

Productivity Growth and Labor Reallocation: Latin America versus East Asia

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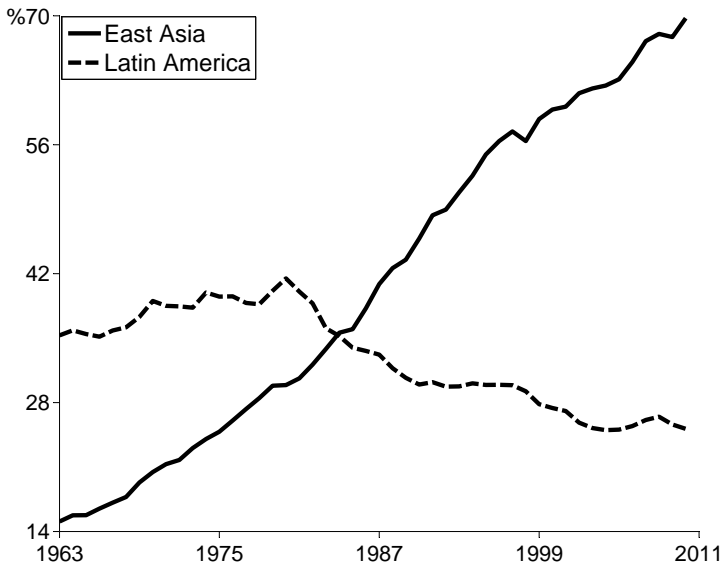
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Growth Miracles vs. Development Outliers

Labor productivity relative to the U.S. (%), 1963-2010



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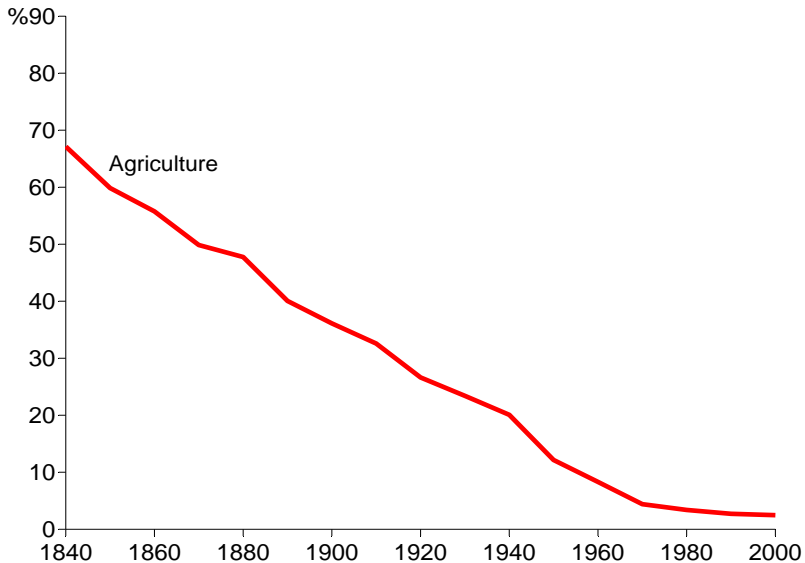
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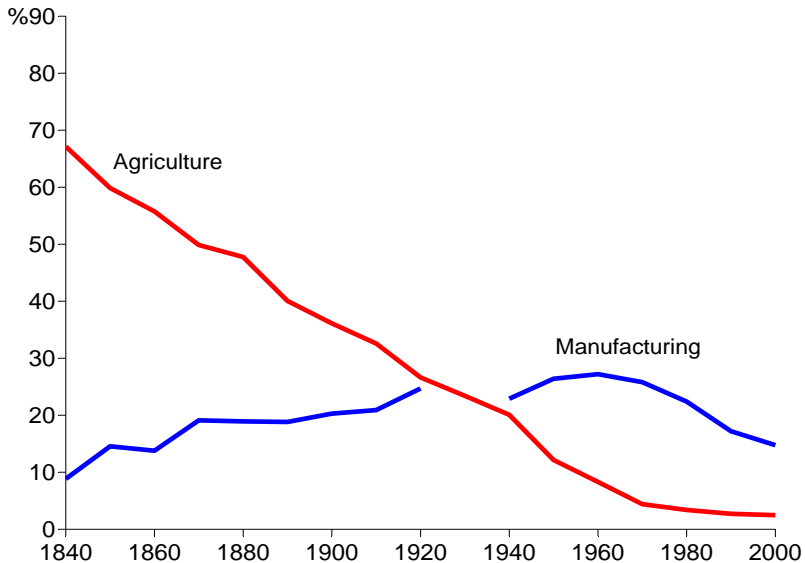
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 3. the poor performance of Latin America relative to East Asia (Lin, 1988; Comeau, 2003; de Gregorio and Lee, 2004; Grabowski, 2008)
- ▶ The comparative studies have mentioned the differences in both policies and institutions in explaining the divergence between the two regions, mostly focusing on the aggregate macroeconomic indicators

This paper explores the reasons behind this divergence using a multi-sector model of structural transformation

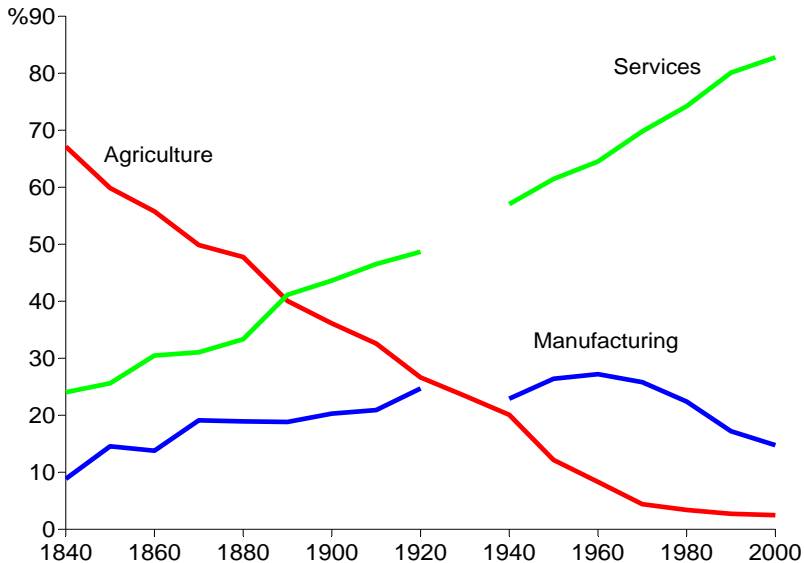
Employment Shares by Sector, U.S. 1840-2000



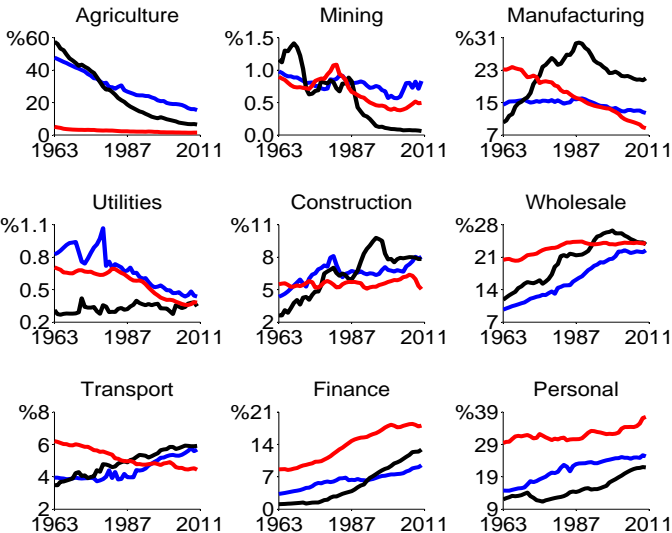
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Employment Shares by Sector, U.S. 1840-2000



Sectoral employment shares (%), 1963-2010



(Black: East Asia; Blue: Latin America; Red: U.S.)

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- ▶ What is the role of productivity growth within individual sectors in Latin America's falling behind?

Findings

- ▶ Sectoral productivity growth rates in all sectors in Latin America have not been high enough to avoid the stagnation of aggregate productivity in Latin America.

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Findings

- ▶ Sectoral productivity growth rates in all sectors in Latin America have not been high enough to avoid the stagnation of aggregate productivity in Latin America.
- ▶ Low aggregate labor productivity growth in Latin America is not the result of a specific sector, instead it is an economy-wide phenomenon regarding all sectors.

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- ▶ Can differences in sectoral productivity growth rates account for the sectoral reallocation of labor in development outliers (Latin America) and growth miracles (East Asia)?
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Findings

- ▶ Sectoral productivity growth rates in all sectors in Latin America have not been high enough to avoid the stagnation of aggregate productivity in Latin America.
- ▶ Low aggregate labor productivity growth in Latin America is not the result of a specific sector, instead it is an economy-wide phenomenon regarding all sectors.
- ▶ However, the findings highlight the possible importance of raising productivity in manufacturing and wholesale to have significant increases in aggregate productivity growth rates.

A NINE-SECTOR MODEL

Sectoral Classification

1. *Agriculture* (agriculture, forestry and fishing);
2. *Mining* (mining and quarrying)
3. *Manufacturing*
4. *Utilities*
5. *Construction*
6. *Wholesale* (wholesale and retail trade, hotels and restaurants)
7. *Transport* (transport, storage and communication)
8. *Finance* (finance, insurance, and real estate)
9. *Personal services* (community, social and personal services and government services)

Firms and technologies

$$\max \quad p_j Y_j - \omega N_j$$

s.t.

$$Y_j = \theta_j N_j$$

$$N_j > 0$$

where p_j is producer price for sector j

Y_j is output produced in sector j

ω is the wage rate

N_j is labor employed in sector j

θ_j is labor productivity of sector j

Households and preferences

$$\max U(\bar{A}, C)$$

s.t.

$$p_A \bar{A} + p_1 C_1 + p_2 C_2 + \dots + p_8 C_8 = \omega$$

where

$$U(\bar{A}, C) = \bar{A} + \log(C)$$

$$C = \left[\gamma_1^{1/\eta} C_1^{(\eta-1)/\eta} + \gamma_2^{1/\eta} C_2^{(\eta-1)/\eta} + \dots + \gamma_8^{1/\eta} C_8^{(\eta-1)/\eta} \right]^{\eta/(\eta-1)}$$

η is substitution elasticity between different goods

γ_j is share of good j in non-agricultural consumption

Competitive equilibrium

Given a set of prices, a competitive equilibrium consists of consumption decisions that are the household's allocations $\{\bar{A}, C_1, C_2, \dots, C_8\}$, and factor allocations for the firms, $\{N_A, N_1, N_2, \dots, N_8\}$ such that given prices

1. the firm's allocations solve its profit maximization problem
2. the household's allocations solve the household's utility maximization problem
3. all product and factor markets clear

- ▶ The household is endowed with one unit of productive time:

$$N_A + N_1 + N_2 + \dots + N_8 = 1$$

- ▶ There is no international trade or capital accumulation:

$$\bar{A} = Y_A, \quad C_1 = Y_1, \quad \dots, \quad C_8 = Y_8$$

Characterization

- ▶ Employment share in agriculture:

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- ▶ Employment share in a non-agricultural sector j :

$$N_j = \frac{\gamma_j \theta_j^{\eta-1} (1 - \bar{A}/\theta_A)}{\gamma_1 \theta_1^{\eta-1} + \gamma_2 \theta_2^{\eta-1} + \dots + \gamma_8 \theta_8^{\eta-1}}, \quad j = 1, 2, \dots, 8.$$

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- ▶ Relative prices:

$$\frac{p_i}{p_j} = \frac{\theta_j}{\theta_i}, \quad i \neq j.$$

Quantitative Analysis

1. Model calibration and predictions for the U.S

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4. Counterfactuals

Model calibration and predictions for the U.S

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- ▶ $\eta = 0.4696$ to match the average annual growth in aggregate labor productivity in the U.S. between 1963 and 2010.

Sectoral productivity levels and convergence

Relative Sectoral Productivity Levels in 1963 and Growth Rates

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 - ▶ aggregate labor productivity relative to that of the U.S. in 1963

Calibrated sectoral productivity levels in 1963

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Country	Agriculture	Mining	Manufacturing	Utilities	Construction	Wholesale	Transport	Finance	Personal
Korea	0.0804	0.0672	0.2939	0.4445	0.1759	0.1013	0.1635	2.0254	0.2804
Taiwan	0.1017	0.0114	0.1569	0.1095	0.2364	0.1915	0.1001	2.7339	0.1820
Argentina	0.2245	0.5391	0.2906	0.0856	0.3879	0.6520	0.2536	1.8225	0.6925
Bolivia	0.0719	0.0049	0.2066	1.6831	0.0575	0.4252	0.1311	11.0160	0.1769
Brazil	0.0892	0.3243	0.2719	0.0462	0.1298	0.4330	0.2535	0.4025	0.5994
Chile	0.1704	0.0218	0.4965	0.2172	0.2963	0.9864	0.4502	3.5159	0.4719
Colombia	0.1042	0.0727	0.4506	0.6334	0.3538	0.8141	0.3750	0.3322	0.3944
Costa Rica	0.0999	1.4235	0.6175	0.1264	0.1414	0.6909	0.4840	2.3077	0.4144
Mexico	0.1022	0.1276	0.5001	0.5422	0.4475	0.8338	0.8208	7.4198	0.5992
Peru	0.1001	0.0503	0.5420	1.0967	0.5000	0.7994	0.5934	0.8244	0.5431
Venezuela	0.1587	0.1199	1.8974	0.2840	0.9494	1.6818	1.2795	3.1050	0.9707

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- ▶ Venezuela had the highest productivity levels in 1963, in comparison with other Latin American countries, in three sub-sectors of the service sector: wholesale, transport and personal services
- ▶ This is no surprise, since Venezuela was almost as rich as the U.S. in about that year

Average annual growth of labor productivity by sector (%), 1963-2010

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Country	Agriculture	Mining	Manufacturing	Utilities	Construction	Wholesale	Transport	Finance	Personal	Aggregate
Korea	4.57	4.20	7.00	9.98	3.50	3.28	5.79	-2.51	0.35	5.64
Taiwan	3.66	9.09	4.41	3.90	1.01	6.01	4.87	2.40	3.23	5.66
Argentina	2.77	2.07	2.40	5.24	0.69	-0.02	3.10	-0.59	-0.62	0.99
Bolivia	2.64	2.36	-0.24	0.53	-1.82	-2.40	0.39	-4.13	-1.45	0.98
Brazil	3.20	4.33	1.16	4.20	0.36	-0.56	1.80	-0.34	-0.21	1.47
Chile	4.84	3.14	2.32	1.40	0.35	0.26	2.89	-0.27	0.50	2.02
Colombia	1.73	0.28	0.93	2.17	-0.19	-2.12	0.52	1.14	1.38	0.93
Costa Rica	3.01	2.43	1.81	1.05	1.13	-1.69	2.64	-1.33	-0.75	1.46
Mexico	1.38	2.45	0.52	3.51	-1.91	-1.43	1.03	-2.90	-1.10	0.42
Peru	1.38	0.48	1.08	1.69	0.33	-1.96	-1.09	-0.22	-0.53	0.39
Venezuela	2.09	-3.85	0.45	4.51	-1.92	-2.03	-0.07	0.21	0.34	0.30
U.S.	3.85	0.74	3.00	2.24	-1.84	1.85	2.75	0.46	-0.10	1.23

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Taiwan	3.66	9.09	4.41	3.90	1.01	6.01	4.87	2.40	3.23	5.66
Argentina	2.77	2.07	2.40	5.24	0.69	-0.02	3.10	-0.59	-0.62	0.99
Bolivia	2.64	2.36	-0.24	0.53	-1.82	-2.40	0.39	-4.13	-1.45	0.98
Brazil	3.20	4.33	1.16	4.20	0.36	-0.56	1.80	-0.34	-0.21	1.47
Chile	4.84	3.14	2.32	1.40	0.35	0.26	2.89	-0.27	0.50	2.02
Colombia	1.73	0.28	0.93	2.17	-0.19	-2.12	0.52	1.14	1.38	0.93
Costa Rica	3.01	2.43	1.81	1.05	1.13	-1.69	2.64	-1.33	-0.75	1.46
Mexico	1.38	2.45	0.52	3.51	-1.91	-1.43	1.03	-2.90	-1.10	0.42
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Venezuela	2.09	-3.85	0.45	4.51	-1.92	-2.03	-0.07	0.21	0.34	0.30
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- ▶ Labor productivity growth rates in all sectors in East Asia (except agriculture in Taiwan and finance in Korea) are higher than those of the U.S.

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Argentina	2.77	2.07	2.40	5.24	0.69	-0.02	3.10	-0.59	-0.62	0.99
Bolivia	2.64	2.36	-0.24	0.53	-1.82	-2.40	0.39	-4.13	-1.45	0.98
Brazil	3.20	4.33	1.16	4.20	0.36	-0.56	1.80	-0.34	-0.21	1.47
Chile	4.84	3.14	2.32	1.40	0.35	0.26	2.89	-0.27	0.50	2.02
Colombia	1.73	0.28	0.93	2.17	-0.19	-2.12	0.52	1.14	1.38	0.93
Costa Rica	3.01	2.43	1.81	1.05	1.13	-1.69	2.64	-1.33	-0.75	1.46
Mexico	1.38	2.45	0.52	3.51	-1.91	-1.43	1.03	-2.90	-1.10	0.42
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U.S.	3.85	0.74	3.00	2.24	-1.84	1.85	2.75	0.46	-0.10	1.23

- ▶ Labor productivity growth rates in all sectors in East Asia (except agriculture in Taiwan and finance in Korea) are higher than those of the U.S.
- ▶ A divergence is clearly observed for three big sectors in Latin America: agriculture (save Chile), manufacturing, and the wholesale sector.

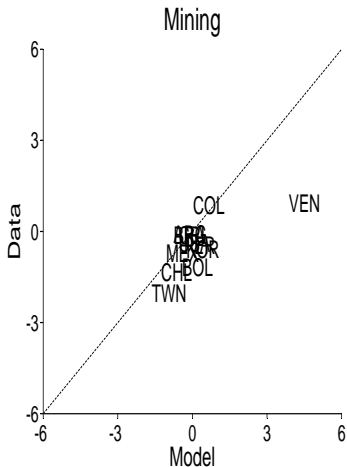
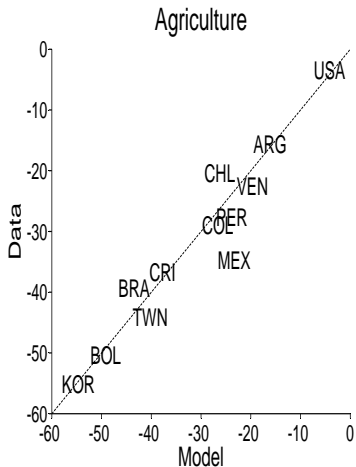
Structural change across countries

Let's have a first look

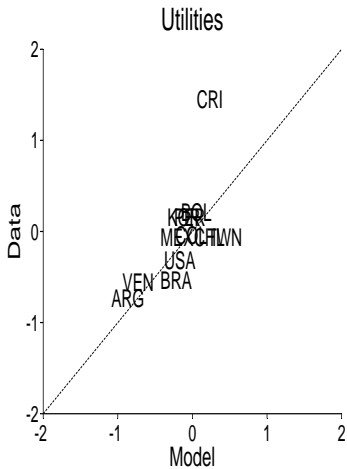
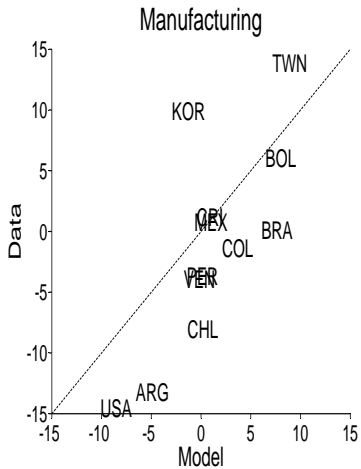
Percentage point change in the sectoral employment shares

- ▶ Next plots display the percentage point change in each sector's employment share between the first and last years in the model and in the data
- ▶ There is significant heterogeneity among countries in terms of the changes in the sectoral employment shares
- ▶ The model is particularly successful in replicating the declines in employment share in agriculture in almost all countries, i.e., almost all points are along the 45-degree line

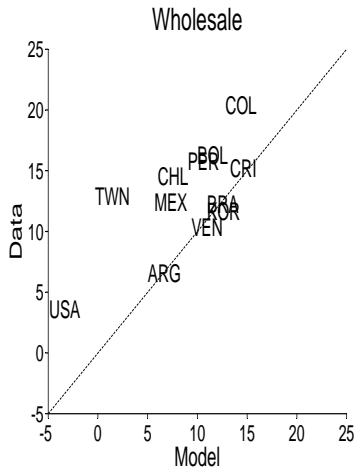
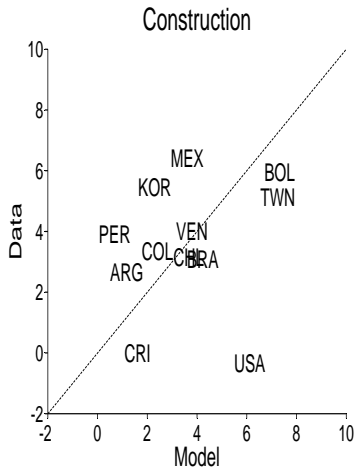
Percentage point change in the sectoral employment shares



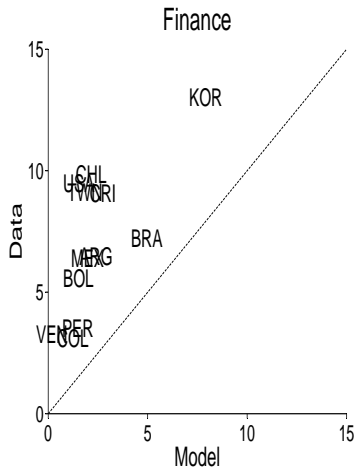
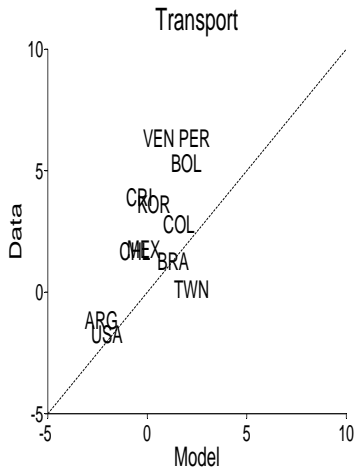
Percentage point change in the sectoral employment shares



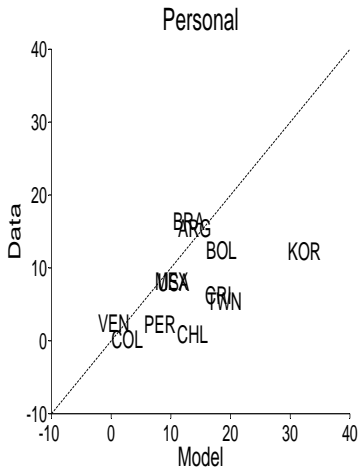
Percentage point change in the sectoral employment shares



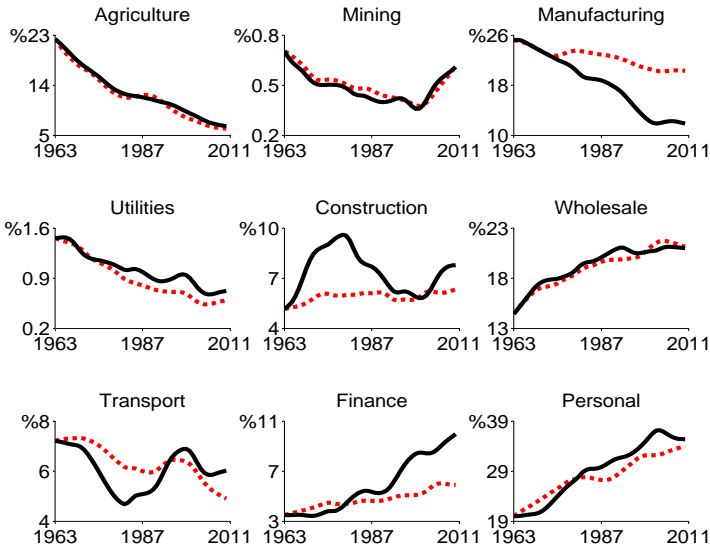
Percentage point change in the sectoral employment shares



Percentage point change in the sectoral employment shares

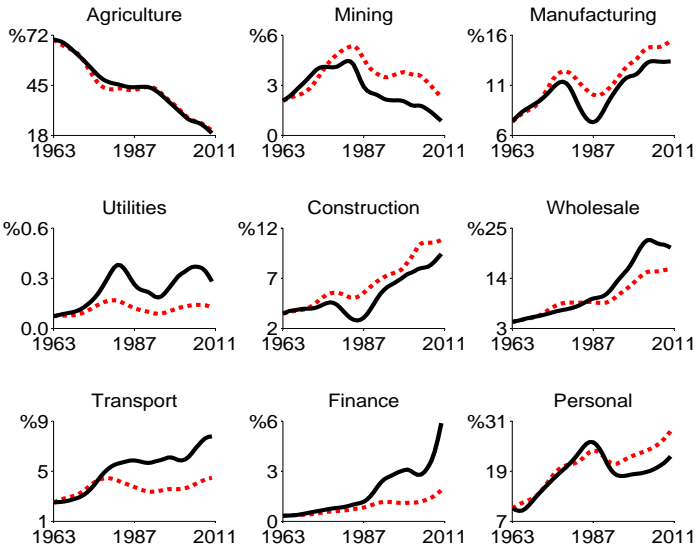


Sectoral employment shares, Argentina, 1963-2010



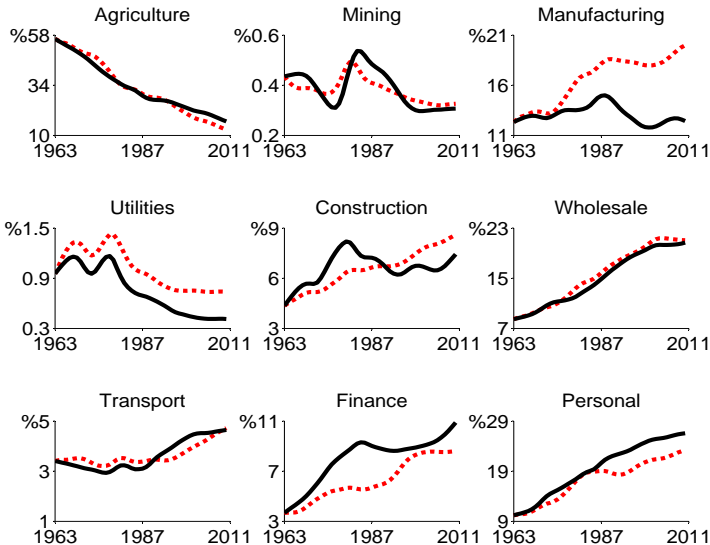
(Solid: Data; Dashed: Model)

Sectoral employment shares, Bolivia, 1963-2010



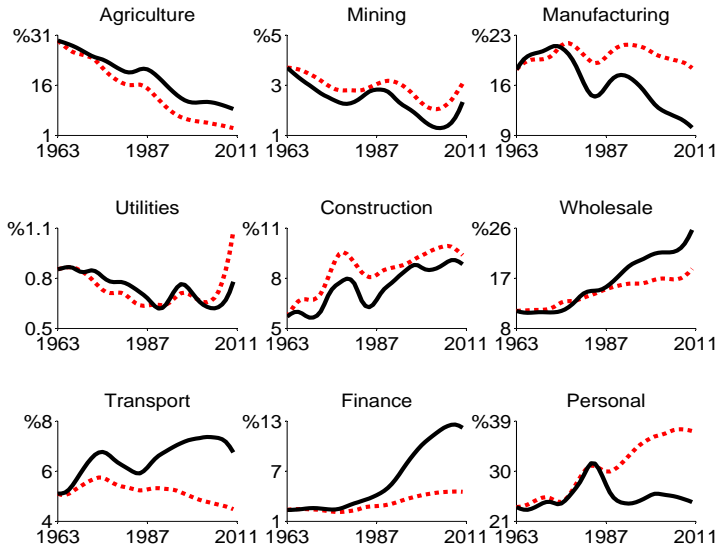
(Solid: Data; Dashed: Model)

Sectoral employment shares, Brazil, 1963-2010



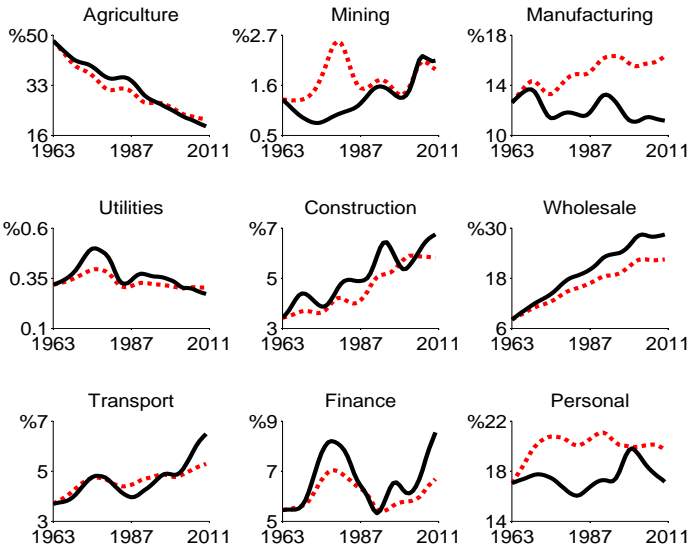
(Solid: Data; Dashed: Model)

Sectoral employment shares, Chile, 1963-2010



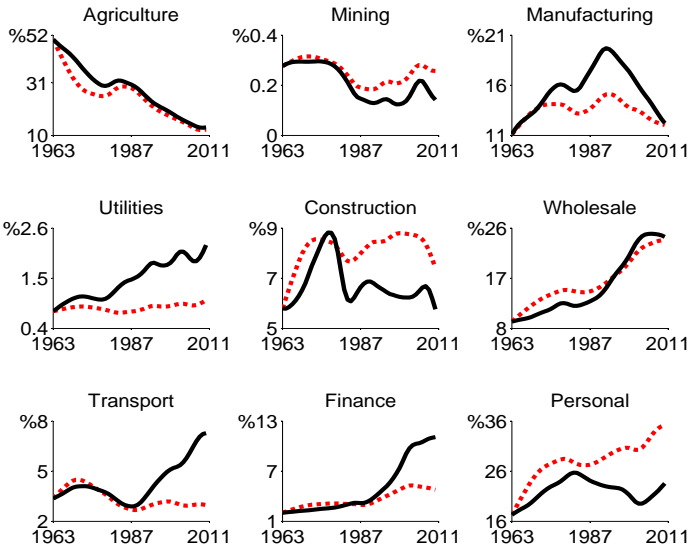
(Solid: Data; Dashed: Model)

Sectoral employment shares, Colombia, 1963-2010



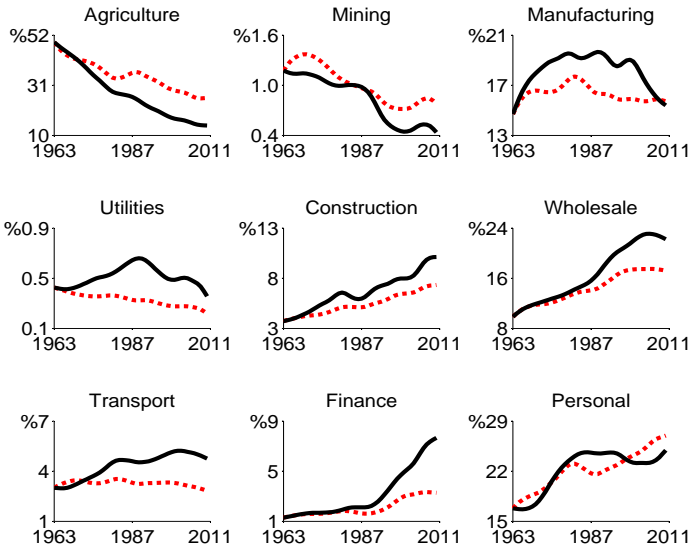
(Solid: Data; Dashed: Model)

Sectoral employment shares, Costa Rica, 1963-2010



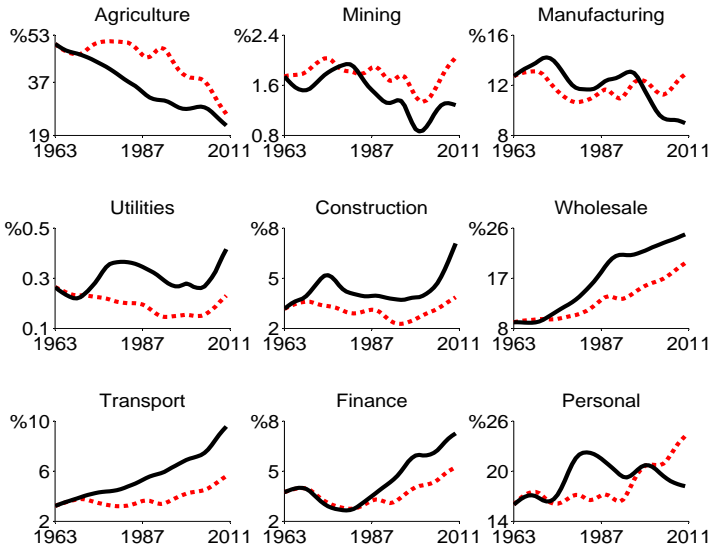
(Solid: Data; Dashed: Model)

Sectoral employment shares, Mexico, 1963-2010



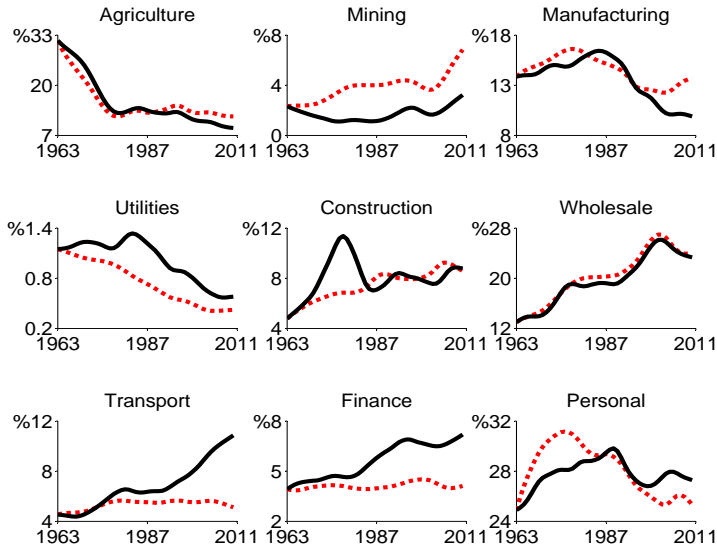
(Solid: Data; Dashed: Model)

Sectoral employment shares, Peru, 1963-2010



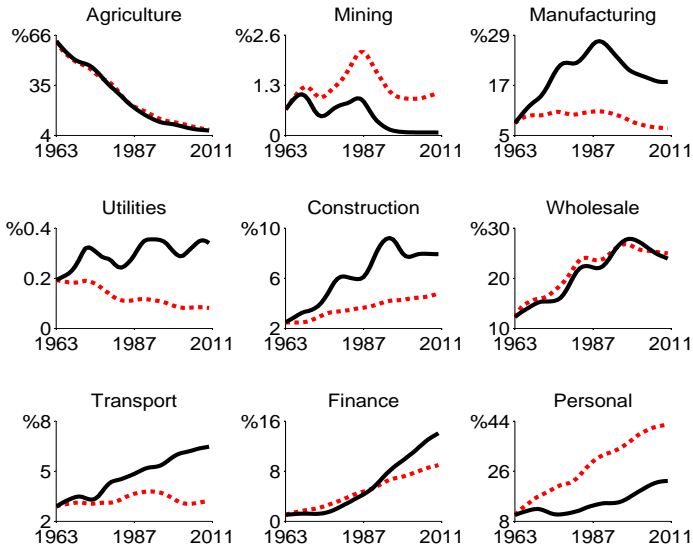
(Solid: Data; Dashed: Model)

Sectoral employment shares, Venezuela, 1963-2010



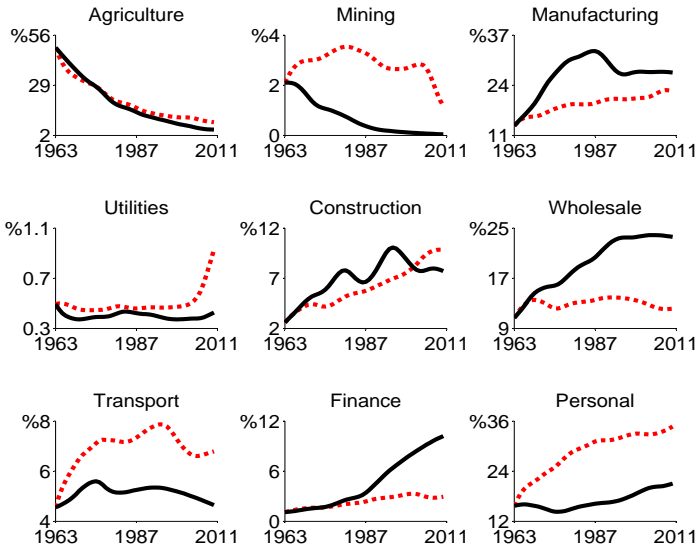
(Solid: Data; Dashed: Model)

Sectoral employment shares, Korea, 1963-2010



(Solid: Data; Dashed: Model)

Sectoral employment shares, Taiwan, 1963-2010



(Solid: Data; Dashed: Model)

Four criteria for the performance of the model in replicating the actual sectoral employment shares in each country

1. The root mean square error (RMSE) criterion,

$RMSE = \sqrt{\frac{\sum_{t=1}^T (z_t - \hat{z}_t)^2}{T}}$, where T is number of years, z is the data value and \hat{z} is the model's predicted value

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2. The Nash-Sutcliffe efficiency (NSE) criterion,

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3. The index of agreement, $d = 1 - \frac{\sum_{t=1}^T (z_t - \hat{z}_t)^2}{\sum_{t=1}^T (|\hat{z}_t - \mu_z| + |z_t - \mu_z|)^2}$.

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4. The fourth statistic is the correlation statistic ($CORR$).

Model performance criteria for employment shares

	Agriculture	Mining	Manufacturing	Utilities	Construction	Wholesale	Transport	Finance	Personal	Total
United States										
RMSE	0.004	0.003	0.034	0.001	0.030	0.044	0.002	0.050	0.031	0.199
mNSE	0.520	-0.616	0.297	0.470	-13.646	-2.183	0.648	-0.244	-0.806	
md	0.806	0.382	0.612	0.649	0.064	0.239	0.827	0.445	0.459	
CORR	0.976	0.432	0.997	0.879	0.501	-0.529	0.965	0.977	0.875	
Korea										
RMSE	0.014	0.008	0.114	0.002	0.030	0.013	0.018	0.021	0.150	0.371
mNSE	0.920	-1.367	-1.587	-3.356	-0.470	0.736	-0.470	0.595	-3.273	
md	0.959	0.297	0.279	0.187	0.405	0.864	0.405	0.747	0.211	
CORR	0.999	0.471	0.424	-0.553	0.941	0.980	0.350	0.977	0.903	
Taiwan										
RMSE	0.031	0.023	0.084	0.001	0.017	0.076	0.019	0.033	0.124	0.408
mNSE	0.751	-2.807	-1.028	-4.059	-0.002	-0.795	-7.439	0.172	-5.887	
md	0.860	0.208	0.330	0.165	0.563	0.356	0.119	0.543	0.130	
CORR	0.996	0.181	0.703	0.142	0.710	0.365	0.729	0.904	0.651	
Argentina										
RMSE	0.006	0.0003	0.052	0.001	0.019	0.005	0.008	0.019	0.024	0.136
mNSE	0.829	0.607	-0.065	0.347	-0.369	0.708	-0.023	0.256	0.564	
md	0.916	0.803	0.483	0.741	0.418	0.855	0.462	0.535	0.743	
CORR	0.995	0.957	0.958	0.979	0.493	0.970	0.490	0.941	0.968	
Bolivia										
RMSE	0.018	0.012	0.015	0.001	0.015	0.034	0.019	0.013	0.031	0.159
mNSE	0.874	-0.201	0.263	-0.464	0.256	0.558	-0.241	0.216	0.294	
md	0.935	0.443	0.664	0.406	0.650	0.736	0.420	0.561	0.698	
CORR	0.994	0.613	0.918	0.863	0.936	0.977	0.648	0.972	0.849	

	Agriculture	Mining	Manufacturing	Utilities	Construction	Wholesale	Transport	Finance	Personal	Total
Brazil										
RMSE	0.024	0.0005	0.043	0.003	0.010	0.008	0.003	0.020	0.028	0.139
mNSE	0.807	0.417	-4.039	-0.012	-0.356	0.835	0.492	-0.137	0.520	
md	0.911	0.620	0.178	0.500	0.436	0.920	0.676	0.510	0.725	
CORR	0.992	0.821	0.095	0.964	0.504	0.995	0.882	0.823	0.978	
Chile										
RMSE	0.047	0.006	0.049	0.001	0.011	0.031	0.016	0.041	0.070	0.271
mNSE	0.254	-0.058	-0.423	0.239	0.007	0.452	-1.481	0.178	-2.274	
md	0.691	0.521	0.378	0.641	0.582	0.644	0.287	0.549	0.296	
CORR	0.992	0.961	0.342	0.613	0.924	0.975	-0.354	0.992	0.206	
Colombia										
RMSE	0.024	0.007	0.032	0.0005	0.006	0.039	0.004	0.008	0.028	0.148
mNSE	0.720	-0.310	-2.978	0.213	0.324	0.395	0.472	0.279	-2.675	
md	0.849	0.416	0.201	0.573	0.681	0.668	0.655	0.598	0.219	
CORR	0.975	0.159	-0.220	0.965	0.903	0.999	0.884	0.925	-0.056	
Costa Rica										
RMSE	0.042	0.001	0.026	0.007	0.016	0.018	0.017	0.026	0.070	0.222
mNSE	0.627	0.294	-0.123	-0.620	-1.270	0.664	-0.150	0.399	-2.258	
md	0.799	0.612	0.469	0.382	0.314	0.800	0.432	0.601	0.282	
CORR	0.974	0.921	0.881	0.648	0.404	0.983	-0.151	0.954	0.413	
Mexico										
RMSE	0.089	0.002	0.021	0.002	0.014	0.031	0.013	0.017	0.018	0.207
mNSE	0.136	0.307	-0.643	-1.876	0.149	0.437	-0.752	0.365	0.379	
md	0.542	0.630	0.373	0.258	0.563	0.663	0.332	0.617	0.665	
CORR	0.973	0.929	0.679	-0.067	0.987	0.991	-0.214	0.978	0.799	
Peru										
RMSE	0.102	0.004	0.016	0.001	0.014	0.048	0.021	0.011	0.030	0.247
mNSE	-0.197	-0.238	-0.068	-1.466	-1.080	0.226	-0.255	0.330	-0.433	
md	0.492	0.448	0.324	0.275	0.325	0.578	0.444	0.609	0.414	
CORR	0.745	0.741	0.221	-0.035	0.560	0.951	0.875	0.883	0.056	
Venezuela										
RMSE	0.021	0.023	0.015	0.003	0.017	0.008	0.022	0.018	0.018	0.144
mNSE	0.657	-3.943	0.380	-0.207	-0.016	0.784	-0.043	-0.524	-0.691	
md	0.804	0.168	0.645	0.481	0.471	0.895	0.475	0.396	0.464	
CORR	0.964	0.484	0.829	0.850	0.314	0.994	0.556	0.579	0.526	

Strategy for Counterfactual Experiments

- ▶ Which sector(s) is (are) responsible for the aggregate productivity differences between Latin America and East Asia?
- ▶ Aggregate labor productivity is given by a weighted average of the productivity growth of the sectors with the weights being the corresponding employment shares
- ▶ I set the growth rate of labor productivity in one sector to the growth rate in that sector in Korea/Taiwan, leaving the other sectoral growth rates as in each Latin American country
- ▶ For completeness, all sectoral growth rates are set to the corresponding rates in Korea/Taiwan
- ▶ The strategy is having full disaggregation (changing productivity growth rates sector by sector) and full counterfactual (changing all productivity paths at once)

Average annual growth of aggregate labor productivity (%), 1963-2010

Average annual growth of aggregate labor productivity (%), 1963-2010

	(a): Using productivity of Korea													
	Data	B	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12
Argentina	0.99	0.95	1.03	0.97	2.01	0.99	1.11	1.62	1.12	0.79	1.24	3.21	2.63	1.52
Bolivia	0.98	0.30	0.51	0.31	1.66	0.51	0.53	1.18	0.55	0.46	0.67	4.26	2.44	1.84
Brazil	1.47	1.46	1.59	1.46	2.79	1.50	1.63	2.20	1.71	1.27	1.61	3.98	3.49	1.99
Chile	2.02	1.55	1.55	1.57	2.65	1.62	1.73	2.16	1.74	1.36	1.51	3.37	3.18	1.75
Colombia	0.93	1.04	1.39	1.08	2.46	1.14	1.23	2.12	1.37	0.71	0.77	3.69	3.47	1.44
Costa Rica	1.46	1.04	1.18	1.07	2.32	1.11	1.16	1.99	1.26	0.95	1.35	3.98	3.16	1.83
Mexico	0.42	-0.04	0.41	-0.02	1.44	0.05	0.25	0.86	0.31	-0.001	0.36	3.95	2.24	1.58
Peru	0.39	0.39	0.85	0.43	1.81	0.52	0.55	1.41	0.83	0.21	0.63	3.95	2.71	1.68
Venezuela	0.30	0.12	0.29	0.27	1.79	0.16	0.41	1.17	0.51	-0.11	0.12	3.55	2.68	0.98

Average annual growth of aggregate labor productivity (%), 1963-2010

(a): Using productivity of Korea

	Data	B	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12
Argentina	0.99	0.95	1.03	0.97	2.01	0.99	1.11	1.62	1.12	0.79	1.24	3.21	2.63	1.52
Bolivia	0.98	0.30	0.51	0.31	1.66	0.51	0.53	1.18	0.55	0.46	0.67	4.26	2.44	1.84
Brazil	1.47	1.46	1.59	1.46	2.79	1.50	1.63	2.20	1.71	1.27	1.61	3.98	3.49	1.99
Chile	2.02	1.55	1.55	1.57	2.65	1.62	1.73	2.16	1.74	1.36	1.51	3.37	3.18	1.75
Colombia	0.93	1.04	1.39	1.08	2.46	1.14	1.23	2.12	1.37	0.71	0.77	3.69	3.47	1.44
Costa Rica	1.46	1.04	1.18	1.07	2.32	1.11	1.16	1.99	1.26	0.95	1.35	3.98	3.16	1.83
Mexico	0.42	-0.04	0.41	-0.02	1.44	0.05	0.25	0.86	0.31	-0.001	0.36	3.95	2.24	1.58
Peru	0.39	0.39	0.85	0.43	1.81	0.52	0.55	1.41	0.83	0.21	0.63	3.95	2.71	1.68
Venezuela	0.30	0.12	0.29	0.27	1.79	0.16	0.41	1.17	0.51	-0.11	0.12	3.55	2.68	0.98

(b): Using productivity of Taiwan

	Data	B	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12
Argentina	0.99	0.95	1.00	1.05	1.40	0.95	0.97	2.22	1.06	1.23	2.07	4.29	2.63	2.56
Bolivia	0.98	0.30	0.44	0.34	1.09	0.33	0.43	1.75	0.50	1.27	1.29	5.31	2.45	2.85
Brazil	1.47	1.46	1.51	1.53	2.16	1.46	1.50	2.80	1.64	1.68	2.41	5.03	3.45	2.95
Chile	2.02	1.55	1.51	1.62	2.02	1.57	1.60	2.77	1.68	1.83	2.34	4.47	3.18	2.81
Colombia	0.93	1.04	1.33	1.12	1.81	1.05	1.10	2.76	1.30	1.14	1.54	4.91	3.45	2.36
Costa Rica	1.46	1.04	1.11	1.18	1.64	1.06	1.04	2.58	1.19	1.39	2.13	4.94	3.08	2.77
Mexico	0.42	-0.04	0.35	0.02	0.79	-0.03	0.12	1.48	0.23	0.60	1.13	5.02	2.21	2.55
Peru	0.39	0.39	0.79	0.47	1.13	0.41	0.42	2.04	0.76	0.60	1.40	5.07	2.67	2.54
Venezuela	0.30	0.12	0.25	0.31	1.06	0.11	0.28	1.79	0.43	0.32	0.90	4.64	2.55	1.93

On the importance of the level of disaggregation

I run the model economy with three-sectors following Duarte and Restuccia (2010) and compare the findings of the three-sector model with those from the nine-sector model

I study a shift-share analysis to decompose aggregate labor productivity growth into different components and show that results are sensitive to the level of disaggregation by performing the same decomposition at two levels of disaggregation.

Three-Sector Model

Table: Productivity levels in 1963

Country	Agriculture	Industry	Services
Korea	0.0804	0.2895	0.2397
Taiwan	0.1017	0.1676	0.2502
Argentina	0.2245	0.3111	0.6906
Bolivia	0.0719	0.1739	0.4161
Brazil	0.0892	0.2239	0.4731
Chile	0.1704	0.3922	0.7721
Colombia	0.1042	0.4087	0.4811
Costa Rica	0.0999	0.4480	0.6260
Mexico	0.1022	0.5221	0.9457
Peru	0.1001	0.4817	0.6611
Venezuela	0.1587	1.3750	1.4032
US	1.0000	1.0000	1.0000

Table: Productivity growth (%), 1963-2010

Country	Agriculture	Industry	Services
Korea	4.57	5.70	1.04
Taiwan	3.66	3.47	3.99
Argentina	2.77	2.01	0.12
Bolivia	2.64	-0.47	-1.46
Brazil	3.20	1.23	-0.10
Chile	4.84	1.99	0.89
Colombia	1.73	0.75	0.07
Costa Rica	3.01	1.60	-0.73
Mexico	1.38	-0.05	-0.92
Peru	1.38	0.60	-0.98
Venezuela	2.09	-2.21	-0.57
US	3.85	1.39	0.87

Average annual growth of aggregate labor productivity (%), 1963-2010

	Data	B	With Korean data				With Taiwanese data			
			E1	E2	E3	E4	E1	E2	E3	E4
Argentina	1.03	1.04	1.12	2.13	1.63	2.82	1.09	1.47	3.50	4.06
Bolivia	0.68	0.64	0.87	2.25	1.98	4.13	0.79	1.64	3.62	5.28
Brazil	1.51	1.50	1.63	2.79	2.20	3.67	1.55	2.14	4.00	4.86
Chile	1.87	1.79	1.78	2.92	1.89	3.01	1.74	2.24	3.78	4.25
Colombia	1.03	1.01	1.36	2.46	1.61	3.47	1.30	1.79	3.44	4.69
Costa Rica	1.05	1.06	1.20	2.29	2.20	3.60	1.13	1.61	4.10	4.82
Mexico	0.34	0.14	0.60	1.84	1.35	3.64	0.53	1.16	3.13	4.86
Peru	-1.73	0.31	0.76	1.79	1.55	3.61	0.70	1.12	3.38	4.83
Venezuela	-0.28	-0.55	-0.37	1.91	0.44	3.17	-0.42	1.20	2.18	4.43

D: Data; B: Benchmark; E1: Experiment for agriculture; E2: Experiment for industry; E3: Experiment for services; E4: Experiment for all sectors.

Shift-Share Analysis of Productivity Growth

$$\begin{aligned} \frac{Y_T}{N_T} - \frac{Y_0}{N_0} = & \underbrace{\sum_{j=1}^J \alpha_{j0} \left(\frac{Y_{jT}}{N_{jT}} - \frac{Y_{j0}}{N_{j0}} \right)}_{\text{Intra-Sectoral Effect}} \\ & + \\ & \underbrace{\sum_{j=1}^J (\alpha_{jT} - \alpha_{j0}) \frac{Y_{j0}}{N_{j0}}}_{\text{Static Sectoral Effect}} + \underbrace{\sum_{j=1}^J (\alpha_{jT} - \alpha_{j0}) \left(\frac{Y_{jT}}{N_{jT}} - \frac{Y_{j0}}{N_{j0}} \right)}_{\text{Dynamic Sectoral Effect}} \\ & \underbrace{\hspace{10em}}_{\text{Structural Change Effect}} \end{aligned}$$

$\frac{Y_T}{N_T} - \frac{Y_0}{N_0}$ is the labor productivity growth between years 0 and T , j is the industry, and α_{jT} is the share of employment in industry j in year T

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Relative contribution of different sources (%), 1963-2010

Country	Overall productivity change	9-sector disaggregation			3-sector disaggregation		
		Intra	Static	Dynamic	Intra	Static	Dynamic
Korea	4.55	3.11	2.11	-0.67	2.98	1.00	0.57
Taiwan	7.46	9.44	0.44	-2.43	4.90	0.41	2.15
Argentina	0.63	1.21	0.09	-0.67	1.00	0.08	-0.44
Bolivia	0.40	0.53	1.64	-1.78	0.15	1.17	-0.93
Brazil	1.07	0.71	0.85	-0.49	0.53	0.81	-0.27
Chile	1.29	1.35	0.44	-0.50	1.30	0.20	-0.21
Colombia	0.61	0.44	0.57	-0.40	0.35	0.34	-0.08
Costa Rica	0.57	0.32	0.77	-0.53	0.33	0.63	-0.40
Mexico	0.22	0.06	0.97	-0.81	-0.12	0.58	-0.24
Peru	0.21	0.04	0.53	-0.36	-0.02	0.47	-0.24
Venezuela	-0.49	-0.53	0.38	-0.34	-0.51	0.08	-0.06
United States	0.61	0.62	0.22	-0.23	0.67	0.03	-0.09

In most of the cases, the three-sector disaggregation gives a somewhat bigger weight to the structural-change effect (sum of the static and dynamic terms), whereas the nine-sector disaggregation leaves more of the explanation to intra-sectoral effect.

DISCUSSION

If the paths of productivity differ significantly across countries, then it is important to ask what factors are responsible for these differences?

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Is it policies that influence the diffusion of technology, or perhaps policies that generate misallocation of inputs across producers?

Economy-Wide Distortions

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- ▶ Different studies emphasize different type of distortions regarding the agricultural and non-agricultural policies in Latin America that hinder productivity growth, such as restrictive labor laws concerning retaining policies, high taxation, legal requirements and completion times for business processes, price, product, and service regulations, and government ownership.
- ▶ Barriers to formal market entry, regulation and barriers to competition, trade barriers and employment protection are important to understand the productivity differences between Latin America and the U.S.

Manufacturing and wholesale

- ▶ “In the milk industry, for example, controls on raw milk prices resulted in an uncompetitive sector full of small, informal, and unproductive operators. The scale of inefficiency is such that one processing plant in the north-east of Brazil relies for its supplies on producers whose output is less than two liters a day.” (Baily et al., 1998, p. 86)

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- ▶ Lagakos (2016) finds that value added per worker is much higher in the modern segment than in the traditional segment of the retail sector in Argentina, Brazil, and Mexico. However, small retailers still endure in Latin America thanks to different factors, such as informality, informal credit (the operator writes the name of the debtor in a small notebook), virtual wallet (when the customer is short of small amounts of cash at the register and is allowed to pay the next time), etc. (see D’Andrea et al., 2006).

CONCLUDING REMARKS

- ▶ Sectors do not show the same patterns in either trend or dispersion over time, and countries do not perform similarly across sectors

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- ▶ Productivity growth in agriculture in Latin America has not been high enough to release labor from agriculture as we observe in East Asian countries