New Evidence on Sectoral Labor Productivity: Implications for Industrialization and Development

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I Motivation

Productivity Gaps and Development

- Clear-cut situation in one-sector growth model:
  - Aggregate productivity gaps with frontier are a natural measure of development level.
  - PWT offers PPPs that permit the easy calculation of aggregate productivity gaps.
- More nuanced situation in multi-sector growth model:
  - Productivity gaps differ across sectors:
    productivity gaps are larger in agriculture than in the aggregate (FAO data until 1985).
  - Usual interpretation: Moving out of agriculture must close aggregate productivity gap.
- Our question: Does it matter to which non-agricultural sector employment moves?

Common Notion: It Does Matter Where Employment Moves

- Closing aggregate productivity gaps requires *industrialization*,
  because in manufacturing the productivity gaps are smaller than in the aggregate.
- Although this notion is common in the macro-development literature,
  there are many more papers stating it than data points supporting it.
- Data on comparable manufacturing productivity levels are missing for poor countries
  (UNIDO has manufacturing productivity levels since 1965,
  but they are in *domestic* prices and cover only formal manufacturing).

We Make Two Contributions

1) Construct New Database of Sectoral Productivity Levels in International Prices

- Expand the Economic Transformation Database (ETD) from the GGDC.

2) Measure Productivity Gaps at Sectoral Level in New Database

- Productivity gaps in manufacturing are indeed *smaller* than in agriculture, but they are also *larger* than in the aggregate.
- There is no unconditional convergence of manufacturing productivity, that is, productivity gaps in manufacturing do not necessarily shrink.

II New Database of Sectoral Productivity Levels

Expansions of the ETD

- We add 13 rich countries and impute PPPs in manufacturing and agriculture.

Expanded Economic Transformation Database (EETD)

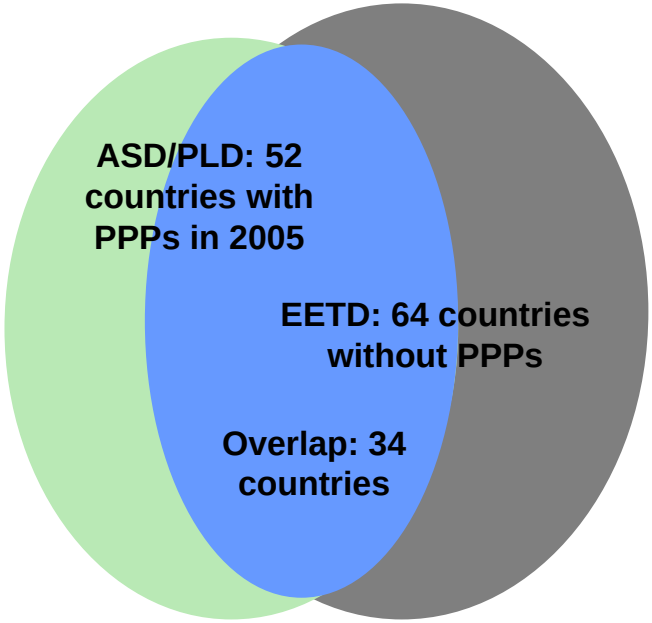
- Sectoral data
  - 12 sectors: employment and value added in current and constant *domestic* prices;
  - agriculture and manufacturing: value added also in constant *international* prices.
- 64 countries during 1990–2018
  - more than 4/5 of world population and of world GDP;
    13 of the world's most populous countries and largest economies.
  - majority of countries poor;
    numerous examples in which productivity growth stagnates or catches up.

Table 1: EETD

ETD			Eurostat, EUKLEMS	Nat. Stat. Office, OECD
Africa	**Asia**	**Latin America**	**Europe**	
Botswana	Bangladesh	Argentina	Austria	Australia
Burkina Faso	Cambodia	Bolivia	Belgium	Sweden
Cameroon	China	Brazil	Denmark	U.S.
Egypt	Hong Kong	Chile	Finland	
Ethiopia	India	Colombia	France	
Ghana	Indonesia	Costa Rica	Germany	
Kenya	Israel	Ecuador	Italy	
Lesotho	Japan	Mexico	Netherlands	
Malawi	Korea (Rep.)	Peru	Spain	
Mauritius	Lao PDR		U.K.	
Morocco	Malaysia			
Mozambique	Myanmar			
Namibia	Nepal			
Nigeria	Pakistan			
Rwanda	Philippines			
Senegal	Singapore			
South Africa	Sri Lanka			
Tanzania	Taiwan			
Tunisia	Thailand			
Uganda	Turkey			
Zambia	Vietnam			

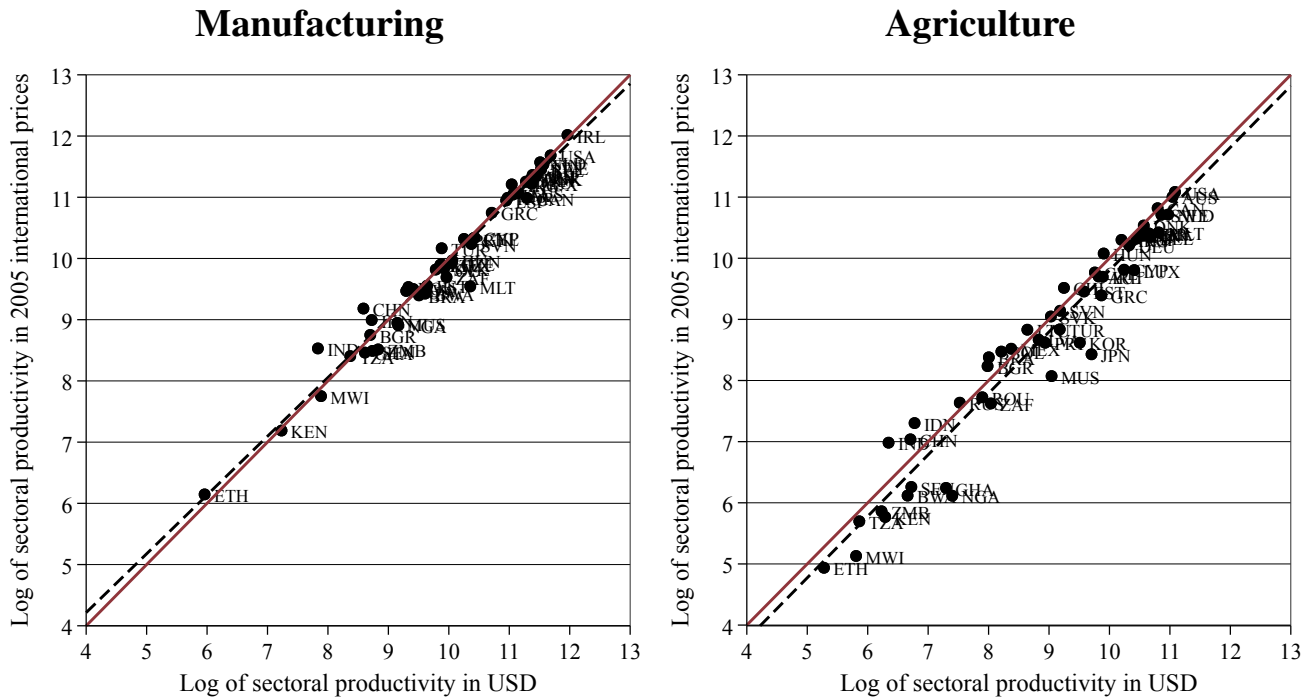
Impute comparable productivity levels in constant international prices

- African Sector Database (ASD) and Productivity Level Database (PLD) from the GGDC:



- Blue EETD countries: use PPPs to calculate productivity levels for 2005.
- Grey EETD countries: impute productivity levels for 2005
  - regress log productivity in international prices on that in USD for ASD/PLD countries;
  - use regression result to impute log productivity in international prices where missing.
- Years other than 2005: calculate productivity levels using domestic real prod. growth.

Imputation Regressions

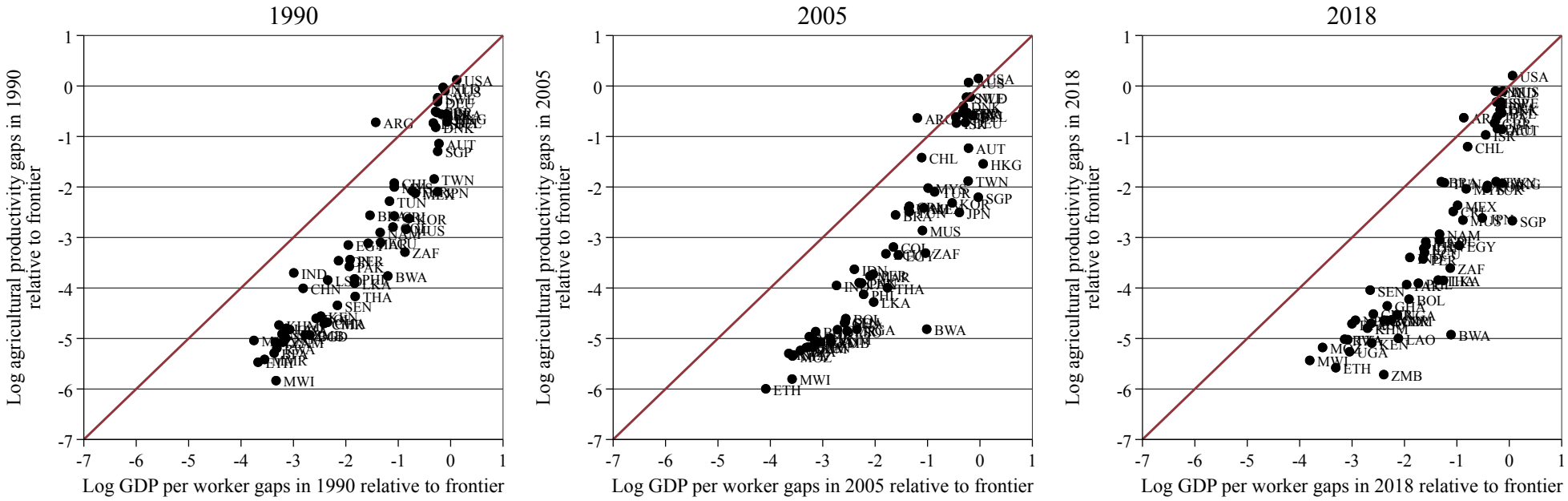


III Sectoral Productivity Gaps in Cross Section of Countries

Definitions

- Productivity: value added in constant international prices per worker.
- Productivity gap: productivity relative to frontier productivity.
- Frontier productivity in a sector and year:
  average of three highest productivities in that sector and year.

Figure 1: Productivity Gaps in Agriculture vs. Aggregate (EETD)



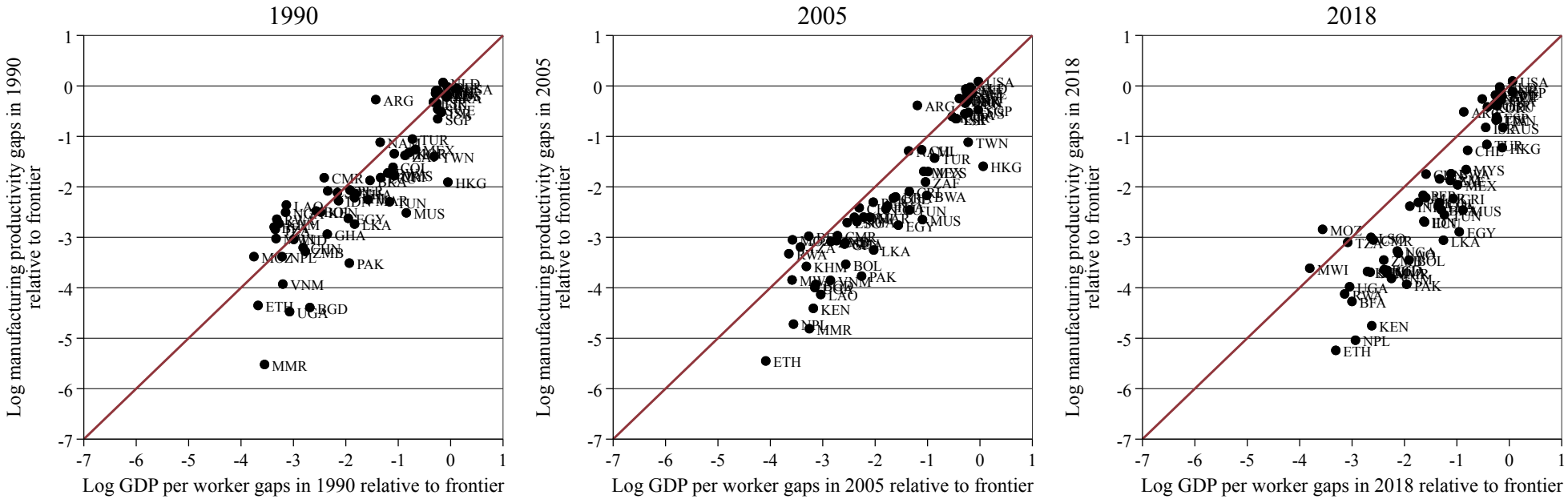
Usual Interpretation of Previous Graphs (Restuccia et al, JME, 2008)

- For poor countries, productivity gaps in agriculture are lager than in the aggregate.
- Productivity gaps in non-agriculture must be smaller than in the aggregate.
- Moving out of agriculture must close aggregate productivity gaps.

However

- Non-agriculture is heterogeneous including manufacturing, services, etc.
- Our new data set allows us to measure productivity gaps in manufacturing, instead of non-agriculture.

Figure 2: Productivity Gaps in Manufacturing vs. Aggregate (EETD)



Interpretation

- For poor countries, productivity gaps in manufacturing are
  - *smaller* than in agriculture;
  - *larger* than in the aggregate.
- Industrialization does not cause largest reduction in aggregate productivity gaps.
- Poor countries in our sample would benefit from moving out of manufacturing.

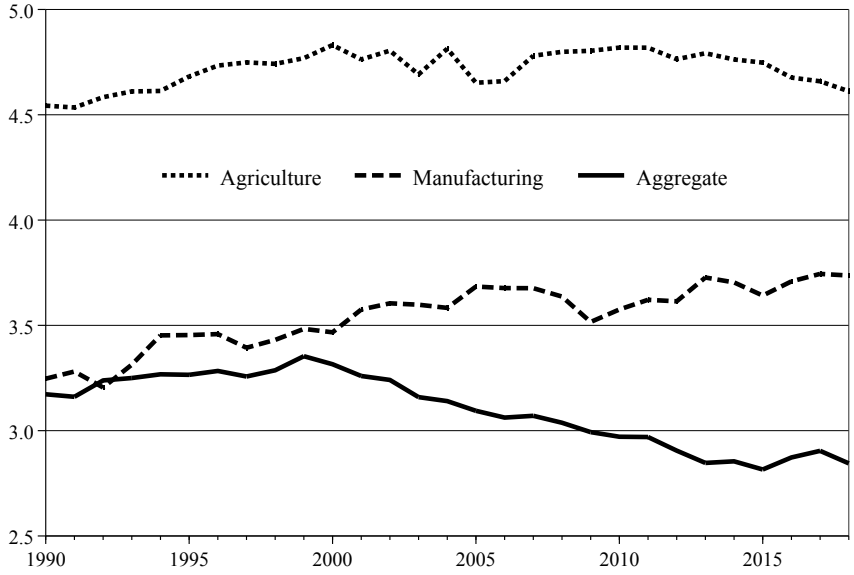
IV Sectoral Productivity Gaps over Time

Convergence

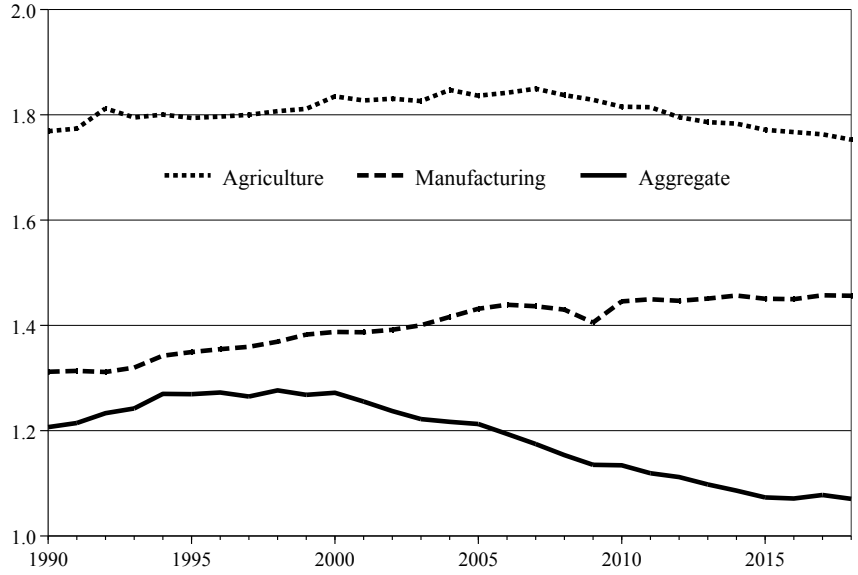
- Rodrik (QJE, 2013) found that manufacturing productivity converges.
- Industrialization then reduces aggregate productivity gaps in the future.
- Although the previous graphs didn't suggest convergence in manufacturing, we can also assess σ- and β-convergence in our new dataset.

σ-Convergence

90–10 Percentiles of Log Product.



Standard Deviation of Log Product.



β-Convergence

- Standard convergence regression:

$$\begin{aligned}\Delta \log(LP_{jt}) &= \alpha + \beta\left[\log(LP_{Ft-1}) - \log(LP_{jt-1})\right] + \varepsilon_{jt} \\ &= \alpha - \beta \log(LP_{jt-1}) + D_t + \varepsilon_{jt}.\end{aligned}$$

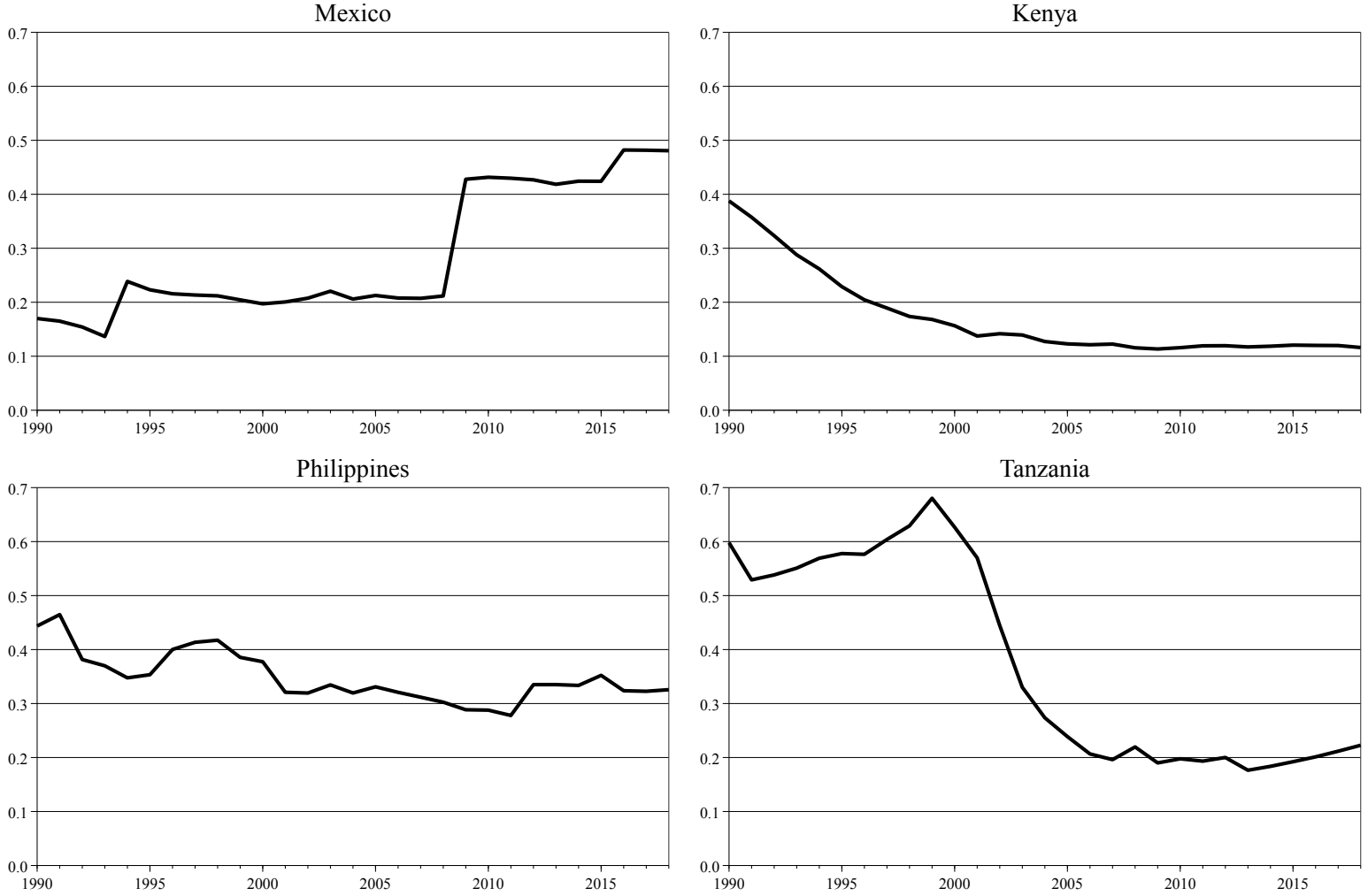
  $\beta > 0$: unconditional convergence.

- Regression results: β positive but very close to zero,
  i.e., no unconditional convergence in manufacturing, agriculture, or aggregate.
- The regression result for manufacturing differs sharply from Rodrik's (QJE, 2003).

Differences with Rodrik (QJE, 2013)

- Constructions of productivity levels
  - Rodrik: in current USD via exchange rates.
  - We: in constant international prices via PPPs.
  - It turns out the difference in data construction is not crucial!
- Data sources
  - Rodrik: UNIDO 1965–2005, formal employment.
  - We: GGDC 1990–2018, all employment including informal and own-account.
  - It turns out the difference in data coverage is crucial!

Figure 3: UNIDO/GGDC Manufacturing Employment in Four Large Countries from Three Continents



V Conclusion

- We have found little evidence that industrialization reduces aggregate productivity gaps.
- We have focused on the effects of industrialization on productivity *levels*.
- We note that (de-)industrialization may also affect aggregate productivity *growth* (Baumol's Cost Disease is a prominent example for rich countries).
- We leave studying the growth effects for future research.

Defensive Slides

Countries in the Africa Database

Botswana; Ethiopia; Ghana; Kenya; Malawi; Mauritius; Nigeria; Senegal; South Africa; Tanzania; Zambia.

Countries in the Productivity Level Database

Argentina; Australia; Austria; Belgium; Brazil; Bulgaria; Canada; Chile; China; Cyprus; Czech Republic; Denmark; Estonia; Finland; France; Germany; Greece; Hungary; India; Indonesia; Ireland; Italy; Japan; Latvia; Lithuania; Luxembourg; Malta; Mexico; Netherlands; Poland; Portugal; Romania; Russia; Slovakia; Slovenia; South Africa; South Korea; Spain; Sweden; Turkey; United Kingdom; United States.

Countries in both the EETD and the FAO Database

Argentina; Australia; Austria; Bangladesh; Belgium; Bolivia; Brazil; Burkina Faso; Cameroon; Chile; Colombia; Costa Rica; Denmark; Ecuador; Egypt; Ethiopia; Finland; France; Germany; Ghana; India; Indonesia; Israel; Italy; Japan; Kenya; Malawi; Malaysia; Mexico; Morocco; Mozambique; Nepal; Netherlands; Nigeria; Pakistan; Peru; Philippines; Republic of Korea; Rwanda; Senegal; South Africa; Spain; Sri Lanka; Sweden; Tanzania; Thailand; Tunisia; Turkey; Uganda; United Kingdom; United States.

Productivity Imputations

- Regression in 2005 for 52 countries in ASD/PLD:

$$\log LP_j^{Int} = \phi_0 + \phi_1 \log LP_j^{USD} + \varepsilon_j$$

- Results for manufacturing:

ϕ_0	ϕ_1	R^2
0.377	0.960	0.972
(0.253)	(0.023)	

- Results for agriculture:

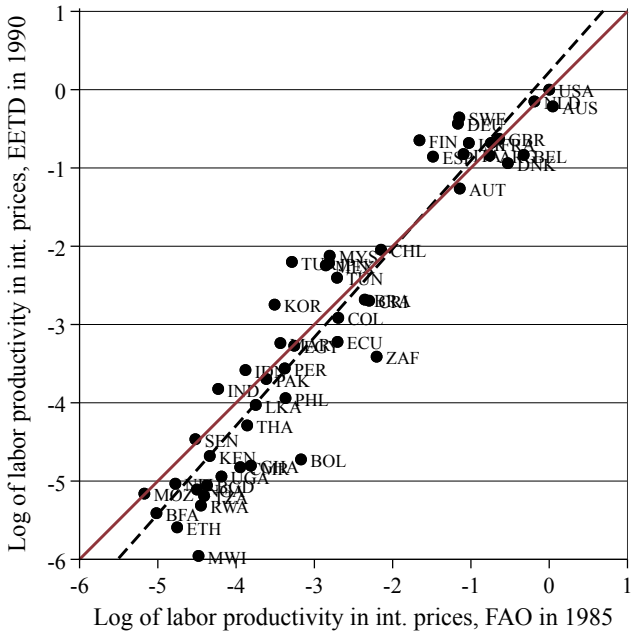
ϕ_0	ϕ_1	R^2
−0.256	1.006	0.944
(0.327)	(0.035)	

Agricultural Productivity in FAO Data

Table 2: Regression of EETD on FAO Agr. Prod. (51 Countries in FAO ∩ EETD)

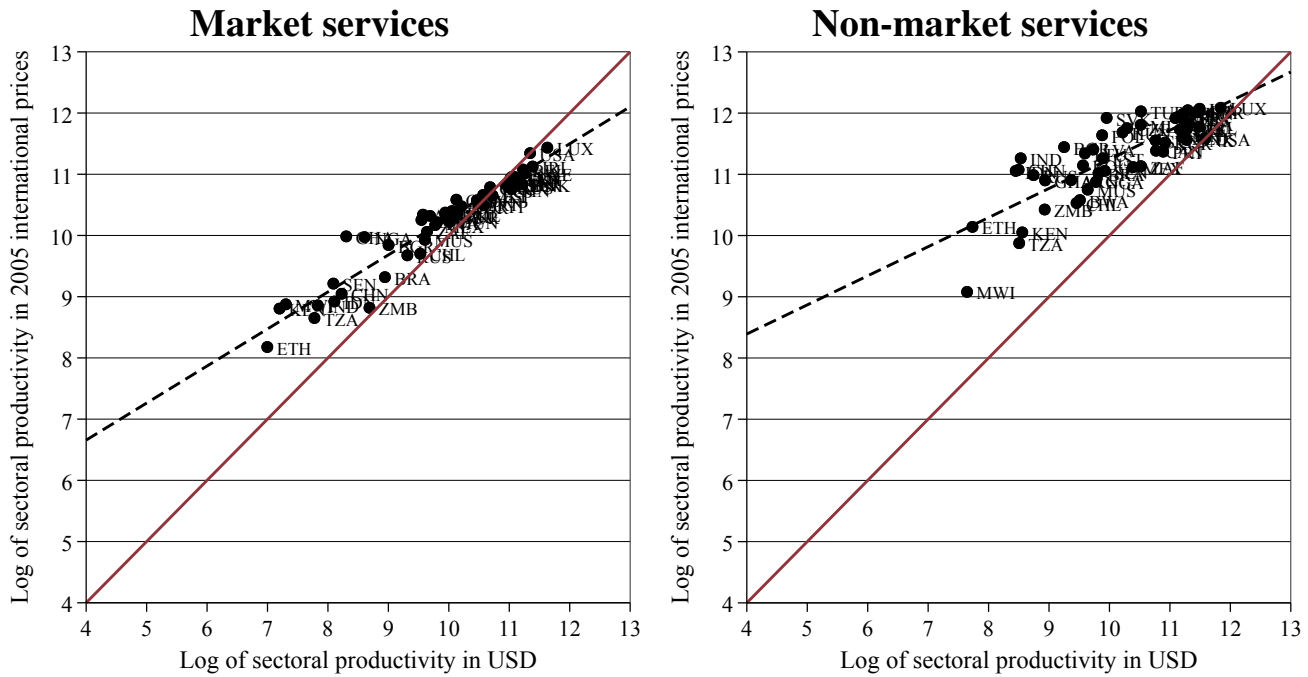
ϕ_0	ϕ_1	R^2
0.225	1.129	0.899
(0.142)	(0.044)	

Figure 4: Agricultural Productivity Levels in FAO and EETD (51 Countries)



Deviation from the LOP in Services

Figure 5: Service Productivities in USD vs. International Prices
(52 Countries from ASD/PLD, 2005)



- Note the relation to the Penn Effect ("services cheaper in poor countries").

Sectoral vs. Aggregate Productivity Gaps with Frontier

Figure 6: Productivity Gaps in Goods vs. Aggregate

(34 Countries in EETD ∩ ASD/PLD)

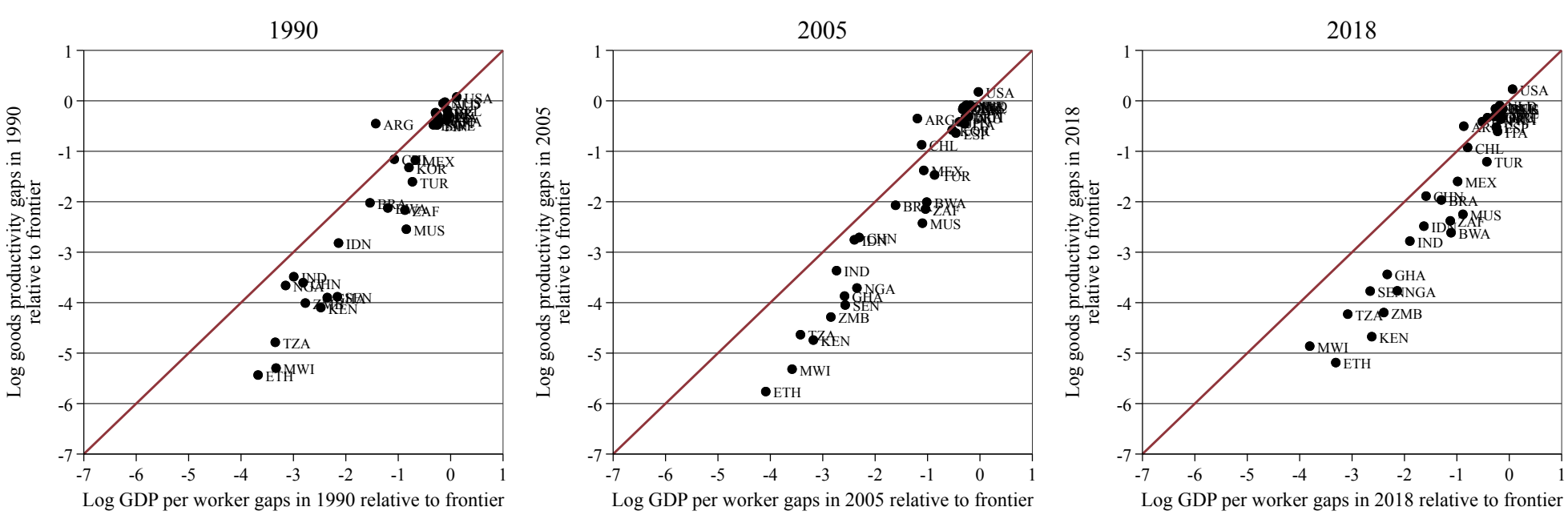


Figure 7: Productivity Gaps in Services vs. Aggregate

(34 Countries in EETD ∩ ASD/PLD)

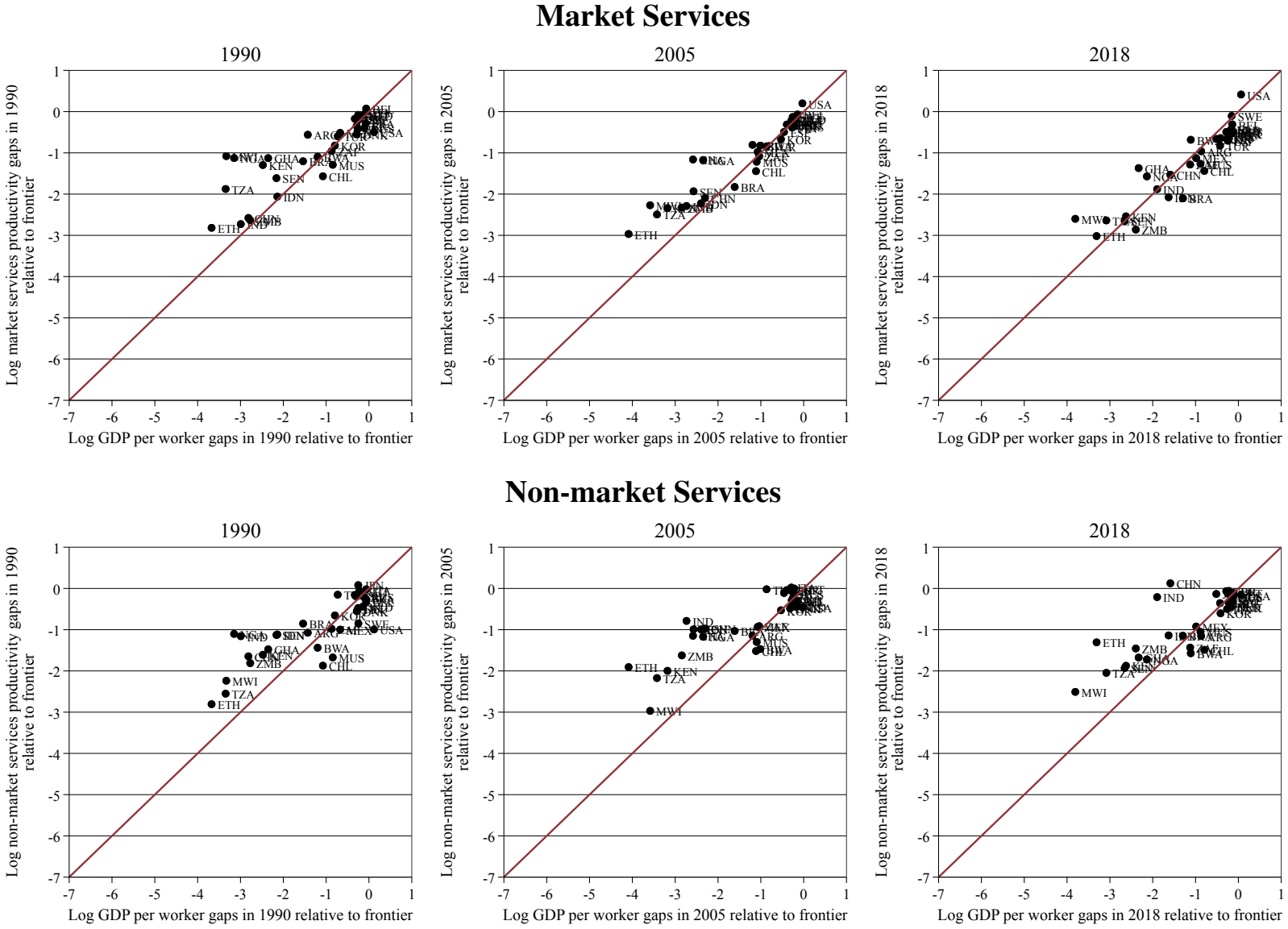


Table 3: Convergence Regressions (64 countries in EETD, 1990–2018)

	Aggregate		Manufacturing		Agriculture	
	(1)	(2)	(3)	(4)	(5)	(6)
β	−0.006	−0.041	−0.003	−0.046	−0.002	−0.128
	(0.013)	(0.011)	(0.002)	(0.014)	(0.001)	(0.023)
Number of observations	1,792					
Units	Constant international prices from 2005					
Time fixed effects	Yes					
Country fixed effects	No	Yes	No	Yes	No	Yes

- Nothing special about convergence in manufacturing in the EETD.
- Practically no unconditional convergence
  ($\beta = -0.006$: starting at 0.1 of the frontier, 28 years later one ends up at 0.143).
- Strong conditional convergence
  ($\beta = -0.041$: starting at 0.1 of own BGP, 28 years later one ends up at 0.490).

Table 4: Geographic Robustness of Convergence Regressions (EETD, 1990–2018)

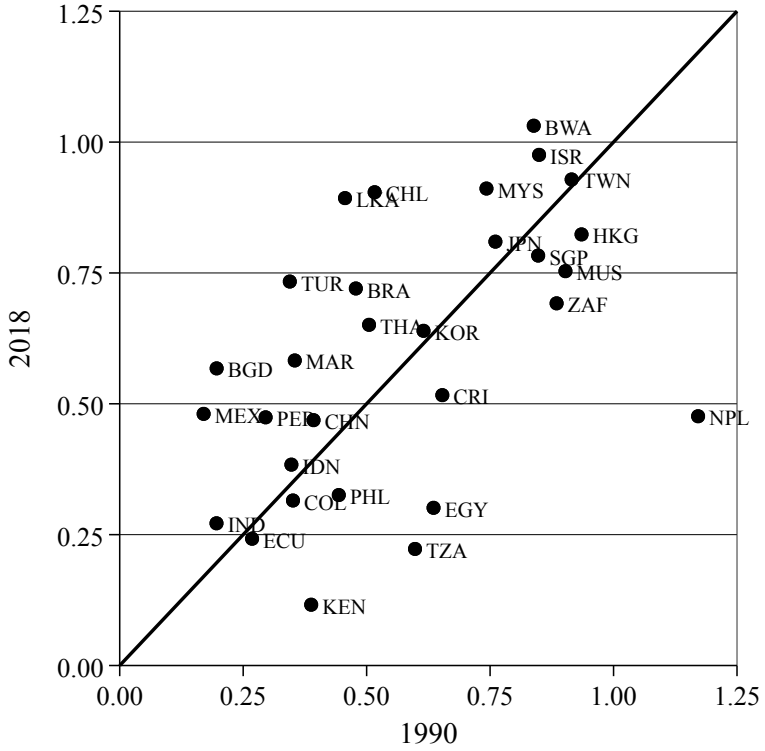
	Aggregate		Manufacturing		Agriculture	
	(1)	(2)	(3)	(4)	(5)	(6)
	Sub-Saharan African countries excluded					
β	−0.010	−0.033	−0.005	−0.055	−0.003	−0.140
	(0.002)	(0.011)	(0.003)	(0.023)	(0.001)	(0.033)
Observations	1,288					
Number of countries	46					
	South and East Asian countries excluded					
β	−0.003	−0.055	0.003	−0.050	0.0001	−0.164
	(0.001)	(0.021)	(0.002)	(0.013)	(0.001)	(0.036)
Observations	1,232					
Number of countries	44					
	Latin American countries excluded					
β	−0.005	−0.036	−0.003	−0.043	−0.002	−0.126
	(0.001)	(0.010)	(0.002)	(0.014)	(0.001)	(0.024)
Observations	1,540					
Number of countries	55					
Units	Constant international prices from 2005					
Time fixed effects	Yes					
Country fixed effects	No	Yes	No	Yes	No	Yes

Table 5: Coverage Ratios UNIDO–EETD Manufacturing Employment
(30 countries in EETD ∩ UNIDO, 1990–2018)

$\frac{\text{UNIDO Employment}}{\text{EETD Employment}}$	0–0.25	0.25–0.50	0.50–0.75	0.75–1.00
Number of Countries	2	11	11	6

- For nearly half of the countries, UNIDO has less than half of EETD employment.
- In addition, the coverage changes considerably over time.

Figure 8: Changes in the Manufacturing Employment Coverage Ratios
UNIDO–EETD (30 countries in EETD ∩ UNIDO)



Use of UNIDO Data Changes Convergence Results

Table 6: Convergence Regressions for Manufacturing in Current USD Prices, EETD versus UNIDO (41 countries in EETD ∩ UNIDO, 1995–2005)

	EETD	UNIDO
β	−0.007	−0.020
	(0.005)	(0.006)
Number of observations	410	
Units	Current prices in USD	
Time fixed effects	Yes	
Country fixed effects	No	

Figure 9: Manufacturing Productivity Growth in UNIDO versus Change in Coverage Employment Ratio (30 countries in EETD ∩ UNIDO, 1990–2018)