K), real estate (L), government services (O + P + Q) and other services (R + S + T + U). Together these sectors cover the total economy.

The database is constructed by an in-depth investigation of the availability and reliability of statistical sources on a country-by-country basis. The time series are consistent over time. By using linking procedures, major breaks between the series have been repaired. Furthermore, international consistency is ensured through the System of National Accounts for value added, the employment concept of persons engaged and the use of a harmonized classification of sectors. The ETD uses persons engaged as the employment concept rather than employees, and it bases employment numbers on large-scale surveys. Hence, overlap in coverage of the employment statistics and value added from the national accounts is maximized.[7] See de Vries et al. (2021) for detailed documentation of the sources and methods. The data are publicly available and for free at www.ggdc.net and www.wider.unu.edu.

"Appendix 1" discusses how the ETD relates to other publicly available datasets. Section 6 examines employment expansion in registered and unregistered firms. For that, we use the UNIDO Industrial Statistics Database complemented with industrial surveys available from national statistical institutes. We construct annual data on VA and employment for 2-digit manufacturing industries building upon the work by Pahl and Timmer (2020). This data construction is also further described in "Appendix 1".

[5] These numbers are based on VA at constant 2015 prices in US dollars for the year 2018, as reported by the UN National Accounts database. As a share of VA in manufacturing the dataset accounts for 99%, 79%, 50% and 74% in Asia, Latin America, MENA and SSA, respectively. Note that Russia is not included in Asia for these calculations.

[6] Comparable data for other developed economies is available at www.euklems.eu and www.worldklems.net.

[7] The ETD does not adopt the revised definition of work by the ILO which excludes subsistence farmers from the labor force, see Klasen (2019) and "Appendix 1" for further discussion. The ETD includes subsistence farmers throughout. Hence, findings presented in this paper are not driven by changes in the measurement of sectoral employment.

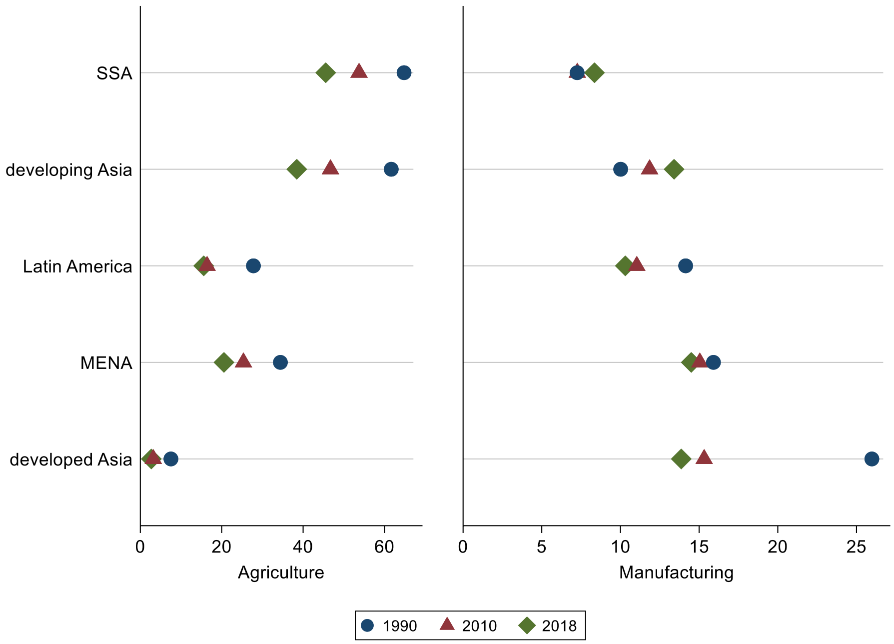

Fig. 1 Employment shares in agriculture and manufacturing, by region. *Notes*: Employment shares in agriculture and manufacturing by region, unweighted averages. *Sources*: Authors' calculations using the ETD, release 15 July 2021.

3 Descriptive Trends

A first step toward understanding industrialization experiences is to map the share of workers employed in the various sectors of the economy. Figure 1 shows several important changes in the allocation of employment. It shows average agricultural and manufacturing employment shares by region for 1990, 2010 and 2018. These years provide useful decadal demarcations that help relate the descriptive statistics to the regression analysis in subsequent sections. Yet, it is not our intention to interpret observations at 2010 or 2018 as breakpoints in trends observed.

The left panel of Fig. 1 shows that the share of employment in agriculture decreased substantially. Between 1990 and 2018, the share of agriculture declined in Latin America from 27.8 to about 15.6% of the workforce; in developing Asia from 61.7 to 38.4%; in developed Asia from 7.5 to 2.7%; in MENA from 34.4 to 20.6%; and in SSA from 64.8 to 45.6%.

The right panel shows trends in manufacturing between 1990 and 2010. In Latin America, the share dropped from 14.1 in 1990 to 11.0% in 2010 and fell further to about 10.3% by 2018. In the MENA countries it declined between 1990 and 2018. Developing Asia defied the trend and saw an increase from 10.0 to 11.9% between 1990 and 2010, further increasing to 13.4% by 2018.

Manufacturing in SSA expanded between 2010 and 2018. The employment share was about 7.2% in 1990 and 7.3% in 2010. After 2010, the share started to rise. On average, it rose by 1.1% points to 8.4% between 2010 and 2018.

Manufacturing value added (MVA) shares can be calculated at real (constant) or nominal (current) prices. The real (nominal) MVA share in developing Asia increased from 14.6 to 19.3% (from 17 to 19%) between 1990 and 2018. In SSA, the real (nominal) MVA share decreased, from 13.6 to 12.1 to 11.5% (from 16.6 to 12.2 to 11%) in 1990, 2010 and 2018. This pattern is opposite to the trend in the employment share. These patterns are a testament to below average productivity growth in manufacturing in SSA.

Figure 2 shows long-run trends of manufacturing employment shares in SSA countries. Note the difference in vertical axes between the two panels. Panel (a) shows SSA countries with a clear historical peak in manufacturing, which includes countries such as Ghana, Mauritius, Nigeria and South Africa. The peaks in Ghana and South Africa are in the 1970s or 1980s during a period of state-led industrialization (Atolia et al. 2020; Lopes and te Velde 2021). At its peak in 1978, manufacturing employed 16% of the workforce in Ghana. Yet, manufacturing is experiencing a renaissance as it is approaching levels close to that peak: In 2018, the share is 15.8%. Panel (b) presents other SSA countries. It suggests a nascent industrialization process in many low-income SSA countries.[8]

The level of manufacturing activity in SSA is increasing but low in comparison with the levels in other regions and from a historical perspective. Figure 5 in "Appendix 2" examines current and historical trends in the manufacturing employment share over comparable levels of economic development. It includes past industrializers, such as Mexico, South Korea and Taiwan as well as recent industrializers such as Ethiopia, Ghana, Kenya and Viet Nam. We included two Asian tigers (South Korea and Taiwan) and Mexico, because they experienced industrialization in the second half of the twentieth century and we have the long-run time series to document it. Clearly, past industrializers faced a very different political and economic environment when they industrialized. Yet, the Figure allows for an (unconditional) comparison with the magnitude of current industrialization trends in developing countries. Figure 5 suggests that the industrialization in SSA countries is to some degree similar to that of past industrializers. Note however, that the start and final year of the series for each country indicate that the Asian tigers managed to shift a larger fraction of its workforce into manufacturing in a shorter period of time compared to SSA countries. Even for Viet Nam, manufacturing employment shares appear substantially lower compared to industrial heights reached by South Korea and Taiwan conditional on GDP per capita.[9] The next sections examine these trends conditional on income, population and country fixed effects.

[8] A manufacturing (re-)naissance is also observed in other developing countries. In Bangladesh, the manufacturing employment share expanded from 2000 onwards, and in 2018, it was slightly above levels observed in the early 1990s. In Mexico, there is a reversal in the de-industrialization trend after 2009, although manufacturing activity is still below levels observed in the early 1990s. Manufacturing expanded throughout in Viet Nam.

[9] As a further comparison: at their peak in the 1960s and 70s, about one quarter to one third of the labor force was employed in manufacturing in Germany, France, Sweden and the UK (van Ark, 1996; Timmer and de Vries 2009; Rodrik, 2016).

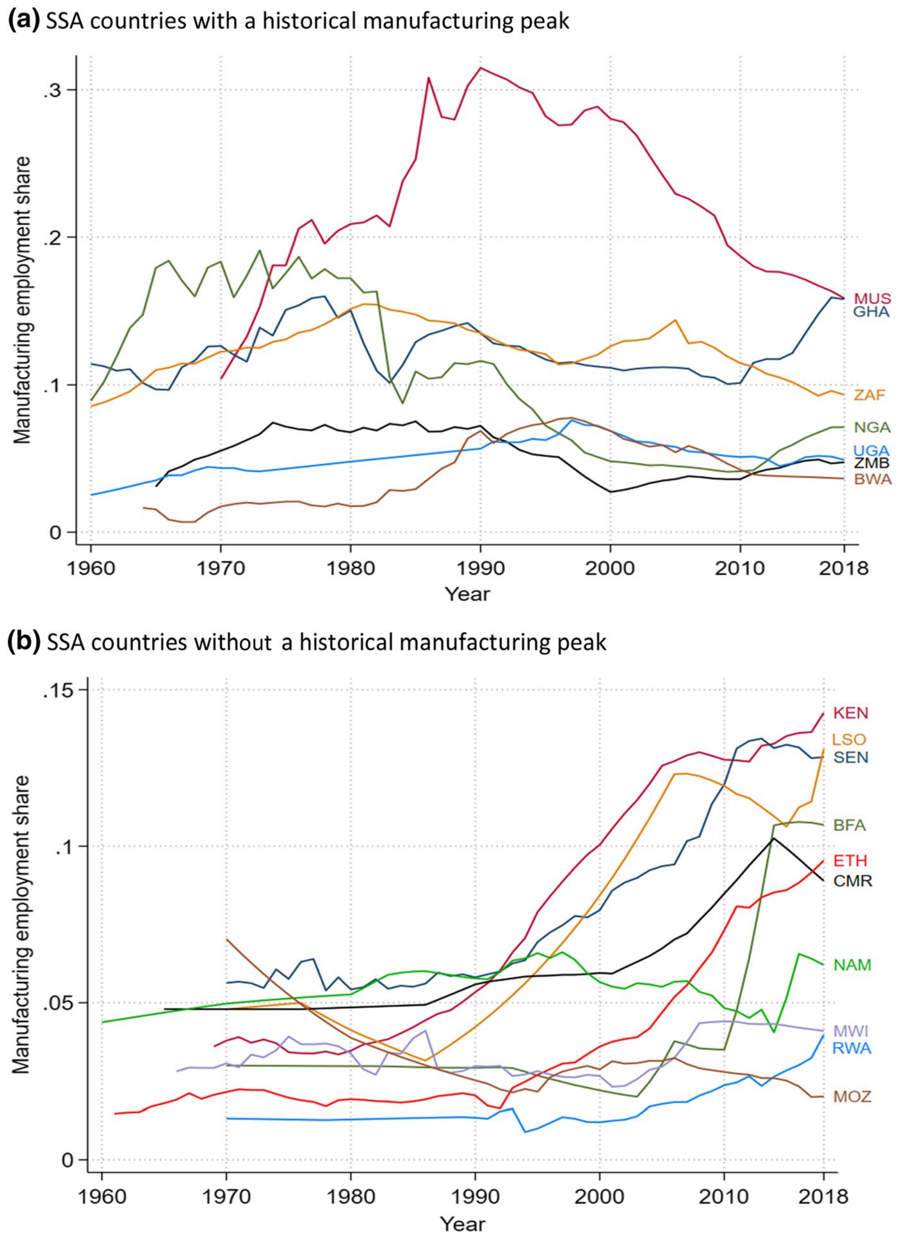

Fig. 2 Long-run trend of manufacturing employment shares in SSA countries. *Notes and sources*: The manufacturing employment share in the ETD is extrapolated backwards using the GGDC 10-sector database (Timmer et al., 2015) and the Expanded African Sector Database (Mensah and Szirmai 2018)

4 Baseline Regression Results

The baseline estimation follows the seminal work by Chenery et al. (1986), recently popularized by Rodrik (2016):

$$\text{Mshare}_{it} = \beta_0 + \beta_1 \ln \text{Y}_{it} + \beta_2 (\ln Y)^2_{it} + \beta_3 \ln P_{it} + \beta_4 (\ln P)^2_{it} + \gamma \text{PD}_t + \alpha_i + \varepsilon_{it}, \quad (1)$$

where Mshare_{it} is the manufacturing employment or output share for country i at time t, β_0 is the constant, $\ln Y$ and $(\ln Y)^2$ are the natural logarithms of per capita income and its squared value, $\ln P$ and $(\ln P)^2$ are the natural logarithms of population and its squared value and α_i are country fixed effects that take into account any time-invariant country-specific features such as geography, endowments and history, which might generate a varying degree of industrialization across countries relative to baseline conditions.[10]

We capture industrialization patterns using period dummies (PD_t) for the 2000s and the 2010–2018 period. Estimated coefficients of the period dummies show the manufacturing share of each period relative to the excluded decade of the 1990s. We closely follow Rodrik (2016) and estimate (1) using OLS with country fixed effects and (heteroskedasticity) robust standard errors.

Table 1 reports results for manufacturing employment shares estimated using (1). Key parameters of interest are those for the decade-fixed effects of the 2000s and 2010s. The first column shows results for the full sample. Subsequent columns show regressions by region. Column (2) finds de-industrialization in developed Asian economies, which specialize in high-skilled labor and become increasingly services-oriented (Buera and Kaboski 2012). This contrasts with developing Asia shown in column (3). The decadal dummy for the 2010s is positive and significant, suggesting employment industrialization. For Latin America, we find significant de-industrialization in the 2000s. The coefficient for the 2010s is also negative but not significant, as in the aggregate sample.

Results for SSA with and without Mauritius are shown in columns 5 and 6.[11] The estimates suggest that the average economy in SSA (excluding Mauritius) had a manufacturing employment share about 1.9% points higher in the 2010s than in the 1990s. Rodrik (2016) found that the share declined by 3.5% points during the period from 1960 to 2011. The point estimate thus suggests a recovery of manufacturing by more than half the downward shift observed in the decades before.[12,13]

[10] We obtain GDP and population numbers from the Maddison 2020 release (Bolt and van Zanden, 2020).

[11] Mauritius has a higher GDP per capita and experienced rapid de-industrialization compared with other countries in SSA (see Fig. 2 panel a), which is why we follow Rodrik (2016) and present results for SSA excluding Mauritius.

[12] Selection bias, whereby only more successful developing countries with better statistical infrastructure are included, is a potential issue. "Appendix 3" compares our results to Rodrik (2016). Once we estimate (1) for the reduced SSA country sample in Rodrik (2016), there is no significant industrialization trend in the 2010s. This suggests results for SSA are sensitive to country coverage. It also provides a motivation to examine cross-country heterogeneity in industrialization trends in Sect. 5.

[13] Tables 5 and 6 report results for real and nominal MVA. The period dummies indicate real output shares were stable over time. In contrast, period dummies for nominal output shares suggest de-industrialization. The absence of a global downward trend in real MVA suggests a slower price increase in manufacturing relative to other sectors.

Table 1 Baseline regressions, manufacturing employment share

	Full sample	Developed Asia	Developing Asia	Latin America	SSA	SSA (*excl. Mauritius*)
	(1)	(2)	(3)	(4)	(5)	(6)
ln population	− 0.200***	0.854	0.140*	− 0.596***	− 0.017	0.056
	(0.047)	(0.617)	(0.078)	(0.103)	(0.080)	(0.073)
ln population squared	0.006***	− 0.032	− 0.005**	0.018***	0.002	− 0.001
	(0.001)	(0.020)	(0.002)	(0.003)	(0.002)	(0.002)
ln GDP per capita	0.386***	0.636	0.300***	0.965***	0.323***	0.232***
	(0.021)	(0.432)	(0.040)	(0.110)	(0.040)	(0.032)
ln GDP per capita squared	− 0.023***	− 0.030	− 0.016***	− 0.056***	− 0.022***	− 0.017***
	(0.001)	(0.021)	(0.002)	(0.006)	(0.003)	(0.002)
2000s	− 0.005***	− 0.035***	0.004	− 0.011***	− 0.002	0.004*
	(0.002)	(0.006)	(0.003)	(0.003)	(0.003)	(0.003)
2010s	− 0.002	− 0.045***	0.010**	− 0.008	0.005	0.019***
	(0.003)	(0.007)	(0.005)	(0.005)	(0.006)	(0.004)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Countries	51	6	14	9	18	17
Observations	1479	174	406	261	522	493
R^2	0.90	0.87	0.92	0.89	0.89	0.84

Dependent variable is the manufacturing employment share. Regressions are estimated using (1). Robust standard errors in parentheses. See Sect. 2 for country groupings. Results for the four MENA countries are not reported separately, but they are included in the full sample in column (1)

$^*p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

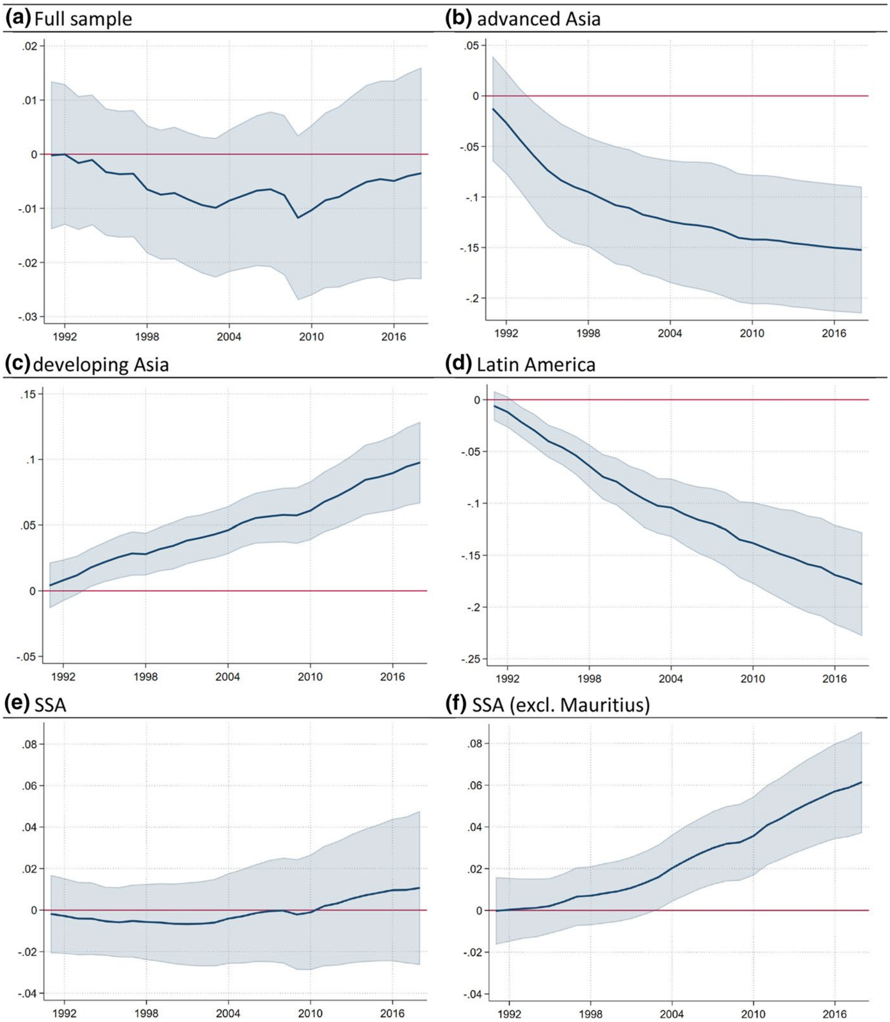

Fig. 3 Annual time trend manufacturing employment share by region. *Notes* Dependent variable is the manufacturing employment share. Shown are coefficient estimates of the year dummies and their 95% confidence intervals using (1)

The dependent variable is observed annually, so period dummies may assign annual idiosyncrasies in employment that take place within a decade to other (annual) explanatory variables. As a result, specifications with decade dummies may underreport actual trends. Figure 3 reports coefficients and their confidence intervals for time trends identified by estimating (1) with year-fixed effects instead of period dummies. It indicates a significant de-industrialization trend in Latin America. Results for other regions are congruent to those with decadal dummies, with industrialization observed in developing Asia and SSA (excluding Mauritius). The point estimates help inform on the timing of industrialization patterns. For SSA,

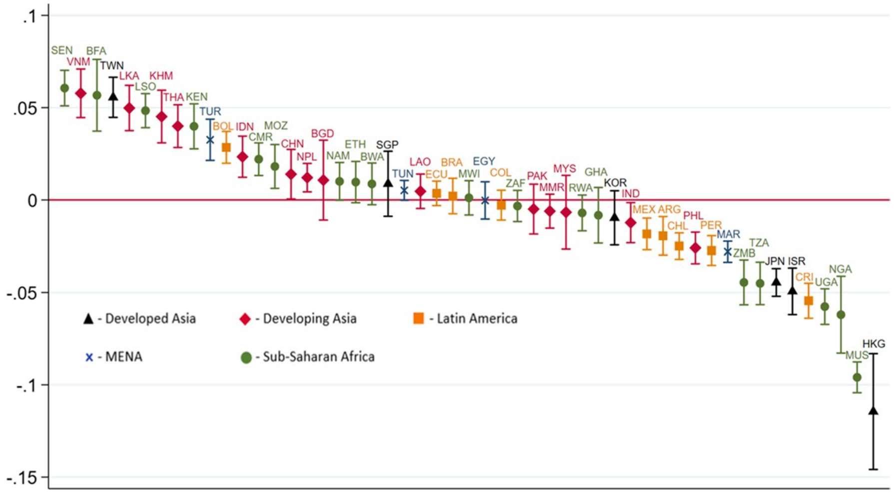

Fig. 4 Exploring cross-country heterogeneity in industrialization. *Notes*: Dependent variable is the manufacturing employment share. Regressions are estimated using (2). Conditional marginal effects of the decadal dummy for the 2010s relative to the 1990s are shown by country. The 95% confidence intervals are based on the delta method Taylor approximation for standard errors of marginal effects. Estimations results are reported in Table 7

the point estimates are significantly above the initial 1990 manufacturing level from 2003 onwards.

5 Industrialization Trends Across Countries

The descriptive analysis revealed substantial variation in industrialization trends across countries within each region. This section explores cross-country heterogeneity in industrialization by interacting the period dummies with country fixed effects. Adding this interaction term to (1) gives:

$$\begin{aligned}\text{Mshare}_{it} = \beta_0 + \beta_1 \ln \text{Y}_{it} + \beta_2 (\ln Y)^2_{it} + \beta_3 \ln P_{it} + \beta_4 (\ln P)^2_{it} \\ + \gamma PD_t + \delta \text{PD}_t \times d_{i=c} + \alpha_i + \varepsilon_{it},\end{aligned} \tag{2}$$

where $PD_t \times d_{i=c}$ is the period dummy (PD) interacted with a dummy for the country (or region) of interest ($d_{i=c}$ = 1 and $d_{i \neq c}$= 0). The coefficient δ indicates how much the period dummy varies by country, holding income and population effects constant. This interaction effect δ compares industrialization in a country relative to the trend in the full sample.[14] The direct effect γ is the global average trend excluding country c. The marginal industrialization effect is the combination of the direct

[14] This section examines employment industrialization. We also observe cross-country heterogeneity in output industrialization (results are available upon request).

and interaction effect ($\delta + \gamma$). The standard error of this marginal effect is calculated using the delta method Taylor approximation.

Figure 4 shows for each economy the marginal effect of the decadal dummy for the 2010s relative to the 1990s, conditional on the covariates in (2). Economies are sorted on the size of the observed change. The figure illustrates substantial cross-country heterogeneity in industrialization. For each country, it provides a comparison to the global average country with similar income and population size. Countries with a significantly higher share of manufacturing workers in SSA include Burkina Faso, Cameroon, Kenya, Lesotho, Mozambique and Senegal. For developing Asia, these include Cambodia, Indonesia, Sri Lanka, Thailand and Viet Nam. Furthermore, above average industrial development is observed in Bolivia, Taiwan and Turkey. This heterogeneity within regions and across decades is important for the interpretation of broader regional trends. Our findings illustrate that industrialization is possible within every continent. Therefore, broader regional findings cannot be generalized to all countries within a region. Moreover, it indicates that some countries experience industrialization relative to the common trend after we standardize for relevant characteristics such as income and population. That might point at a relative better performance on industrialization strategies or in such fundamentals as human capital and government effectiveness.

6 Manufacturing Activity in Registered and Unregistered Firms

Typically, industrial surveys cover firms that meet registration criteria or surpass an employment size threshold (see "Appendix 1" for details). Thus, we will refer to firms included in industrial surveys as registered firms. For each country-year, employment at registered firms in the 2-digit manufacturing dataset is subtracted from manufacturing employment in the ETD. The residual is defined as employment at unregistered firms.[15] Hence, the split explores how industrialization trends relate to changes at registered or unregistered firms.

Table 2 reports results from estimating (1), where the dependent variable is the manufacturing employment share in either registered (columns 1–3) or unregistered firms (columns 4–6).[16] Conditional on income and demographics, the change in the manufacturing employment share for the 2010s is positive yet insignificant for registered firms in developing Asia and Latin America (see columns 1 and 2). We also do not find a significant pattern for unregistered firms in developing Asia and Latin America.[17] In SSA, the 2010s dummy is significantly negative for registered

[15] We cannot infer whether traditional or modern techniques are used in production. This is likely to differ across unregistered firms, although the majority of unregistered firms use traditional techniques (Diao and McMillan, 2018).

[16] In comparison to the baseline results in Sect. 4, fewer countries are included because country coverage is smaller in the 2-digit manufacturing dataset (see "Appendix 1" for further information).

[17] Within developing Asia this may vary by country. In some countries such as Viet Nam, structural change is found to be related to an expansion of jobs at registered firms (McCaig 2011; McCaig and Pavcnik, 2018), although at first it was characterized by a large and growing share of employment in unregistered firms (McMillan and Zeufack, 2022). In other countries such as India, jobs appear mainly created at small firms (de Vries et al. 2012).

Table 2 Manufacturing employment shares at registered and unregistered firms

	Registered firms			Unregistered firms		
	Developing Asia	Latin America	SSA (*excl. Mauritius*)	Developing Asia	Latin America	SSA (*excl. Mauritius*)
	(1)	(2)	(3)	(4)	(5)	(6)
ln population	0.040	− 1.047***	0.071**	− 0.008	0.451***	− 0.057
	(0.107)	(0.090)	(0.034)	(0.099)	(0.136)	(0.104)
ln population squared	− 0.003	0.029***	− 0.002*	− 0.000	− 0.011**	0.004
	(0.003)	(0.003)	(0.001)	(0.003)	(0.004)	(0.003)
ln GDP per capita	0.030	1.101***	0.140***	0.196***	− 0.136	− 0.068
	(0.043)	(0.083)	(0.022)	(0.051)	(0.155)	(0.052)
ln GDP per capita squared	0.001	− 0.058***	− 0.009***	− 0.012***	0.002	0.001
	(0.003)	(0.004)	(0.001)	(0.003)	(0.008)	(0.003)
2000s	− 0.005	0.001	− 0.001	0.006*	− 0.012***	− 0.000
	(0.004)	(0.003)	(0.001)	(0.004)	(0.005)	(0.003)
2010s	0.002	0.003	− 0.004**	0.005	− 0.011	0.010*
	(0.006)	(0.004)	(0.002)	(0.006)	(0.007)	(0.005)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Countries	10	9	12	10	9	12
Observations	281	261	341	281	261	341
R^2	0.92	0.90	0.96	0.76	0.82	0.85

Dependent variable is the manufacturing employment share, in either registered (columns 1–3) or unregistered firms (columns 4–6). Regressions are estimated using (1). Robust standard errors in parentheses

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

firms (see column 3).[18] In contrast, column 6 suggests that there has been significant employment expansion in unregistered firms in SSA in the 2010s.

We also ran regressions for the split by real MVA shares (reported in Table 9 in "Appendix 2"). For developing Asia, we again find that industrialization does not appear dominantly driven by either registered or unregistered firms. For SSA, the output share declines in unregistered firms whereas for registered firms the output share increases. This points at productivity improvements among firms included in industrial surveys (Rodrik 2013). It also aligns with Diao et al. (2021) who observe productivity growth among large firms in Ethiopia and Tanzania yet no increase in employment. Unregistered firms absorb workers and do not experience much productivity growth. The findings presented here suggest this pattern appears to hold more widely across SSA.[19]

7 Concluding Remarks

This paper analyzed industrialization trends in developing countries based on the new GGDC/UNU-WIDER Economic Transformation Database. Several middle-income countries that had their peak industrialization in the 1970s or 1980s, such as Ghana and Nigeria, are experiencing a manufacturing renaissance after the 2000s. This suggests that there can be repeated peaks in manufacturing shares. Many developing countries in Asia and SSA without a historical peak appear to experience an industrial naissance. For developing Asia, we find that industrialization does not appear dominantly driven by employment expansion in registered or unregistered firms. However, for SSA unregistered firms appear to absorb workers and do not experience comparable growth in output.

The results carry implications about the opportunities for growth and development. In SSA, unregistered firms may meet rising domestic demand and provide employment in the process. There are several explanations for this trend, and they carry different policy implications. One interpretation is that sustained economic growth is possible if productivity improves in unregistered firms (IMF 2018). That may require a growth strategy that targets small- and medium-sized firms (Rodrik 2021) and trade integration that encourages sales to regional markets (Lopes and te Velde 2021; McMillan and Zeufack 2022). An alternative interpretation is that barriers to labor mobility increase allocative inefficiency, which

[18] Table 8 shows that employment de-industrialization in SSA is observed in registered firms across various industries, including food processing and wood products.

[19] We explored the role of domestic and foreign demand in driving industrialization. We classified a country as a manufactures (non-manufactures) exporter if its average share of manufactures in exports exceeds (falls below) 75% using the BACI database from 1995 to 2018. The findings suggest manufactures exporters experienced employment de-industrialization, whereas non-manufactures exporters did not. The higher exposure to international competition may have incentivized manufacturing exporters to improve productivity and not absorb workers. The industrialization in non-manufactures exporters could be driven by local demand for basic manufactures, which is less exposed to international competition. In future research we intend to examine the role of domestic and foreign demand using time series input–output tables for SSA.

would require a growth strategy that targets decreasing these barriers. Pavcnik (2017) points at potential imperfect labor mobility across firms and industries due to worker skills, rigid labor markets and the type of firm that a worker works for. The study also points at a role for the geographic location of workers in the context of low and imperfect interregional worker mobility. The nature of the analysis in this paper precludes us from identifying particular policies that may stimulate growth, which is an important area for future research.

The findings also create new questions for further research. Why has there been a manufacturing (re-)naissance? Does it imply that manufacturing can still be important for economic development? Rising labor costs in China and its move to more sophisticated manufactures create opportunities for industrialization in developing countries. But any such employment opportunities are likely to be constrained, among others by recent advances in automation, which tend to displace factory workers in the performance of routine tasks (Autor et al. 2003; Reijnders et al. 2021; Rodrik 2021).

Appendix 1: Data

This appendix first discusses the guiding philosophy of the GGDC/UNU-WIDER Economic Transformation Database (ETD) to ensure it meets requirements of consistency necessary for growth and productivity analysis. We then discuss the relation to other publicly available datasets, followed by a description of the construction of annual data on value added and employment for 2-digit manufacturing industries.

Consistency Requirements

Gross VA in real and nominal prices is from the National Accounts (NA) published by the National Statistical Institutes (NSIs). Value added (VA) by sector is compiled according to the UN System of National Accounts (SNA). This system accounts for income from formal and informal activities. In addition, international comparability is high, in principle. However, NSIs frequently change their methodologies and conduct new surveys. The general approach is to start with GDP data for the most recent available benchmark years from the NA provided by the NSI or Central Bank. These data are typically compiled according to the 2008 SNA (UN 2008), but it varies by country, as some countries still follow the approaches outlined in the 1993 SNA (UN 1993). Historical NA series are subsequently linked to the benchmark year data. The linking procedure ensures that growth rates of individual series are retained while absolute levels are adjusted according to the most recent information and methods.

Volume data are estimated separately from constructed series of nominal VA and price deflators. This has several advantages. In cases where price statistics are missing or inaccurate, price trends of the aggregate sector are representative of the underlying detailed sectors. It is more reasonable to make this assumption for price developments than for volume growth rates. In addition, this method allows information on price developments to be added from external sources, such as the consumer price index, when this is not available from primary sources.

The VA from real estate activities (ISIC rev. 4, industry L) consists of VA from rental activities and imputations of owner-occupied housing. The latter imputation is based on an equivalent rent approach and is part of the official estimation of GDP. Imputed income from dwellings does not have an employment equivalent and therefore is preferably excluded in productivity analyses. This is possible because real estate activities are separately reported in the ETD.

Employment in the ETD is defined as "all persons engaged," thus including all paid employees, but also self-employed and family workers, with an age of 15 years and older. Hence, it aims to include formal and informal workers. Ideally, labor input is measured in hours worked, as differences in hours worked across sectors affect sectoral productivity gaps (Gollin et al. 2014; McCullough 2017). However, the data, insofar as they are available, are irregular and information on hours worked typically covers only the formal sector.

Employment information is typically not available from a country's NA, as it is not part of the SNA. For most countries, population censuses are used as these ensure full coverage of the (formal and informal) working population and a reliable sectoral breakdown. However, population censuses are typically quinquennial or decennial and cannot be used to derive annual trends. Moreover, many developing countries had a census scheduled for 2019/2020, which could not be incorporated because of a lag in data dissemination. Several population censuses have also been postponed due to the Covid-19 pandemic.

Whenever appropriate, population censuses are used to indicate absolute levels of employment, and labor force surveys (LFS) and establishment surveys are used to indicate trends in between. For countries where population census data are not used, nationally representative LFS are used as benchmarks instead. If employment series are not available to measure trends between benchmarks, the interpolation between benchmarks is based on the ILO model-based sectoral employment trends or the average trends in labor productivity between benchmark years for non-agricultural sectors. Employment in agriculture is interpolated between benchmarks using series of the economically active population in agriculture (see de Vries et al. 2021 for further information).

Here, we provide one specific example of how we arrived at manufacturing employment estimates for Ethiopia. To start with, source data on manufacturing employment in Ethiopia provide conflicting information on levels and trends. The trend in manufacturing employment between the 2005 and 2013 national LFS suggests an annual manufacturing employment growth rate of 2.7%, which is lower than the population growth rate of 3.1% and total employment growth rate of 3.8% reported in the LFS for this period. Furthermore, the growth rate conflicts with other sources, which indicate higher growth rates of manufacturing employment. For example, data from the small-scale industry surveys for 2006 and 2014 suggest an annual growth rate of 14.6%. The data from the urban employment and unemployment survey for 2010 and 2014 give an annual growth rate of 10.3%, and the large and medium-scale manufacturing censuses for 2010–2015 give an annual growth rate of 15.3%. We follow the approach by Diao et al. (2021) to estimate recent levels and trends in manufacturing employment for Ethiopia. Namely, we combine manufacturing workers reported in the large and medium-scale manufacturing censuses (including temporary workers), non-food manufacturing workers from the small-scale industry survey (excluding seasonal workers), and urban and rural food manufacturing workers reported in the living standards measurement study surveys.

Relation to Other Publicly Available Datasets

Several alternative sectoral datasets are publicly available. The best known is the World Bank's World Development Indicators (WDI). Figures for VA in the WDI are based on national accounts data and therefore comparable to those in the ETD. For employment, recent editions of the WDI use ILO model-based estimates.

The measurement of sectoral employment in the ETD and the ILO model have several similarities, including the selection of available statistical sources to create inter-temporally consistent series and the use of nationally representative data sources. Yet, whereas the ETD prefers population censuses, the ILO model prioritizes LFS. Sometimes LFS are not nationally representative, but are biased toward urban agglomerations. It also matters whether an LFS is conducted during the dry or harvesting season. For example, the 2014 and 2018 LFS of Burkina Faso were conducted in the dry season. As a result, the employment share in agriculture drops from about 80% in 2006 to around 30% from 2014 onwards in the ILO model-based estimates. The ETD aims to avoid such unreliable series. Another major difference is the use of econometric imputation methods to fill blanks in the ILO model (see Klasen 2019 for a discussion).

Perhaps most importantly, at the 19th International Conference of Labor Statisticians (ICLS) in 2013 it was decided to narrow the definition of the labor force to those who work for pay or profit (ICLS 2013). That revised definition of the labor force induces a downward effect on the level of agricultural employment, because farmers that mainly or exclusively produce for own use are no longer included in employment by the ILO model-based estimates (Gaddis et al. 2020; Klasen 2019).

The revised definition of the labor force by the ILO is problematic for several reasons (Klasen 2019). First, it will be difficult to obtain accurate and consistent time series of employment in developing countries where subsistence production is common. Second, it will result in breaks in the series. Third, it will create inconsistency between VA and employment. Production of agricultural goods for own use falls within the boundaries of the SNA and is therefore included in agricultural VA, even if workers are not reported by the ILO. Labor productivity suddenly shoots up as output is measured, but workers are not measured. Fourth, it results in misleading information on the sectoral distribution of employment (Gaddis et al. 2020). Subsistence farmers who mostly produce for subsistence, but outside the peak season undertake some non-agricultural activities will now be categorized according to these minor off-farm activities.

Currently it is not clear whether, how or for which countries and time periods the 19th ICLS standards have been implemented. This problem also applies to the time series of agricultural employment in the WDI, which directly derive from the ILO model-based estimates. The ETD aims to avoid these issues, as it includes subsistence production workers.

Manufacturing Data for Registered Firms

The primary source for constructing the 2-digit manufacturing data is the UNIDO Industrial and Statistical Database (UNIDO INDSTATS 2, 2020). This is complemented with national accounts or industrial surveys from NSIs when there is no reliable benchmark or consistent series from the UNIDO INDSTATS 2. For example, Nigeria's value added series from 1997 to 2018 is not available in UNIDO INDSTATS 2. To obtain a series for Nigeria, we use detailed industry trends from the rebased national accounts data. The general approach follows Pahl and Timmer (2020). The guiding principle is to ensure the data is consistent over time, across variables (employment and value added) and across countries.

In Pahl and Timmer (2020), missing data are treated as follows: First, all negative entries for all variables are set to missing. In the primary data (INDSTATS), zeros could appear when the industry is not sampled in the respective year or when there is no economic activity in that industry. To distinguish between these two, Pahl and Timmer (2020) treat zeros as missing (i) if an industry has a positive value in year 1, a zero in year 2, but a positive value in year 3, assuming that zero in between is a missing value. Again, zero values are treated as missing if (ii) industry records zeros at the beginning or end of time series but emerges from 0% to more than 5% of total manufacturing and vice versa, allowing for the possibility that industries emerge and vanish, only if the change is not beyond 5% of total manufacturing. This indicates a more considerable change in series from (or to) zero as missing information. Since our sample is mainly for developing countries where apart from the light industry (food processing and textile industries), the average share of other sectors is about 5%, treating zeros as missing if the share in year $t-1$ or $t+1$ is less than 5% of total manufacturing, would drop most missing observations or sectors. Therefore, we make treatment of zeros and missing information country- and sector-specific. For example, if the average share of a series of a specific industry is more than 10%, between 5 and 10% and below 5% then we treat zeros as missing if the industry emerges from zero to 5%, 1% and 0.2% of total manufacturing, respectively. Finally, observations are treated as missing if there is a positive value for other variables. For example, if there is a positive value for value added, but the employment variable is zero, we treat the zeros as missing information.

Table 3 Coverage 2-digit manufacturing dataset

ETD economies covered	
Developing Asia (10)	Bangladesh, China, India, Indonesia, Malaysia, Myanmar, Philippines, Sri Lanka, Thailand, Viet Nam
Advanced Asia (4)	Israel, Japan, Korea (Rep. of), Singapore
Latin America (9)	Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, Mexico, Peru
Middle East and North Africa (4)	Egypt, Morocco, Tunisia, Turkey
Sub-Saharan Africa (13)	Botswana, Cameroon, Ethiopia, Ghana, Kenya, Malawi, Mauritius, Namibia, Nigeria, Senegal, South Africa, Tanzania, Uganda
ETD countries not included in 2-digit manufacturing dataset	Burkina Faso, Cambodia, Taiwan, Hong Kong (China), Lesotho, Mozambique, Pakistan, Laos, Rwanda, Zambia,
Time period (annual)	1990–2018
Variables	Gross value added at constant (2015) prices (national currency in millions)
	Gross value added at current prices (national currency in millions)
	Number of employees (in thousands)
Principal sources	UNIDO INDSTATS 2, 2020, National accounts; Industrial Surveys; business surveys

We fill in missing data using interpolation, extrapolation and backpolation as follows. We use value added in basic prices as a benchmark for value added series, then interpolate between benchmark years, backpolate from the last benchmark or extrapolate from the latest benchmark using growth trend from national accounts data if detailed industry series are available in national accounts data or industrial production survey. If there is no detailed industry data from national accounts or industrial production surveys, we use growth trends of total manufacturing value added from the INDSTATS. For employment series, we use the number of employees as benchmarks, then interpolate, extrapolate and backpolate using the growth trend of total manufacturing labor productivity trend. We express value added in constant prices following Schreyer (2002), where domestic industry deflator is the US industry deflator adjusted for domestic inflation in the manufacturing sector. The data cover 40 developing countries that are also in the ETD (Table 3). The data are disaggregated into 2-digit manufacturing industries (see Table 4). This results in data for value added (current and constant prices) and employment at the 2-digit ISIC Rev. 4 level from 1990 to 2018.

Table 4 Manufacturing industries

ISIC rev 4	ETD	ISIC rev. 4 description
C10–C12	FOOD	Manufacture of food products, beverages and tobacco products
C13–C15	TEXT	Manufacture of textiles, wearing apparel and leather products
C16–C18	WOOD, PAPER & PRINT	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials; Manufacture of paper and paper products; Printing and reproduction of recorded media
C19–C22	PETRO, CHEMICALS & RUBBER	Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products; Manufacture of basic pharmaceutical products and pharmaceutical preparations; Manufacture of rubber and plastic products
C23–C25	MINERAL & METALS	Manufacture of other nonmetallic mineral products; Manufacture of basic metals; Manufacture of fabricated metal products, except machinery and equipment
C26–C27	COMPUTER & ELECTRICAL	Manufacture of computer, electronic and optical products; Manufacture of electrical equipment
C28	MACHINERY	Manufacture of machinery and equipment not elsewhere classified.
C29–C30	TRANSPORT	Manufacture of motor vehicles, trailers and semi-trailers; Manufacture of other transport equipment
C31–C33	FURNI; OTH.	Manufacture of furniture; other manufacturing; Repair and installation of machinery and equipment
Cf	TOTAL	Total manufacturing

Appendix 2: Additional Tables and Figures

See Fig. 5 and Tables 5, 6, 7, 8, 9.

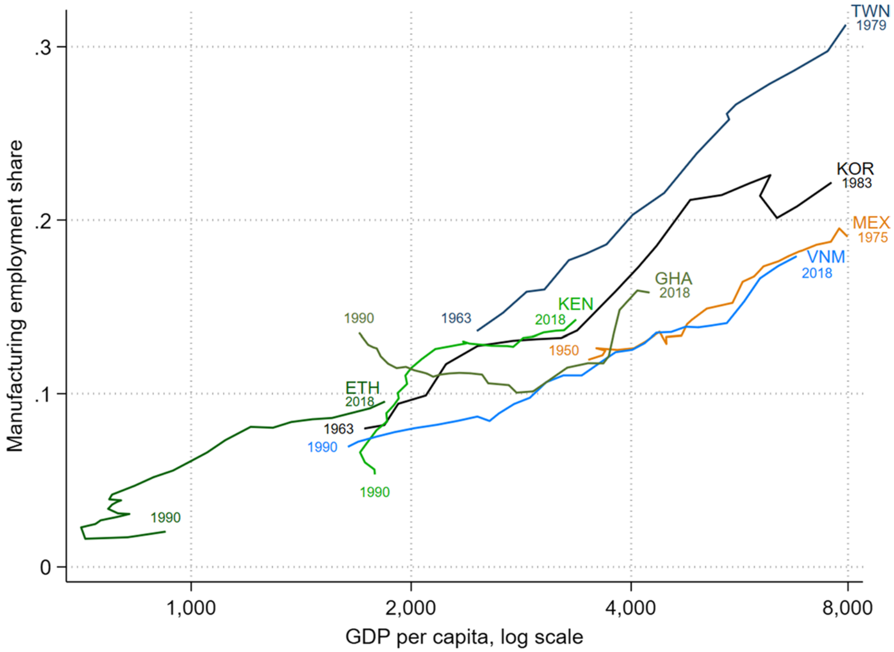

Fig. 5 Comparison of industrialization trends. *Notes and sources:* Industrialization trends in manufacturing employment for selected countries and time periods. Initial and final years are shown. Series in the ETD are extrapolated backwards using the GGDC 10-sector database (Timmer et al. 2015) and the expanded Africa sector database (Mensah and Szirmai 2018). Real GDP per capita in 2011 PPPs is from the Maddison 2020 release (Bolt and van Zanden 2020)

Table 5 Baseline regressions, real manufacturing output shares

	Full sample	advanced Asia	developing Asia	Latin America	SSA	SSA (excl. Mauritius)
	(1)	(2)	(3)	(4)	(5)	(6)
ln population	− 0.207***	− 0.801	− 0.091	− 0.674***	0.291***	0.341***
	(0.056)	(0.504)	(0.127)	(0.078)	(0.101)	(0.098)
ln population squared	0.005***	0.019	0.002	0.019***	− 0.008***	− 0.010***
	(0.002)	(0.016)	(0.003)	(0.003)	(0.003)	(0.003)
ln GDP per capita	0.058**	0.615*	0.280***	0.725***	0.188***	0.130***
	(0.027)	(0.342)	(0.049)	(0.080)	(0.046)	(0.042)
ln GDP per capita squared	− 0.002	− 0.023	− 0.013***	− 0.041***	− 0.014***	− 0.010***
	(0.002)	(0.016)	(0.003)	(0.004)	(0.003)	(0.003)
2000s	0.006***	0.001	− 0.003	0.003	0.001	0.006**
	(0.002)	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)
2010s	− 0.000	0.004	− 0.016**	− 0.005	− 0.002	0.006
	(0.003)	(0.005)	(0.007)	(0.005)	(0.005)	(0.005)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Countries	51	6	14	9	18	17
Observations	1479	174	406	261	522	493
R^2	0.89	0.96	0.91	0.97	0.86	0.86

Dependent variable is the real manufacturing output share. Regressions are estimated using (1). Robust standard errors in parentheses. See Sect. 2 for the country groupings. Results for the four MENA countries are not reported separately, but included in the full sample in column (1)

$^*p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Table 6 Baseline regressions, nominal manufacturing output shares

	Full sample	advanced Asia	developing Asia	Latin America	SSA	SSA (*excl. Mauritius*)
	(1)	(2)	(3)	(4)	(5)	(6)
ln population	0.065	0.623	0.516***	− 0.785***	0.488***	0.519***
	(0.057)	(0.783)	(0.098)	(0.121)	(0.093)	(0.092)
ln population squared	− 0.004**	− 0.024	− 0.015***	0.019***	− 0.015***	− 0.016***
	(0.002)	(0.026)	(0.003)	(0.004)	(0.003)	(0.003)
ln GDP per capita	0.249***	1.148**	0.433***	0.415***	0.203***	0.168***
	(0.028)	(0.513)	(0.044)	(0.116)	(0.052)	(0.052)
ln GDP per capita squared	− 0.013***	− 0.053**	− 0.023***	− 0.024***	− 0.013***	− 0.011***
	(0.002)	(0.024)	(0.003)	(0.006)	(0.003)	(0.003)
2000s	− 0.000	− 0.014***	0.003	0.007	− 0.010***	− 0.008***
	(0.002)	(0.005)	(0.004)	(0.005)	(0.003)	(0.003)
2010s	− 0.014***	− 0.016***	− 0.016**	0.005	− 0.031***	− 0.027***
	(0.003)	(0.006)	(0.007)	(0.007)	(0.005)	(0.005)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Countries	51	6	14	9	18	17
Observations	1479	174	406	261	522	493
R^2	0.90	0.95	0.93	0.91	0.84	0.84

Dependent variable is the nominal manufacturing output share. Regressions are estimated using (1). Robust standard errors in parentheses. See Sect. 2 for the country groupings. Results for the four MENA countries are not reported separately, but included in the full sample in column (1)

$^*p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Table 7 Region and country-specific industrialization trends, manufacturing employment

Economies by region	2010s × C	2010s	Marginal effect (net shift)	2000s × C	2000s	Marginal effect (net shift)	R^2
Asia	**0.009*** (0.003)**	**– 0.006* (0.003)**	**0.003 (0.004)**	**– 0.001 (0.003)**	**– 0.005** (0.002)**	**– 0.006** (0.003)**	**0.91**
Advanced Asia	**– 0.037*** (0.006)**	**0.002 (0.003)**	**– 0.035*** (0.006)**	**– 0.029*** (0.005)**	**– 0.001 (0.002)**	**– 0.031*** (0.005)**	**0.91**
Taiwan	0.059*** (0.005)	– 0.003 (0.003)	0.056*** (0.006)	0.035*** (0.005)	– 0.006***(0.002)	0.029*** (0.005)	0.91
Singapore	0.010 (0.008)	– 0.002 (0.003)	0.009 (0.009)	0.011 (0.007)	– 0.005*** (0.002)	0.006 (0.008)	0.91
South Korea	– 0.008 (0.007)	– 0.002 (0.003)	– 0.010 (0.007)	– 0.016** (0.007)	– 0.005*** (0.002)	– 0.021*** (0.006)	0.91
Japan	– 0.047*** (0.005)	0.002 (0.003)	– 0.045*** (0.004)	– 0.026*** (0.005)	– 0.003 (0.002)	– 0.029*** (0.004)	0.91
Israel	– 0.048*** (0.006)	– 0.002 (0.003)	– 0.049*** (0.006)	– 0.038*** (0.006)	– 0.004** (0.002)	– 0.042*** (0.006)	0.91
Hong Kong (China)	– 0.114*** (0.016)	0.002 (0.003)	– 0.117*** (0.016)	– 0.097*** (0.016)	– 0.002 (0.002)	– 0.099*** (0.016)	0.92
Developing Asia	**0.030*** (0.003)**	**– 0.010*** (0.003)**	**0.020*** (0.004)**	**0.015*** (0.003)**	**– 0.009*** (0.002)**	**0.006** (0.002)**	**0.91**
Viet Nam	0.061*** (0.006)	– 0.003 (0.003)	0.058*** (0.007)	0.028*** (0.004)	– 0.006*** (0.002)	0.022*** (0.004)	0.91
Sri Lanka	0.054*** (0.006)	– 0.004 (0.003)	0.050*** (0.006)	0.039*** (0.006)	– 0.006*** (0.002)	0.033*** (0.006)	0.91
Cambodia	0.049*** (0.007)	– 0.003 (0.003)	0.045*** (0.007)	0.031*** (0.003)	– 0.006*** (0.002)	0.024*** (0.003)	0.91
Thailand	0.044*** (0.006)	– 0.004 (0.003)	0.040*** (0.006)	0.025*** (0.004)	– 0.006*** (0.002)	0.019*** (0.004)	0.91
Indonesia	0.026*** (0.005)	– 0.003 (0.003)	0.023*** (0.006)	0.009** (0.004)	– 0.005*** (0.002)	0.004 (0.004)	0.91
China	0.016** (0.006)	– 0.002 (0.003)	0.014** (0.007)	– 0.025*** (0.007)	– 0.004** (0.002)	– 0.029*** (0.007)	0.91
Nepal	0.015*** (0.004)	– 0.003 (0.003)	0.012*** (0.004)	0.022*** (0.003)	– 0.006*** (0.002)	0.017*** (0.003)	0.91
Bangladesh	0.013 (0.011)	– 0.002 (0.003)	0.011 (0.011)	– 0.016* (0.009)	– 0.005*** (0.002)	– 0.020** (0.009)	0.91
Laos	0.007* (0.004)	– 0.002 (0.003)	0.005 (0.005)	0.011*** (0.003)	– 0.005*** (0.002)	0.006* (0.003)	0.91
Pakistan	– 0.003 (0.006)	– 0.002 (0.003)	– 0.005 (0.007)	– 0.006 (0.005)	– 0.005*** (0.002)	– 0.010** (0.005)	0.91
Myanmar	– 0.004 (0.004)	– 0.002 (0.003)	– 0.006 (0.005)	– 0.004 (0.003)	– 0.005*** (0.002)	– 0.009*** (0.003)	0.91
Malaysia	– 0.005 (0.010)	– 0.002 (0.003)	– 0.007 (0.010)	0.013 (0.011)	– 0.005*** (0.002)	0.008 (0.011)	0.91
India	– 0.010** (0.004)	– 0.002 (0.003)	– 0.012** (0.006)	– 0.004 (0.003)	– 0.005*** (0.002)	– 0.009*** (0.003)	0.91
Philippines	– 0.024*** (0.003)	– 0.002 (0.003)	– 0.026*** (0.004)	– 0.011*** (0.003)	– 0.005*** (0.002)	– 0.016*** (0.003)	0.91
Latin America	**– 0.013*** (0.003)**	**0.001 (0.003)**	**– 0.012*** (0.003)**	**– 0.008*** (0.002)**	**– 0.003 (0.002)**	**– 0.011*** (0.002)**	**0.91**
Bolivia	0.031*** (0.004)	– 0.003 (0.003)	0.028*** (0.004)	0.029*** (0.004)	– 0.006*** (0.002)	0.023*** (0.004)	0.91

Table 7 (continued)

Economies by region	2010s × C	2010s	Marginal effect (net shift)	2000s × C	2000s	Marginal effect (net shift)	R^2
Ecuador	0.006** (0.003)	– 0.002 (0.003)	0.004 (0.003)	0.002 (0.002)	– 0.005*** (0.002)	– 0.003 (0.002)	0.91
Brazil	0.004 (0.004)	– 0.002 (0.003)	0.002 (0.005)	0.005 (0.004)	– 0.005*** (0.002)	– 0.000 (0.004)	0.91
Colombia	– 0.001 (0.004)	– 0.002 (0.003)	– 0.003 (0.004)	– 0.004 (0.004)	– 0.005*** (0.002)	– 0.009** (0.004)	0.91
Mexico	– 0.017*** (0.004)	– 0.002 (0.003)	– 0.018*** (0.004)	– 0.006 (0.005)	– 0.005*** (0.002)	– 0.011** (0.005)	0.91
Argentina	– 0.018*** (0.005)	– 0.001 (0.003)	– 0.019*** (0.005)	– 0.024*** (0.005)	– 0.004** (0.002)	– 0.028*** (0.005)	0.91
Chile	– 0.024*** (0.003)	– 0.001 (0.003)	– 0.025*** (0.004)	– 0.016*** (0.002)	– 0.004** (0.002)	-0.020*** (0.002)	0.91
Peru	– – 0.026*** (0.003)	– 0.002 (0.003)	– 0.027*** (0.004)	– 0.021*** (0.004)	– 0.004*** (0.002)	– 0.025*** (0.004)	0.91
Costa Rica	– 0.053*** (0.005)	– 0.001 (0.003)	– 0.054*** (0.005)	– 0.028*** (0.004)	– 0.004** (0.002)	– 0.032*** (0.004)	0.91
MENA	**0.005 (0.003)**	**– 0.002 (0.003)**	**0.002 (0.004)**	**0.012*** (0.003)**	**– 0.006*** (0.002)**	**0.006** (0.003)**	**0.91**
Turkey	0.035*** (0.005)	– 0.002 (0.003)	0.033*** (0.006)	0.041*** (0.005)	– 0.006*** (0.002)	0.035*** (0.005)	0.91
Tunisia	0.007*** (0.002)	– 0.002 (0.003)	0.005* (0.003)	0.012*** (0.002)	– 0.005*** (0.002)	0.007*** (0.002)	0.91
Egypt	0.002 (0.003)	– 0.002 (0.003)	– 0.000 (0.005)	0.003 (0.003)	– 0.005*** (0.002)	– 0.002 (0.003)	0.91
Morocco	– 0.027*** (0.002)	– 0.001 (0.003)	– 0.028*** (0.003)	– 0.011*** (0.002)	– 0.005*** (0.002)	– 0.016*** (0.002)	0.91
Sub-Saharan Africa	**– 0.001 (0.004)**	**– 0.002 (0.003)**	**– 0.003 (0.004)**	**0.003 (0.003)**	**– 0.006*** (0.002)**	**– 0.003 (0.003)**	**0.91**
Senegal	0.064*** (0.004)	– 0.004 (0.003)	0.061*** (0.005)	0.032*** (0.004)	– 0.006*** (0.002)	0.026*** (0.004)	0.91
Burkina Faso	0.060*** (0.009)	– 0.003 (0.003)	0.057*** (0.010)	0.009*** (0.003)	– 0.005*** (0.002)	0.004 (0.003)	0.91
Lesotho	0.055*** (0.005)	– 0.007** (0.003)	0.048*** (0.005)	0.056*** (0.006)	– 0.008*** (0.002)	0.048*** (0.006)	0.91
Kenya	0.042*** (0.005)	– 0.002 (0.003)	0.040*** (0.006)	0.042*** (0.005)	– 0.005*** (0.002)	0.037*** (0.005)	0.91
Cameroon	0.024*** (0.003)	– 0.002 (0.003)	0.022*** (0.005)	0.007*** (0.002)	– 0.005*** (0.002)	0.002 (0.003)	0.91
Mozambique	0.021*** (0.006)	– 0.003 (0.003)	0.018*** (0.006)	0.025*** (0.004)	– 0.006*** (0.002)	0.019*** (0.004)	0.91
Namibia	0.012** (0.005)	– 0.002 (0.003)	0.010* (0.005)	0.007** (0.003)	– 0.005*** (0.002)	0.002 (0.003)	0.91
Ethiopia	0.012*** (0.004)	– 0.002 (0.003)	0.010* (0.006)	0.016*** (0.003)	– 0.005*** (0.002)	0.010*** (0.003)	0.91
Botswana	0.011** (0.005)	– 0.002 (0.003)	0.009 (0.006)	0.010** (0.004)	– 0.005*** (0.002)	0.005 (0.004)	0.91

Table 7 (continued)

Economies by region	2010s × C	2010s	Marginal effect (net shift)	2000s × C	2000s	Marginal effect (net shift)	R^2
Malawi	0.003 (0.004)	– 0.002 (0.003)	0.001 (0.005)	0.006* (0.003)	– 0.005*** (0.002)	0.001 (0.003)	0.91
South Africa	– 0.001 (0.004)	– 0.002 (0.003)	– 0.003 (0.004)	0.021*** (0.003)	– 0.005*** (0.002)	0.015*** (0.003)	0.91
Rwanda	– 0.005 (0.005)	– 0.002 (0.003)	– 0.007 (0.005)	0.001 (0.004)	– 0.005*** (0.002)	– 0.004 (0.004)	0.91
Ghana	– 0.006 (0.007)	– 0.002 (0.003)	– 0.008 (0.008)	– 0.016*** (0.004)	– 0.005*** (0.002)	– 0.021*** (0.004)	0.91
Zambia	– 0.042*** (0.005)	– 0.003 (0.003)	– 0.045*** (0.006)	– 0.033*** (0.005)	– 0.005*** (0.002)	– 0.038*** (0.005)	0.91
Tanzania	– 0.043*** (0.004)	– 0.002 (0.003)	– 0.045*** (0.006)	– 0.024*** (0.004)	– 0.005*** (0.002)	– 0.029*** (0.004)	0.91
Uganda	– 0.055*** (0.003)	– 0.002 (0.003)	– 0.058*** (0.005)	– 0.025*** (0.005)	– 0.005*** (0.002)	– 0.030*** (0.005)	0.91
Nigeria	– 0.058*** (0.010)	– 0.004 (0.003)	– 0.062*** (0.011)	– 0.055*** (0.009)	– 0.005*** (0.002)	– 0.060*** (0.010)	0.91
Mauritius	– 0.099*** (0.004)	0.003 (0.003)	– 0.096*** (0.004)	– 0.039*** (0.009)	– 0.003 (0.002)	– 0.041*** (0.009)	0.91
Sub-Saharan Africa excl. Mauritius	**0.013*** (0.004)**	**– 0.005* (0.003)**	**0.008** (0.004)**	**0.009*** (0.003)**	**– 0.007*** (0.002)**	**0.002 (0.002)**	**0.91**

Dependent variable is the manufacturing employment share. Regressions estimated using equation (2). Each row represents a regression with period interactions with the respective country relative to the other ETD economies. Each row in bold font type represents a regression with period interactions with the respective region relative to the other ETD economies. Economies within each region are ordered by direction and magnitude of deviation. Coefficients for control variables are omitted for brevity. Results for each country-specific regression are available upon request. Robust standard errors in parentheses. Delta method Taylor approximations for standard errors of net effects

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

Table 8 Regressions on manufacturing employment share by 2-digit industry, Sub-Saharan Africa

	Food	Textiles	Wood, paper and print	Petro, chemicals and rubber	Minerals and metals	Computer and electrical	Machinery	Transport	Furniture; other
ln population	− 0.058***	0.058***	0.003	− 0.032***	0.040***	0.009	− 0.000	0.061***	0.005
	(0.013)	(0.019)	(0.007)	(0.009)	(0.011)	(0.007)	(0.001)	(0.008)	(0.003)
ln population squared	0.002***	− 0.002***	− 0.000	0.001***	− 0.001***	− 0.000	0.000	− 0.002***	− 0.000
	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ln GDP per capita	0.019***	0.050***	0.014***	0.032***	0.021***	0.025***	− 0.004***	0.004	0.006***
	(0.005)	(0.009)	(0.002)	(0.003)	(0.006)	(0.003)	(0.001)	(0.003)	(0.001)
ln GDP per capita squared	− 0.001***	− 0.003***	− 0.001***	− 0.002***	− 0.001***	− 0.002***	0.000***	− 0.000	− 0.000***
	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
2000s	− 0.001	0.001	− 0.001***	0.000	− 0.001**	− 0.000**	0.000	− 0.000*	0.000
	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
2010s	− 0.001*	0.000	− 0.001***	0.001	− 0.001**	− 0.000	0.000	− 0.001**	− 0.000
	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	370	370	341	232	329	175	336	169	370
R^2	0.911	0.791	0.947	0.953	0.937	0.963	0.979	0.967	0.928

Dependent variable is the 2-digit manufacturing employment share in total employment. See "Appendix 1" for sources and description of manufacturing industries. Regressions are estimated using (1). Robust standard errors in parentheses

*$p < 0.10$, **$p < 0.05$, ***$p < 0.0$

Table 9 Manufacturing real output shares at registered and unregistered firms

	Registered firms			Unregistered firms		
	developing Asia	Latin America	SSA (*excl. Mauritius*)	developing Asia	Latin America	SSA (*excl. Mauritius*)
	(1)	(2)	(3)	(4)	(5)	(6)
ln population	− 0.976***	− 1.698***	0.278***	1.674***	1.024***	0.359***
	(0.246)	(0.290)	(0.103)	(0.294)	(0.302)	(0.128)
ln population squared	0.023***	0.060***	− 0.010***	− 0.043***	− 0.041***	− 0.009**
	(0.007)	(0.009)	(0.003)	(0.009)	(0.009)	(0.004)
ln GDP per capita	0.040	0.456	0.264***	0.353**	0.269	0.008
	(0.134)	(0.281)	(0.067)	(0.150)	(0.280)	(0.085)
ln GDP per capita squared	0.004	− 0.028*	− 0.012***	− 0.024***	− 0.013	− 0.006
	(0.008)	(0.015)	(0.004)	(0.009)	(0.015)	(0.005)
2000s	− 0.033**	− 0.019***	0.007	0.030**	0.022***	− 0.010*
	(0.014)	(0.007)	(0.005)	(0.015)	(0.007)	(0.006)
2010s	− 0.019	− 0.035***	0.023***	0.006	0.030***	− 0.021**
	(0.018)	(0.011)	(0.008)	(0.020)	(0.011)	(0.010)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Countries	10	9	12	10	9	12
Observations	280	261	341	280	261	341
R^2	0.69	0.7	0.7	0.46	0.9	0.69

Dependent variable is the manufacturing real output share, in either registered (columns 1–3) or unregistered firms (columns 4–6). Regressions are estimated using (1). Robust standard errors in parentheses

$^*p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Appendix 3: A Comparison with Rodrik (2016)

The recent expansion in manufacturing employment, in particular in Sub-Saharan Africa, contrasts with findings of de-industrialization by Rodrik (2016). Why do the findings differ? First, the analysis in Rodrik (2016) is based on a longer panel dataset including pre-1990 observations. Second, Rodrik (2016) uses a smaller set of countries. Third, the ETD uses more recent national accounts data and new employment sources. Coverage of new (often small-scale manufacturing and services) activities tends to improve if new surveys and censuses are conducted. Hence, the findings could also differ due to data vintages.

We examine these potential explanations in Table 10. As before, the dependent variable is the manufacturing employment share. Regressions are estimated using (1). Only results of the decadal dummy for the 2010s are shown. Column (1) reproduces the baseline findings. In Column (2), observations before 1990 are included by extrapolating the ETD series backwards using the GGDC 10-sector database (10SD) and the Extended Africa Sector Database (EASD). In Column (3), the country sample is restricted to countries included in the 10SD used by Rodrik (2016). In Column (4), the time series for the 10SD countries are updated using trends from the ETD, hence retaining levels of economic activity reported in the 10SD.

Table 10 Sample heterogeneity and data vintages

	(1)	(2)	(3)	(4)
SSA (excl. Mauritius)				
2010s	0.0190***	0.0144***	0.0079	− 0.0046
	(0.0044)	(0.0042)	(0.0058)	(0.0038)
Latin America				
2010s	− 0.0079	− 0.0449***	− 0.0092*	− 0.0116***
	(0.0053)	(0.0046)	(0.0054)	(0.0054)
Developing Asia				
2010s	0.0104**	− 0.0130***	− 0.0049	0.0012
	(0.0045)	(0.0050)	(0.0074)	(0.0067)
Full ETD country sample	Yes	Yes	No	No
Including observations pre-1990	No	Yes	No	No
10SD country sample used in Rodrik (2016)	No	No	Yes	Yes
10SD levels updated to 2018	No	No	No	Yes

Dependent variable is the manufacturing employment share. Regressions are estimated using (1). Only the 2010 decadal dummies are shown. Robust standard errors in parentheses. Column (1) shows the base line findings. In column (2), the ETD series are extrapolated backwards using the 10SD and the EASD. In Column (3), the country sample is restricted to countries included in the 10SD used by Rodrik (2016). In Column (4), the country sample is also restricted to countries included in the 10SD. In addition, the time series in the 10SD were updated using the trends from the ETD. Venezuela is not in the ETD. It is included in the regressions in columns (2) and (3), but with time series that stop in 2011

$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

First, consider the comparison for Sub-Saharan Africa. Column (2) extends the sample by including observations pre-1990. This does not substantially change the baseline results. Next, note that 18 Sub-Saharan African countries are included in the ETD. Of these, 11 are included in the 10SD. Column (3) restricts the country sample to those in the 10SD. This results indicate a positive yet insignificant industrialization trend for Sub-Saharan Africa. It suggests that the results of Rodrik (2016) are sensitive to sample heterogeneity. Indeed, for several of the additional Sub-Saharan African countries in the ETD we observe industrialization. Some countries, such as Burkina Faso, Cameroon, Lesotho and Mozambique, experience industrialization patterns that significantly exceed the global average trend (discussed in Sect. 5). The inclusion of these countries in column 1 appears to drive the significant industrialization trend in the 2010s.

Column (4) reports results where the country sample is restricted, and in addition, the old 10SD levels are used. The coefficient of the 2010 decadal dummy for Sub-Saharan Africa now turns negative, as in Rodrik (2016). Indeed, the closer we move toward the data used by Rodrik (2016), the closer we get to reproduce his results. Once we also use the vintage of the control variables in Rodrik (2016), we find that the 2010s decadal dummy is − 0.018 and statistically significant at the 1% level (relative to the 1990s).

For Latin America, the inclusion of pre-1990 observations in column (2) reproduces the de-industrialization trend in Rodrik (2016). The sample of countries is comparable, the only difference being that Ecuador is included and Venezuela excluded from the ETD in comparison with the 10SD. Hence, the results in column (3) for the restricted country sample are comparable to the baseline in column (1). Using the 10SD levels in column (4), also only slightly alters the results. In line with the annual time trend reported in Fig. 3, de-industrialization appears as the typical pattern in Latin America.

A comparison of the results for Asia is more difficult. This is because only a few (6 out of 14) developing Asian countries are in the 10SD used by Rodrik (2016). That is, long-run time series for many developing Asian countries in the ETD are not available, so the coefficient for developing Asia in column (2) is reported for completeness but difficult to interpret. It is only for these six developing Asian countries that we can extend the series backwards and do the analysis presented in column (2). This contrasts with the analysis for 14 countries included in column (1). Column (3) suggests that the results for developing Asia are also sensitive to country coverage, as the industrialization trend is insignificant in the smaller country set. The ETD includes several countries that have industrialized, such as Cambodia and Viet Nam, which appear to drive the significant industrialization trend shown in column (1). Finally, column (4) suggests that the use of 10SD levels is not driving the differences in results.

Rodrik (2016) showed that industrialization peaked at higher income levels in the pre-1990 period compared to the post-1990 period. We also explore shifts in the hump-shaped manufacturing curve here. Following Rodrik (2016), we run regressions similar to equation (1), which drop the decadal dummies and interact income and income-squared with post-1990, post-2000 or post-2010 dummies, respectively. Table 11 presents the results. Columns (1)–(3) report results using an extended

Table 11 Regressions with interaction terms

	(1)	(2)	(3)	(4)
ln population	0.089*** (0.021)	0.093*** (0.022)	0.097*** (0.024)	− 0.205*** (0.047)
ln population squared	− 0.003*** (0.001)	− 0.003*** (0.001)	− 0.003*** (0.001)	0.006*** (0.001)
ln GDP per capita	0.180*** (0.025)	0.327*** (0.032)	0.445*** (0.022)	0.276*** (0.024)
ln GDP per capita squared	− 0.008*** (0.001)	− 0.018*** (0.001)	− 0.025*** (0.001)	− 0.016*** (0.001)
ln GDP per capita × post-1990	0.213*** (0.019)			
ln GDP per capita squared × post-1990	− 0.014*** (0.001)			
ln GDP per capita × post-2000		0.082*** (0.018)		
ln GDP per capita squared × post-2000		− 0.006*** (0.001)		
ln GDP per capita × post-2010			0.033 (0.025)	0.026 (0.019)
ln GDP per capita squared × post-2010			− 0.003* (0.001)	− 0.002** (0.001)
Backward extrapolation pre-1990	Yes	Yes	Yes	No
ETD countries only	No	No	No	Yes
Extended sample with advanced countries in 10SD	Yes	Yes	Yes	No
Country fixed effects	Yes	Yes	Yes	Yes
Countries	61	61	61	51
Observations	3233	3233	3233	1479
R^2	0.8443	0.8335	0.8196	0.9118

Dependent variable is the manufacturing employment share. Regressions are estimated using equation (1) but dropping decadal dummies and interacting income and income square with post-1990, post-2000 or post-2010 dummies. Columns (1)–(3) show results when the ETD series are extrapolated backwards using the 10SD and the EASD and when advanced countries are included by using employment data from EU KLEMS as a benchmark and extrapolating backward using the 10SD. In Column (4), the sample is restricted to the ETD only. Robust Standard errors are reported in parentheses

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$

dataset, namely (*i*) when observations before 1990 are included by extrapolating the ETD series backward using trends from the GGDC 10-sector database (10SD) and the Extended Africa Sector Database (EASD); and (*ii*) when advanced countries in the Rodrik (2016) sample are included by using employment data from EU KLEMS (van Ark and Jaeger 2017; Stehrer et al. 2019) and extrapolating backward using the 10SD. Column (4) reports regression results from using the ETD only. Results show significant interaction terms when 1990 is used as a breakpoint, consistent with Rodrik (2016). The magnitude and significance of the interaction terms weaken

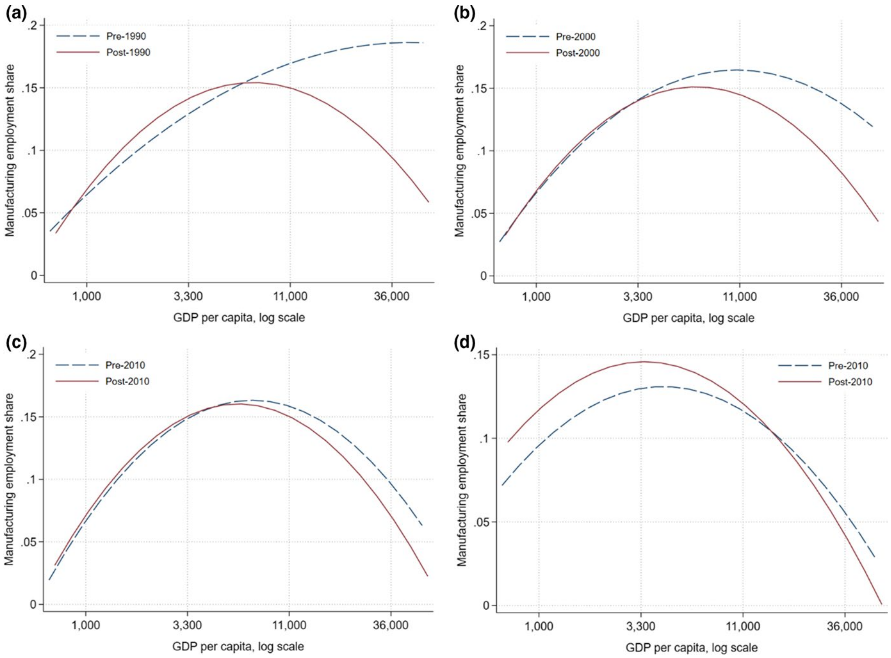

Fig. 6 Simulated manufacturing employment shares. *Notes:* Simulated manufacturing employment share and GDP per capita levels for the pre- and post-periods of the various breakpoints in panels (a)–(d) correspond to the regression estimates in columns (1)–(4) of Table 11

when we use 2000 in column (2) and in particular with 2010 as the breakpoint in columns (3) and (4).

Figure 6 visualizes the simulated manufacturing employment share and GDP per capita levels for the pre- and post-periods of the various breakpoints. Panels (a)–(d) correspond to the models in columns (1)–(4) in Table 11. We computed the 95% confidence intervals for log incomes at which manufacturing shares peak using the delta method. Manufacturing employment peaks at a lower income level in the post-1990 period compared to the pre-1990 period. The bands for the peaks do not overlap when we use 1990 as a breakpoint, indicating that the post-1990 shift toward the origin is statistically significant. The confidence intervals for the pre- and post-2000 and the pre- and post-2010 periods overlap, indicating that there is no statistically significant shift toward the origin. These findings suggest that recent industrialization trends in developing countries weakened the shift in the hump-shaped curve to the origin. Yet, we cautiously note that the breakpoints are arbitrary and later breakpoints lower the number of observations that can be used for identifying any effects.

Acknowledgements We would like to thank the editor Andrei Levchenko, two anonymous reviewers, Johannes van Biesebroeck, Xinshen Diao, Calumn Hamilton, Robert Inklaar, Sam Jones, Joseph Kaboski, Justin Lin, Maggie McMillan, Marti Mestieri, Dani Rodrik, Noah Smith, Andy Sumner, Dirk Willem te Velde, Marcel Timmer and participants at numerous seminars and conferences for stimulating comments and suggestions. We are indebted to the other team members, Linda Arfelt, Dorothea Drees, Mareike Godemann, Calumn Hamilton, Bente Jessen-Thiesen, Ahmet Ihsan Kaya and Pieter Woltjer, for their excellent research assistance to the Economic Transformation Database at the Groningen Growth and Development Centre (GGDC). We are grateful for financial support by UNU-WIDER as part of its Varieties of Structural Transformation program.

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