Productivity Growth and Labor Reallocation: Latin America versus East Asia

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Abstract

The question addressed in this paper is: Can differences in sectoral productivity growth rates account for the different structural transformation experiences of Latin America and East Asia? Over the period 1974 to 2003, Latin American countries exhibit much slower de-agriculturalization than East Asian countries, while the manufacturing employment share has been almost stagnant in Latin America but exhibits a hump shaped pattern among East Asian countries. A multi-sector general equilibrium model, treating sectoral productivity growth rates as exogenous, accounts well for the differing sectoral reallocations of labor in Latin America and East Asia over the sample period. Several counterfactual experiments are conducted. Had Bolivia experienced the same productivity growth in agriculture that Korea has, then the agricultural employment share in Bolivia would have been 12.0 percent in 2003 rather than 27.4 percent. Similarly, if Argentina had experienced the same productivity growth in the manufacturing sector as Korea, then the manufacturing employment share in Argentina would be 4.3 percent in 2003 instead of 11.5 percent. An exploration of policy and institutional factors which account for sectoral productivity differentials across Latin America and East Asia is presented.

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1 Introduction

The development experiences of East Asia (Hong Kong, Korea, Singapore, and Taiwan) and Latin America (Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Mexico, Peru, and Venezuela) sharply contrast over the last several decades. To see the relative performance of these two country groups I analyze how much progress they made after WWII in catching up with the United States. Figure 1 displays their per capita GDP (measured as 1990 International Geary-Khamis dollars) relative to the United States for the 1950-2008 period. Similarly, Figure 2 compares their path of development between 1960 and 2008, where my measure of development is GDP per person employed (measured as 1990 International Geary-Khamis dollars), which is what I mean when I say productivity.[1]

Figure 1 shows that East Asia in 1950 starts at a GDP per capita level that is about 10 percent of the United States. At that time Latin American GDP per capita was 27.6 percent of the United States. The remarkable catching up of the Asian Dragons is visible in Figure 1 where they reach to about 70 percent of the U.S. level by 2008.[2] Per capita incomes in East Asian countries grew so rapidly that they were thirteen to twenty-four times higher in 2008 than they had been in 1950. For example, the real per capita GDP in Taiwan grew by a factor of twenty-four from \$924 in 1950 to \$22,241 in 2008, all measured in 1990 US dollars. This increase in per capita GDP corresponds to a average annual growth rate of 5.6 percent. With its real GDP per capita of \$30,407 in 2008, Hong Kong is now one of the richest economies in the world.

Latin American countries, on the other hand, show relative stagnation, if not deterioration. Figure 2 displays that the productivity of Latin American countries increased from 33.6 percent of the U.S. level in 1960 to 38.9 percent in 1980. However, Latin America has experienced a relative deterioration from 1980 on as the productivity of the group shrunk to 26.6 percent of the U.S. level in 2008. Although Asian countries continued to grow at a steady pace during the 1980s, economic growth in Latin America declined.[3] Cole, Ohanian, Riascos, and Schmitz (2005) argue that Latin America is a "development outlier" since it is the only group of Western countries that have not gained significant ground on U.S. income levels in the last 50 years. The failure to attain higher levels of relative income represents what Restuccia (2008) calls the development problem of Latin America.

Among the fundamental facts is that economic development involves structural transformation (see, e.g, Kuznets 1973). In this transformation, a substantial and permanent shift

[1] The Conference Board, Total Economy Database, January 2009.

[2] See, e.g., Hsieh 2002, Vogel 1991, and Young 1995 on the East Asian growth experience.

[3] Many observers have called the decade of the 1980s the lost decade of development for Latin America. See, for example, Krueger (1993, p.1).

occurs in the composition of income, output, and employment away from agriculture and towards industry and services. Figure 3 shows the changes in the employment share of the six sectors in East Asia, Latin America, and the United States: agriculture, mining and quarrying, manufacturing, utilities, construction, and services.[4]

I observe a significant fall in the employment share of agriculture from 33.9 percent in 1974 to 17.7 percent in 2003 in Latin America. However, while share of employment in agriculture is proportionally decreasing and reaching very low levels in East Asia and the United States, the agricultural employment share is still comparatively very high in Latin America. This observation implies that the relatively low rate of transition from agriculture to non-agricultural activities as being one of the facts of the Latin American economic development. The share of services grew from 41.6 percent to 63.3 percent in Latin America as a group. It is evident that the decline in agriculture's share of employment has been mirrored in an increase in services share of employment, while manufacturing's share of employment has been nearly constant. The share of manufacturing in employment started to fall in the 1990s after remaining relatively stable in the 1980s in Latin America.

Why did Latin America not follow the East Asian structural transformation? Why do we observe higher employment share in agriculture in Latin America compared to the East Asian countries? Why did manufacturing employment share stay almost constant in Latin America? I develop a multi-sector general equilibrium model of structural transformation to provide quantitative answers for such questions. The model abstracts from issues of capital accumulation and international trade and it is effectively a sequence of static resource allocation problems to understand the role of the domestic sectoral productivity changes on the structural transformation of Latin America and East Asia. The reallocation of labor is solely due to the interaction of productivity increases with the type of preferences adopted in the model to focus attention on the following question: Can differences in sectoral productivity growth rates account for the sectoral reallocation of labor in development outliers (Latin America) and growth miracles (East Asia)?

Previous sectoral studies provide a breakdown of convergence and catch-up arguing that there are large and systematic differences in sectoral productivity levels and growth rates across countries and these sectoral differences are important for understanding movements in aggregate income and productivity. For example, Bernard and Jones (1996) study the role of sectors in aggregate productivity movements in 14 OECD countries between 1970 and 1987.[5] They find convergence in services and report that convergence does not hold

[4]The source for all the sectoral data I use in this paper is the Groningen Growth and Development Centre (GGDC) 10-sector database. See Appendix for details.

[5]Bernard and Jones (1996) employ data on total factor productivity for (a maximum of) fourteen OECD countries and six sectors over the period 1970 to 1987. The fourteen countries are Australia, Belgium,

for the manufacturing sector. Services is by far the most significant sector accounting for one-third of aggregate convergence to the United States during the period. In a recent paper, Duarte and Restuccia (2010), hereafter DR, find that differences in labor productivity levels between rich and poor countries are larger in agriculture and services; over time, productivity gaps have been substantially reduced in agriculture and industry but not nearly as much in services.

Comparisons of productivity across countries at the sector level are not easy to make. The crucial point for this comparison is the derivation of sectoral conversion factors to convert output and/or value added from one national currency unit to another since exchange rates are poor indicators of relative price levels between sectors, i.e., prices of goods and services vary greatly among countries, and the commercial market exchange rates used to compare sectoral output do not reliably indicate relative differences in prices. What are needed are purchasing power parities (PPPs), that is, the number of foreign currency units required to buy goods and services equivalent to what can be purchased with one unit of U.S. or another base currency, must be used for meaningful international comparisons of the relative purchasing power of sectoral output produced.

DR study a three-sector model of the structural transformation that is calibrated to the growth experience of the United States, where the United States has been the world productivity leader and sets the world productivity standards. I measure sectoral labor productivity differences across countries at a point in time following the approach of DR because of the lack of comparable PPP-adjusted sectoral output data across a large set of countries. The sectoral productivity levels in 1974, together with data on growth in sectoral labor productivity, imply time paths of sectoral labor productivity for each country.

Specifically, I calibrate and run the model for the United Stated for the years between 1974 and 2003. I choose this sample period since it covers information for all the countries being studied in this paper. I use the calibrated model economy to measure sectoral labor productivity differences across countries in 1974. Then, I run the model economy for each of the Latin American and East Asian countries using country-specific sectoral productivity series between 1974 and 2003. I compare the model predictions with the actual data regarding the allocation of employment to the individual sectors in each country.

Then, I perform two counterfactual experiments to explore why Latin American sectoral employment shares in agriculture and manufacturing did not follow East Asian structural transformation. These experiments suggest that productivity growth in agriculture in Latin

Canada, Denmark, Finland, France, Italy, Japan, Netherlands, Norway, Sweden, United Kingdom, United States, and West Germany. The six sectors are agriculture, mining, manufacturing, utilities (electricity/gas/water), construction, and services.

America has not been high enough to release labor from agriculture as we observe in East Asian countries. Similarly, productivity growth in manufacturing in Latin America has not been high enough to avoid the stagnation of the manufacturing sector.

The paper proceeds as follows. Section 2 develops a six-sector closed economy model, characterizes the competitive equilibrium, and derives equilibrium conditions for sectoral employment shares. Section 3 presents the data, calibration procedure, and all the numerical experiments. Section 4 highlights a variety of extensions of the model and paths for further research. Several aspects of the model can be improved, and several additional questions can be profitably addressed in future work, such as understanding the role of labor market distortions and openness.

2 A Six-Sector Model

There has been a growing interest in calibrated multi-sector general equilibrium models to understand the sources of the structural transformation in factors of production and to quantify the impact of the shifts of resources across the sectors on aggregate growth and productivity. These studies utilize two or three sector models and most of these studies develop two types of models to generate the structural transformation observed in the data.

The first type of models views the structural transformation as a supply-side phenomenon based on the sectoral differences in productivity growth (see, e.g, Baumol 1967, and Ngai and Pissarides 2007). The second type of models views the structural transformation as a demand-side phenomenon based on the sectoral differences in income elasticities of demand. For example, Kongsamut, Rebelo, and Xie (2001) has a three-sector model where consumers have preferences over an agricultural good (a necessity), a manufactured good (with a unit income elasticity), and services (a luxury). These preferences imply that the income elasticity of demand for agricultural good is less than one while that for services is greater than one. There are also models combining the two types of models (Rogerson 2008).[6]

I develop a six-sector general equilibrium model, where the sectors are given by agriculture, mining and quarrying, manufacturing, utilities, construction, and services. My sectoral classification is consistent with the study of Bernard and Jones (1996). Instead of studying a two-sector (agriculture and non-agriculture) or a three-sector (agriculture, industry, and services) model, studying a six-sector model allows for possible sectoral heterogeneity in industrial activities, introducing mining and quarrying, construction, and utilities into the economic environment of the model. However, I do not allow for heterogeneity in the service

[6] Foellmi and Zweimüller (2008) provide a discussion of these two types of models. See also Buera and Kaboski (2009), and Matsuyama (2009) and the references therein for recent studies.

sector.[7]

In the model economy the structural transformation of employment result both from sectoral differences in productivity growth and from non-homothetic preferences. Specifically, in each sector, productivity grows exogenously and I impose a non-homotheticity in preferences affecting the demand for the agricultural good in the model economy introducing a subsistence level of consumption in agriculture.

2.1 The Household

The economy is populated by an infinitely-lived representative household of constant size over time. The population size is normalized to one, without loss of generality. I assume that the household is endowed with one unit of productive time that it supplies inelastically to the market and consumption is the only determinant of the instantaneous utility function, which is given by:

$$U(\bar{A}, C) = \bar{A} + \log(C) \tag{1}$$

The instantaneous utility is defined over the agricultural good ($\bar{A}$) and the composite consumption good (C), which is derived from the industry and services:

$$C = (\gamma_1^{1/\eta} C_1^{(\eta-1)/\eta} + \gamma_2^{1/\eta} C_2^{(\eta-1)/\eta} + ... + \gamma_5^{1/\eta} C_5^{(\eta-1)/\eta})^{\eta/(\eta-1)}, \tag{2}$$

where $C_1, ..., C_5$ are the consumption of the non-agricultural goods. The weights $\gamma_1, ..., \gamma_5$ influence how non-agricultural consumption expenditure is allocated among five sectors. The parameter η is the (constant) elasticity of substitution among the non-agricultural goods and it underlies the magnitudes of price responses to quantity adjustments. Lower substitution elasticity implies that sharper price changes are needed to accommodate a given change in quantities consumed.[8]

[7] In the Online Appendix, I present a model with nine-sectors without doing any aggregation at the sector level for the services. Moreover, I calibrate the model for each country using the country-specific information for each country's sample period. The results are available at `http://www-scf.usc.edu/~ungor/Ungor_LAEA_online_appendix.pdf`

[8] The utility function belongs to the following general type of utility function:

$$U(A, C) = \begin{cases} \bar{A}, & \text{if } A < \bar{A}, \\ \log(C) + \bar{A}, & \text{if } A \geq \bar{A}. \end{cases}$$

This specification of preferences implies that the economy specializes in agriculture until the subsistence level $\bar{A}$ is reached. Moreover, the economy will never produce more agricultural good than $\bar{A}$. Once $\bar{A}$ is reached, the representative household will supply labor to the other five sectors. The idea is that consumers care mainly about food up to a satiation point; beyond that point their attention focuses exclusively on non-agricultural goods. As Laitner (2000) and Stokey (2001) note, technological progress and such a specification of preferences eventually would cause structural change, with the economy endogenously shifting from a

At each date, and given prices, the household chooses consumption of each good to maximize his lifetime utility subject to the budget constraint,

$$p_A \bar{A} + p_1 C_1 + p_2 C_2 + ... + p_5 C_5 = \omega, \tag{3}$$

where p_j is the price of good-j output and ω is the wage-rate in the economy.

2.2 The Firms

At each date there are six goods produced. The production function for sector j is given by

$$Y_j = \theta_j N_j, \tag{4}$$

where Y_j is output of sector j, N_j is labor allocated to production, and θ_j is sector j's labor productivity. Since I abstract from capital and fixed factors in production, differences in labor productivity implicitly incorporates differences due to capital as well as due to the institutional differences across sectors. Firm j problem is given by

$$max \quad p_j Y_j - \omega N_j \qquad s.t. \qquad Y_j = \theta_j N_j, \qquad N_j > 0. \tag{5}$$

2.3 Competitive Equilibrium

Given a set of prices $\{p_A, p_1, p_2, ..., p_5, \omega\}$, a competitive equilibrium consists of consumption decisions that are the household's allocations $\{\bar{A}, C_1, C_2, ..., C_5\}$, and factor allocations for the firms, $\{N_A, N_1, N_2, ..., N_5\}$ such that given prices, the firm's allocations solve its profit maximization problem, the household's allocations solve the household's utility maximization problem, and all product and factor markets clear:

1. The demand of labor from firms must equal this exogenous supply at every date:

$$N_A + N_1 + N_2 + ... + N_5 = 1. \tag{6}$$

2. Since there is no international trade or capital accumulation the following conditions hold at each date implying that the market must clear for each goods and services produced:

$$\bar{A} = Y_A, \quad C_1 = Y_1, \quad ..., \quad C_5 = Y_5. \tag{7}$$

preponderance of agricultural production to marginalization of the same sector (see, also, Gollin, Parente, and Rogerson 2002, 2004, 2007).

The following two propositions characterize the sectoral employment shares at a certain date.

Proposition 1 *Employment share in agriculture is determined solely by the subsistence constraint and labor productivity in agriculture:*

$$N_A = \bar{A}/\theta_A. \tag{8}$$

Increases in the level of agricultural productivity push labor out of the agricultural sector. High agricultural productivity is a necessary condition for industrialization and economic development since poor countries have a much larger fraction of their employment in the agricultural sector than rich countries to be able to produce enough food to satisfy their subsistence requirements. This is consistent with the view in the literature that the agricultural revolution preceded the industrial revolution. For example, Nurkse (1961, p. 52) argues that the introduction of the turnip and other improvements in agriculture led the rise in agricultural productivity and then caused the expansion of the industrial sector.[9]

Proposition 2 *Employment share in a non-agricultural sector j is given by:*

$$N_j = \frac{\gamma_j \theta_j^{\eta-1}(1-\bar{A}/\theta_A)}{\gamma_1\theta_1^{\eta-1} + \gamma_2\theta_2^{\eta-1} + \gamma_3\theta_3^{\eta-1} + \gamma_4\theta_4^{\eta-1} + \gamma_5\theta_5^{\eta-1}}, \qquad j = 1, 2, ..., 5. \tag{9}$$

Productivity increases in sector j lead to flows of labor out of sector j, i.e., $\partial N_j/\partial\theta_j < 0$ as long as $\eta < 1$.

3 Quantitative Analysis

3.1 Calibration and Predictions of the Model for the United States

The model economy is calibrated to the year 1974 for the United States. In particular, the model is parameterized so that it matches sectoral labor allocations in 1974. All time series are de-trended using the Hodrick-Prescott filter with a smoothing parameter of 6.25 before any ratios are computed.[10] I normalize productivity levels across sectors to one for the initial

[9]See Johnston and Mellor (1961) and Johnston (1970) and the references therein.

[10]I am interested in long-term trends, not in yearly fluctuations. I follow Ravn and Uhlig (2002) for choosing 6.25 as a smoothing parameter. The features that I emphasize also hold for other smoothing parameter values for annual data such as 100 and 400. See, also, Jaimovich and Siu (2009) for a very similar discussion of the Hodrick-Prescott filter for annual data.

year. I use data on sectoral labor productivity growth to obtain the time paths of sectoral productivity for the sample period.[11]

I calibrate subsistence in agriculture so that the equilibrium of the model matches the share of employment in agriculture for the initial year. Specifically,

$$\bar{A} = N_{A,1974}. \tag{10}$$

Next, I calibrate γ_j to match the share of employment in sector j for the initial year. Specifically, the weights $\gamma_1, ..., \gamma_5$ are calibrated as follows:

$$\gamma_j = N_{j,1974}/(1 - \bar{A}), \qquad j = 1, ..., 5. \tag{11}$$

Finally, I choose η to match (roughly) the share of employment in manufacturing over time.[12] Calibrated parameters for the United States are reported in Table 1.

Figure 4 shows the model predicted sectoral employment shares and compare with the actual data for the United States between 1974 and 2003. Notice that the model predicted agricultural employment share is independent of η. By construction, the model matches exactly the sectoral shares of employment for the initial year used in the calibration.

The model captures the sectoral trends in each sector's employment share throughout the sample period. For example, during the 1974-2003 period, the model accounts for 85.3 percent of the agricultural employment share on average in the United States. The model predicts a decline in the agricultural employment share in the United States of 2.0 percentage points between 1974 and 2003. The actual fall is 1.5 percentage points. The model almost mimics the 9.9 percentage point decrease in manufacturing from 1974 to 2003. During the sample period, the model accounts for 97.3 percent of the service sector employment share on average implying an increase in the share of labor in services from 68.9 percent in 1974 to 76.1 percent in 2003, while the data increases to 80.4 percent in 2003. The model slightly overpredicts the employment shares in mining and quarrying, and construction.

3.2 Relative Sectoral Productivity Levels and Time Paths

The calibrated benchmark economy imposes discipline on the parameters. Given the value of the parameters, I follow DR and use the model to solve the levels of labor productivity in each sector relative to those in the United States for the year 1974. Specifically, for each

[11] The average annual growth in labor productivity between 1974 and 2003 has been highest in agriculture (3.59 percent), second in manufacturing (3.47 percent), third in utilities (2.06 percent), fourth in services (0.86 percent), fifth in mining and quarrying (0.82 percent), and lowest in construction (-0.79 percent).

[12] Ngai and Pissarides (2008) argue that the elasticity of substitution lies between 0.1 and 0.3.

country, I choose the five labor productivity levels in 1974 to match the sectoral employment shares in each country for the year 1974 and the aggregate labor productivity relative to that of the United States in 1974.[13] Table 2 shows the calibrated levels of labor productivity in each country for the year 1974.

Table 2 shows that the United States is the productivity leader in 1974 compared to the other countries in each sector except a few cases. For example, in agriculture, Hong Kong was the only close competitor at more than 99 percent of the U.S. level. Singapore was in the second place with more than 85 percent of the U.S. productivity. These results are not surprising since the magnitude of the agricultural employment share in total employment in Hong Kong and Singapore have been very similar to that of the United States. Argentina came in third place with about 20 percent of the U.S. level. Agricultural productivity in other countries had less than 20 percent of the that in the United States. Bolivia had the worst performance in 1974 at 5.8 percent of the U.S. level, and performance of Korea was not much better.[14]

The levels of sectoral labor productivity implied by the model for the year 1974 together with data on growth rates of sectoral value added per worker in local currency units imply time paths for sectoral labor productivity in each country between 1974 and 2003. Table 3 reports the average annual growth labor productivity growth rates by country and sector for the period 1974 to 2003. I observe very high average annual growth rates for the East Asian economies. For example, while in 1974 relative sectoral productivity in Korea were all below US level, Korea and Taiwan experienced higher annualized rates of labor productivity growth in all of the six sectors. Hong Kong and Singapore show similar higher average annual growth rate in labor productivity except agriculture in Hong Kong and mining and quarrying in Singapore.

3.3 Patterns of Structural Transformation Across Countries

Figure 5 - 9 show the model predicted sectoral employment shares and compare with the actual data for each country. Given the calibrated value for subsistence level of consumption in agriculture, labor productivity growth in this sector implies a share of employment in

[13]I use The Conference Board, Total Economy Database to get the aggregate labor productivity (for each country) relative to that of the United States in 1974. I use the series of labour productivity per person engaged in 1990 US$ (converted at Geary Khamis PPPs).

[14]These findings, for Latin America, are consistent with the (internationally comparable) data for the year 1985 constructed by Restuccia, Yang, and Zhu (2008). For example, GDP per worker in agriculture relative to the United States was very low except in Argentina, and Bolivia had the lowest GDP per worker in agriculture relative to the United States in 1985 among nine Latin American countries, which is similar to my calibrated productivity levels in agriculture for 1974. Restuccia, Yang, and Zhu dataset is available at `http://www.economics.utoronto.ca/diegor/research/RYZ_data.xls`

agriculture in the model that turns out to be remarkably close to the time series data for each of the East Asian and the Latin American countries except a few cases. There are some periods in which the model economy cannot explain the fall in the agricultural employment share. For example, the model fails to capture the declines in agricultural employment share for Hong Kong in the post-1991 period. Agricultural labor productivity grew at an annual average rate of 4.0 percent during 1974-1991 and then at a rate of -3.5 percent during 1992-2003 in Hong Kong. Since the agricultural productivity growth is the sole reason of the de-agriculturalization (the fall in the share of agricultural employment) in the model, the model keeps silent to explain the movement of labor out of agriculture in these countries for the periods we observe negative growth rates in the agricultural productivity.

There is a close match between the model and the data in non-agricultural sectors (given the simplicity of the model). For example, the model almost mimics the 3 percentage point decrease in manufacturing employment from 1974 to 2003 for Bolivia. The model implies an increase in the share of employment in services from 40.0 percent in 1974 to 55.8 percent in 2003 for Costa Rica, while the data increases to 59.0 percent in 2003. Data and model predictions for all countries and sectors can be compared similarly.

3.4 Counterfactual Experiments

I design two counterfactual experiments to understand the role of the sectoral productivity differences in Latin America and East Asia for the observed sectoral employment shares. Specifically, I ask the following two questions to guide numerical experiments: (1) What would have happened to the agricultural employment share in Latin America if the Latin American countries had had the same productivity in agriculture as Korea? (2) What would have happened to the manufacturing employment share in Latin America if the Latin American countries had had productivity in manufacturing equal to that of Korea?[15] I choose Korea to represent the East Asian productivity experience in all of my experiments.

Figure 11 shows the data, model prediction, and the experiment where I use Korean agricultural productivity growth in each of Latin American countries' agricultural sector. This experiment suggests that productivity growth in agriculture has not been high enough to release labor from agriculture as we observe in East Asian countries. For example, if Bolivia had experienced productivity growth in agriculture equal to that of Korea, then the agricultural employment share in Bolivia would have been 12.0 percent in 2003 instead of 27.4 percent.

[15] This paper focuses on the counterfactual experiments for agriculture and manufacturing employment shares in Latin America. However, the numerical experiments can simply be extended to study other sectors in detail.

Figure 12 shows the data, model prediction, and the experiment where I use Korean manufacturing productivity growth in each of Latin American countries' manufacturing sector. This experiment suggests a steady decline in each of Latin American countries' manufacturing employment share. For example, if Argentina had had the same productivity growth in the manufacturing sector as Korea, then the manufacturing employment share in Argentina would have been 4.3 percent in 2003 instead of 11.5 percent.

3.5 Sectoral Policies

Sector-specific and economywide policies may affect the sectoral productivities. One of the policy issues yielding different outcomes in different countries is the direct and indirect government policies affecting agricultural prices. In an attempt to better understand the interaction of economics and politics of agricultural pricing policies in developing countries, the World Bank undertook a research project, *A Comparative Study of the Political Economy of Agricultural Pricing Policies*, to provide systematic estimates of the degree of price discrimination against agriculture within individual countries and to explain how it changed over time; to determine how this intervention affected such key variables as foreign exchange earnings, agricultural output, and income distribution; and to gain further insight into the political economy of agricultural pricing policy.[16]

By "agricultural pricing policies "is meant the entire array of governmental policies that affect agricultural incomes relative to what they would be in the presence of a laissez-faire system affecting production incentives by making agriculture more or less attractive than other sectors of the economy.[17]

Table 4 shows the direct, indirect, and total rates of nominal protection in agriculture (negative nominal protection rates indicate taxation of agriculture) for Argentina, Brazil, Chile, Colombia, and Korea during the period from 1960 to 1985. Total interventions taxed

[16] The core of this study is an in-depth analysis of the economic effects of agricultural economic interventions in eighteen developing countries during the period from 1960 to 1985. The countries included in the project are Argentina, Brazil, Chile, Colombia, Côte d'Ivoire, Dominican Republic, Egypt, Ghana, Republic of Korea, Malaysia, Morocco, Pakistan, Philippines, Portugal, Sri Lanka, Thailand, Turkey, and Zambia. The synthesis of findings regarding the economic effects of agricultural pricing policies can be found in Schiff and Valdés (1992). The World Bank's research project on "Distortions to Agricultural Incentives" provides the latest work on this topic (www.worldbank.org/agdistortions). Dennis and İşcan (2010) find that the rate of structural transformation is slow in those countries that discriminated against their agriculture; and document that in countries with relatively heavy taxes on their agriculture (See also Fulginiti and Perrin (1993, 1999) for statistical studies on agricultural economic interventions).

[17] These policies include direct interventions to determine agricultural prices, such as government policies determining output prices, subsidies to inputs such as fertilizers and pesticides, and policies affecting the costs of transportation and marketing. Indirect interventions affect the prices of agricultural tradables relative to nontradables (through their impact on the real exchange rate) or to other tradables (as a result of industrial protection).

agriculture in four Latin American countries. When all price interventions are considered, the average tax on agriculture of 39 percent is higher than two times the 18 percent tax from direct price interventions in Argentina. That means that farmers in Argentina received 39 percent less for their output than they would have received in the absence of total price interventions.

In Korea, protection through direct price interventions was larger than taxation through indirect price interventions. Direct price interventions taxed agriculture in Argentina, Chile, and Colombia and protected agriculture in Brazil and Korea. The average reduction in farm prices relative to nonfarm prices because of indirect interventions was 21.3 percent in Argentina, 18.4 percent in Brazil, 20.4 percent in Chile, 25.2 percent in Colombia, and 25.8 percent in Korea.

The average tax on agriculture from industrial protection policies was larger than the average indirect tax in all five countries implying that industrial protection policies, i.e., tariffs and quantitative restrictions, had a greater effect on the indirect tax than did overvaluation of the real exchange rate. The tax on agriculture due to industrial protection polices was above 20 percent in all five countries and was highest in Argentina.[18]

During the process of structural transformation the composition of the manufacturing sector has changed considerably in East Asian countries. In the 1970s and 1980s, Hong Kong, Korea, Singapore, and Taiwan greatly accelerated the growth of their manufacturing output. In these countries, the growth rate of the manufacturing sector expanded at double digit growth rates during all periods before the 1980s. On the other hand, Latin American growth rates never exceeded 10 percent (except in Venezuela between 1950 and 1960). Moreover, the growth rate of the manufacturing sector was negative in Argentina, Bolivia, Brazil, Peru, and Venezuela between 1980 and 1990. The region as a whole saw a sharp drop in the average annual growth rates of manufacturing value added during the 1980s in the context of a significant slowdown in overall economic growth.[19]

The International Comparisons of Output and Productivity (ICOP) Industrial Database (1987 Benchmark) presents time series on comparative levels of value added per person employed in manufacturing in Brazil, Korea, Mexico, and Taiwan relative to the United States. The data indicate that the productivity gap between the Latin American countries and the United States widened, in particular in the 1980s. In the 1990s, Brazil managed to

[18] Restuccia, Yang, and Zhu (2008) argue that a high share of employment and low labor productivity in agriculture are mainly responsible for low aggregate productivity in poor countries. Specifically, Restuccia, Yang, and Zhu (2008) employ a two-sector general-equilibrium model and show that differences in economy-wide productivity, barriers to modern intermediate inputs in agriculture, and barriers in the labor market generate large cross-country differences in the share of employment and labor productivity in agriculture.

[19] Here, I examine the growth rates of the manufacturing sector of the countries for different subperiods in constant (national) prices based on non-filtered data.

stabilize the productivity differential, whereas Mexico continued to loose ground relative to the United States, i.e., by 1998 labour productivity in Brazil (Mexico) stood at 35.1 (25.8) percent of the U.S. level. On the other hand, Korea and Taiwan have achieved rapid catch-up between 1963 and 1999. Comparative productivity levels in manufacturing increased from 11.3 (11.9) percent of the U.S. level in 1963 to 47.3 (30.3) percent in 1999 in Korea (Taiwan).[20] Manufacturing labour productivity catch up with the U.S. accelerated in Korea in the 1990s compared to the 1970s and 1980s.[21]

Restuccia (2008) argues that barriers to formal market entry, regulation and barriers to competition, trade barriers and employment protection may be at the core of productivity differences between Latin America and the United States. Removing these barriers could lead to an increase in long-run relative GDP per worker in Latin America of a factor of four. Cole, Ohanian, Riascos, and Schmitz (2005) document Latin America's high protectionism, high costs to starting a new business, government ownership of banks, and stifling labor market regulations at the sector level.[22]

4 Conclusions and Future Research

In the comparative analysis of economic performance in terms of structural change and the sectoral productivity differences, the contrast between East Asia and Latin America is striking. The contribution of this paper is developing a simple, but relatively detailed, six-sector general equilibrium model and applying it to a nine Latin American and four East Asian countries using a new data set.[23] The main policy message is that we need to look

[20] All the data are available at http://www.ggdc.net/databases/icop87.htm

[21] The U.S. Bureau of Labor Statistics (BLS) provides international comparisons of manufacturing productivity and unit labor costs trends for 17 advanced economies (Australia, Belgium, Canada, Denmark, France, Germany, Italy, Japan, Korea, Netherlands, Norway, Singapore, Spain, Sweden, Taiwan, the United Kingdom, and the United States). According to the latest report available, manufacturing labor productivity increased in 2007 in 14 of the 17 economies compared (http://www.bls.gov/news.release/pdf/prod4.pdf). Korea and Taiwan had the largest productivity increases of 8.7 percent each. On the other hand, Singapore had the steepest decline (-4.0 percent) of the three economies where productivity declined. Over the 2000 - 2007 period, of the 17 economies studied, only Korea, Taiwan, and Sweden had greater productivity growth in manufacturing than the United States.

[22] Cole, Ohanian, Riascos, and Schmitz (2005) provide case studies of nationalization of Venezuelan oil and iron ore, the reversal of nationalization of Chilean copper, the reversal of the ban on imports of PCs into Brazil (competing with the Brazilian PC industry), privatizing Brazilian iron ore, and the privatization of Mexican and Argentinean state-owned enterprises. In all cases, productivity decreased following nationalization or quota imposition, and increased following privatization or lifting of quotas. Brazil began privatization after the mid-1990s. Mexico experienced trade and financial liberalization partly required by its joining of GATT and NAFTA from 1986 to 1994, and political liberalization after 1988.

[23] Timmer and de Vries (2009) study the same data set employing the modified shift-share analysis, which takes account of surplus labour in agriculture and accounts for the contribution to growth from expanding sectors to decompose GDP per worker, for 19 countries in Asia and Latin America and find that growth

deeper into policies that have affected sectoral productivities over time. I argue that the quantitative findings of this paper are promising for the future research and I discuss two possible avenues of research to extend the model of this paper.

First, labor mobility across the sectors of the economy is important for an efficient allocation of resources and the barriers to the sectoral labor movements may have important development consequences. Vollrath (2009), using data covering the period 1970-1990 that includes sector-specific measures of physical and human capital, finds that factor market efficiency can explain nearly 80 percent of the variation in aggregate TFP between countries, and up to 40 percent of the variation in income per capita.[24]

Hsieh and Klenow (2009), using micro data on manufacturing plants, investigate the possible role of factor misallocation in China (1998-2005) and India (1987-1994) compared to the United States. When capital and labor are hypothetically reallocated such that the gaps in marginal products of labor and capital across plants is similar to that observed in the United States, they calculate manufacturing TFP gains of 30-50 percent in China and 40-60 percent in India. De Vries (2009) applies the Hsieh-Klenow model to study allocative efficiency in Brazil's retail sector during the period from 1996 to 2006 using a detailed census dataset of retail firms and finds large potential productivity gains from the reallocation of resources toward the most efficient retailers.[25]

Second, the role of trade policy is worth studying since reductions in trade costs and trade liberalization may cause shifts of comparative advantage across nations which effect reallocations of production factors. For example, Connolly and Yi (2009) study the importance of trade reforms in explaining Korea's growth in output per worker and trade between 1962 and 1995 and find that the broad Korea tariff reduction can explain up to 32 percent of Korea's catch-up in manufacturing output per worker.

A related issue for any open economy in Latin America and East Asia is the implications of China's rapid economic growth in manufacturing; over 2000-2005, manufacturing accounted for 32 percent of China's GDP and 89 percent of its merchandise exports. Coleman (2007) argues that in countries like Japan, South Korea, and Taiwan, the emergence of China seems

accelerations are largely explained by productivity increases within sectors, which is consistent with my findings. I develop a shift-share analysis of productivity growth and show the individual effects of the separate branches on aggregate labour productivity growth for each country in the online Appendix, which is available at `http://www-scf.usc.edu/~ungor/Ungor_LAEA_online_appendix.pdf`

[24]Hayashi and Prescott (2008) employ a two-sector growth model with barriers to labor mobility between sectors, which accounts for the Japanese stagnation between 1885 and 1940. Hayashi and Prescott discuss that were it not for this employment barrier, Japan's prewar GNP would have been close to half of the United States' versus the 36 percent that it actually was.

[25]See also Lagakos (2009) on productivity differences in retail trade to understand aggregate differences. Lagakos argues that low measured productivity in developing-country retail largely represents the optimal choice of technology adoption.

to be associated with falling terms of trade and an overall growth slowdown. The closed economy multi-sector model of this paper can be extended to a multi-country framework in which the effect of openness on the sectoral reallocation of labor can be investigated (e.g., Matsuyama 2009).

Appendix

The source for all the sectoral data I use in this paper is the Groningen Growth and Development Centre (GGDC) 10-sector database, which is available at http://www.ggdc.net/dseries/10-sector.html. Timmer and de Vries (2007, 2009) provide a detailed discussion of the construction of the employment and value added series on a country-by-country basis. The GGDC 10-sector database includes annual data on gross value added at both current and constant prices from 1950 to 2005 for selected Latin America, Asia, and OECD countries as well as data on persons employed, which allows the derivation of labor productivity (value added per worker) series. Employment in this data set is defined as "all persons employed ", thus including all paid employees, but also self-employed and family workers.

The database covers the ten main sectors of the economy as defined in the International Standard Industrial Classification, Revision 2: (1) agriculture, forestry and fishing, (2) mining and quarrying, (3) manufacturing, (4) construction, (5) public utilities, (6) wholesale and retail trade, hotels and restaurants (7) transport, storage and communication, (8) finance, insurance, and real estate (9) community, social and personal services (10) government services. Together these ten sectors cover the total economy. The database combines data for "Community, Social and Personal Services"and "Government Services"(except Taiwan and the United States). The services aggregate is constructed by summing wholesale and retail trade, hotels and restaurants; transport, storage, and communication; finance, insurance, and real estate; community, social, and personal services.

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Table 1: Calibration for the United States

Parameter	Value
$\bar{A}$	0.0315
γ_1	0.0081
γ_2	0.2177
γ_3	0.0068
γ_4	0.0560
γ_5	0.7114
η	0.1000

Table 2: Calibrated Sectoral Productivity Levels in 1974

Country	Agriculture	Mining	Manufacturing	Utilities	Construction	Services
Hong Kong	0.9945	4.5805	0.2004	0.5209	0.4908	0.6971
Korea	0.0648	0.3754	0.2279	0.4554	0.2848	0.5043
Singapore	0.8524	0.8607	0.3130	0.1356	0.3777	0.4740
Taiwan	0.0953	0.1536	0.1849	0.4121	0.2346	0.5889
Argentina	0.2004	0.8979	0.5224	0.2940	0.3289	0.7360
Bolivia	0.0581	0.0254	0.3515	0.8322	0.2122	0.4649
Brazil	0.0745	0.4226	0.3283	0.1621	0.1790	0.4274
Chile	0.1289	0.1040	0.3838	0.3150	0.2574	0.6915
Colombia	0.0765	0.3166	0.6089	0.3894	0.3935	0.4844
Costa Rica	0.0896	0.9034	0.4458	0.1809	0.2045	0.5758
Mexico	0.2004	0.7625	0.4436	0.2497	0.2793	0.6250
Peru	0.0713	0.1186	0.4630	0.8461	0.2846	0.6673
Venezuela	0.1663	0.5329	1.2768	0.4341	0.5120	1.1054

Table 3: Average Annual Growth by Sector (%), 1974-2003

Country	Agriculture	Mining	Manufacturing	Utilities	Construction	Services
Hong Kong	0.81	6.88	6.99	7.76	1.84	1.89
Korea	5.35	4.08	7.21	10.88	2.30	1.09
Singapore	3.87	0.40	4.47	9.16	-0.22	3.50
Taiwan	4.22	6.00	5.10	6.09	1.35	4.78
Argentina	2.82	3.29	1.02	4.86	0.34	-0.79
Bolivia	2.19	3.62	-1.37	-0.85	-4.25	-1.96
Brazil	4.27	2.93	0.28	6.05	0.39	-0.82
Chile	5.25	5.02	2.94	3.17	1.35	0.34
Colombia	1.63	2.00	-0.31	3.12	-2.17	-0.45
Costa Rica	2.17	3.06	0.67	-0.63	0.32	-0.70
Mexico	2.82	3.29	1.02	4.86	0.34	-0.79
Peru	1.50	3.04	0.34	2.10	2.24	-2.05
Venezuela	0.52	-2.86	-0.13	-4.42	13.09	-2.45
United States	3.59	0.82	3.47	2.06	-0.79	0.89

Table 4: Direct and Indirect Protection of Agriculture

		Period averages in percentages			
Country	Period	Indirect protection	Tax due to industrial protection	Direct protection	Total protection
Argentina	1960-84	-21.3	-39.5	-17.8	-39.1
Brazil	1969-83	-18.4	-21.4	10.1	-8.3
Chile	1960-83	-20.4	-37.4	-1.2	-21.6
Colombia	1960-83	-25.2	-37.8	-4.8	-30.0
Korea	1960-84	-25.8	-26.7	39.0	13.2

Source: Schiff and Valdés 1992, Table 2.1.

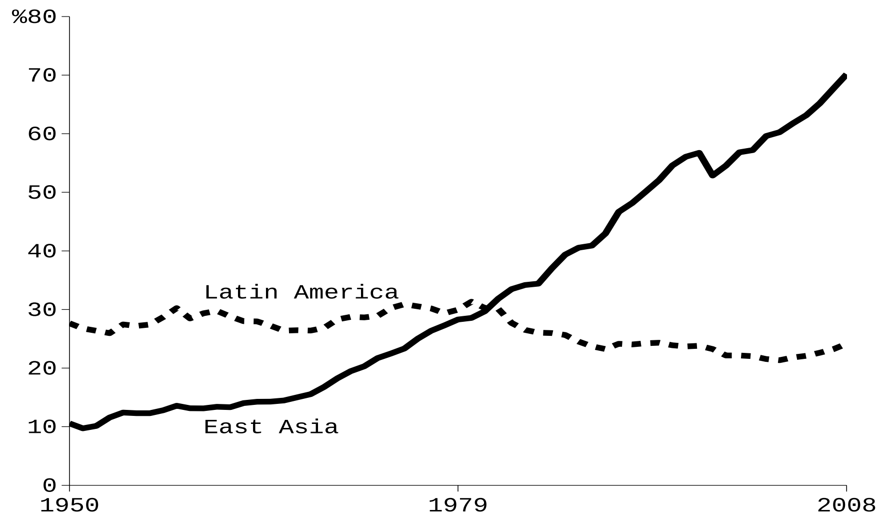

Figure 1: GDP per Capita as a Percentage of the U.S.

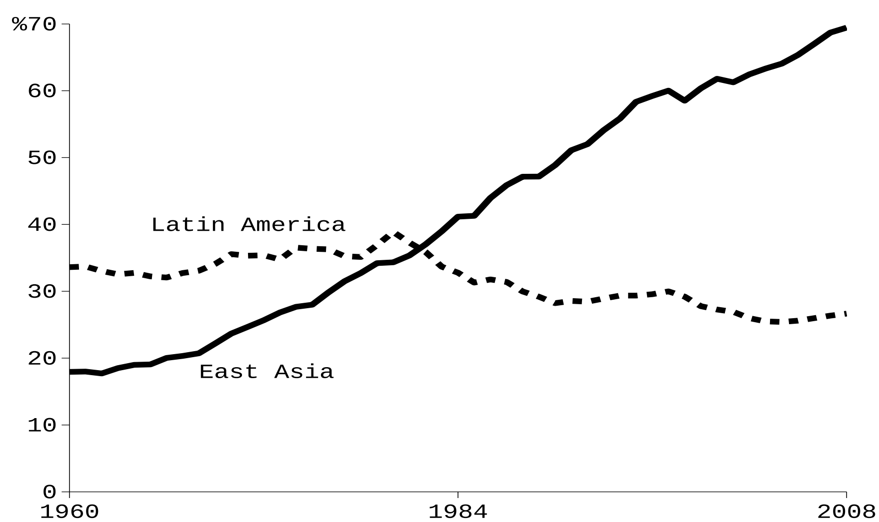

Figure 2: Labor Productivity as a Percentage of the U.S.

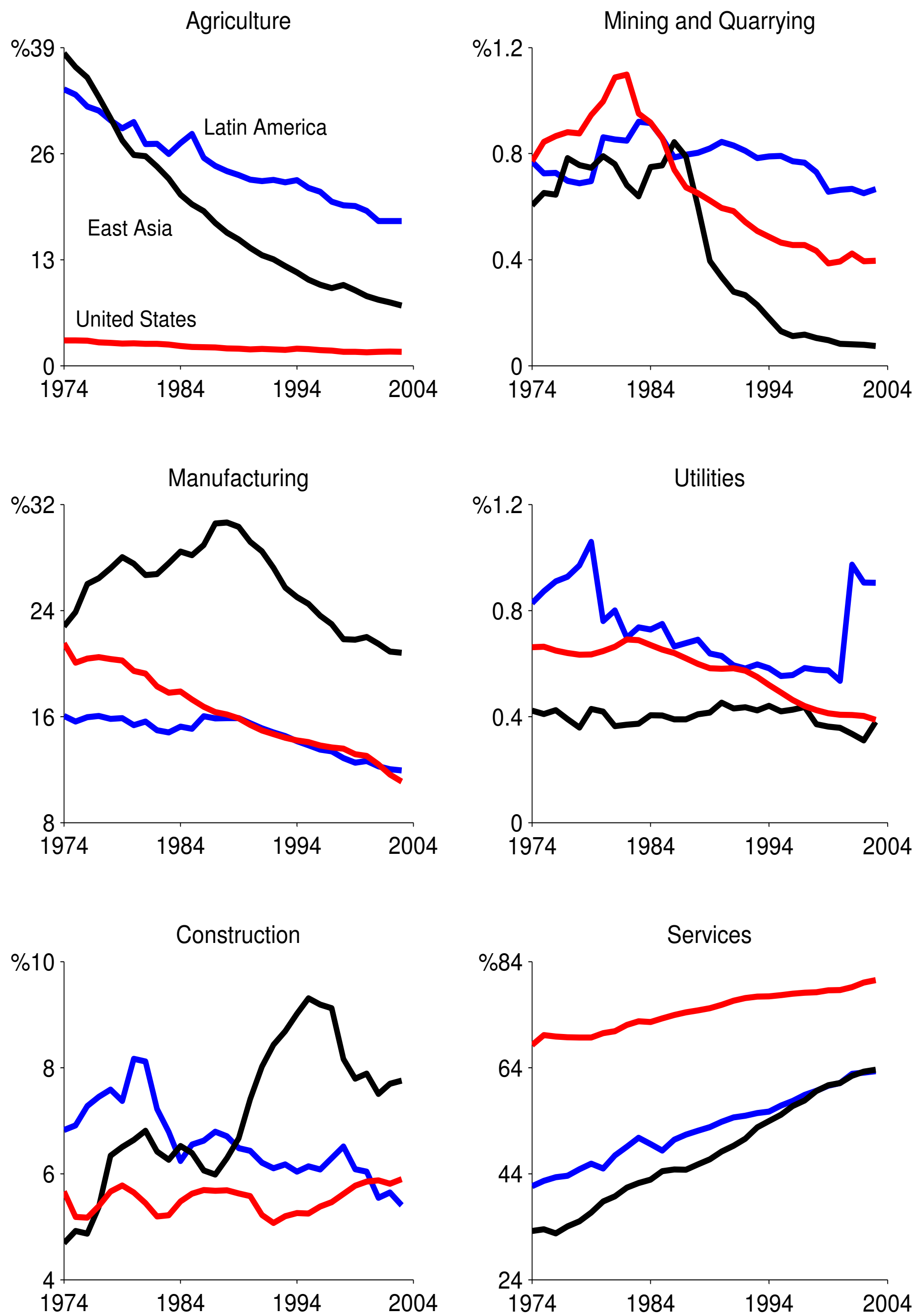

Figure 3: Sectoral Employment Shares, 1974-2003

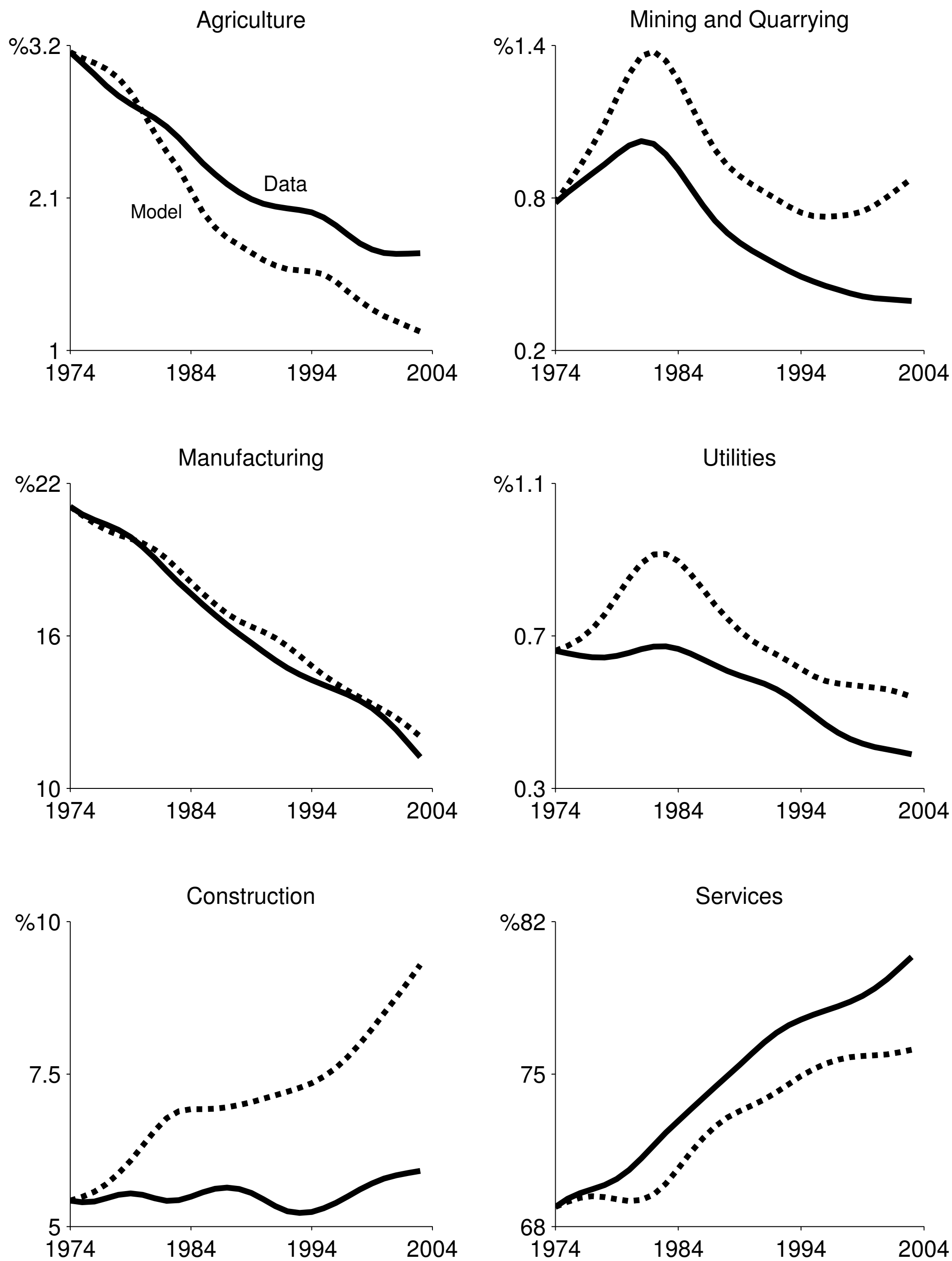

Figure 4: Sectoral Employment Shares, Data versus Model, U.S.: 1974-2003

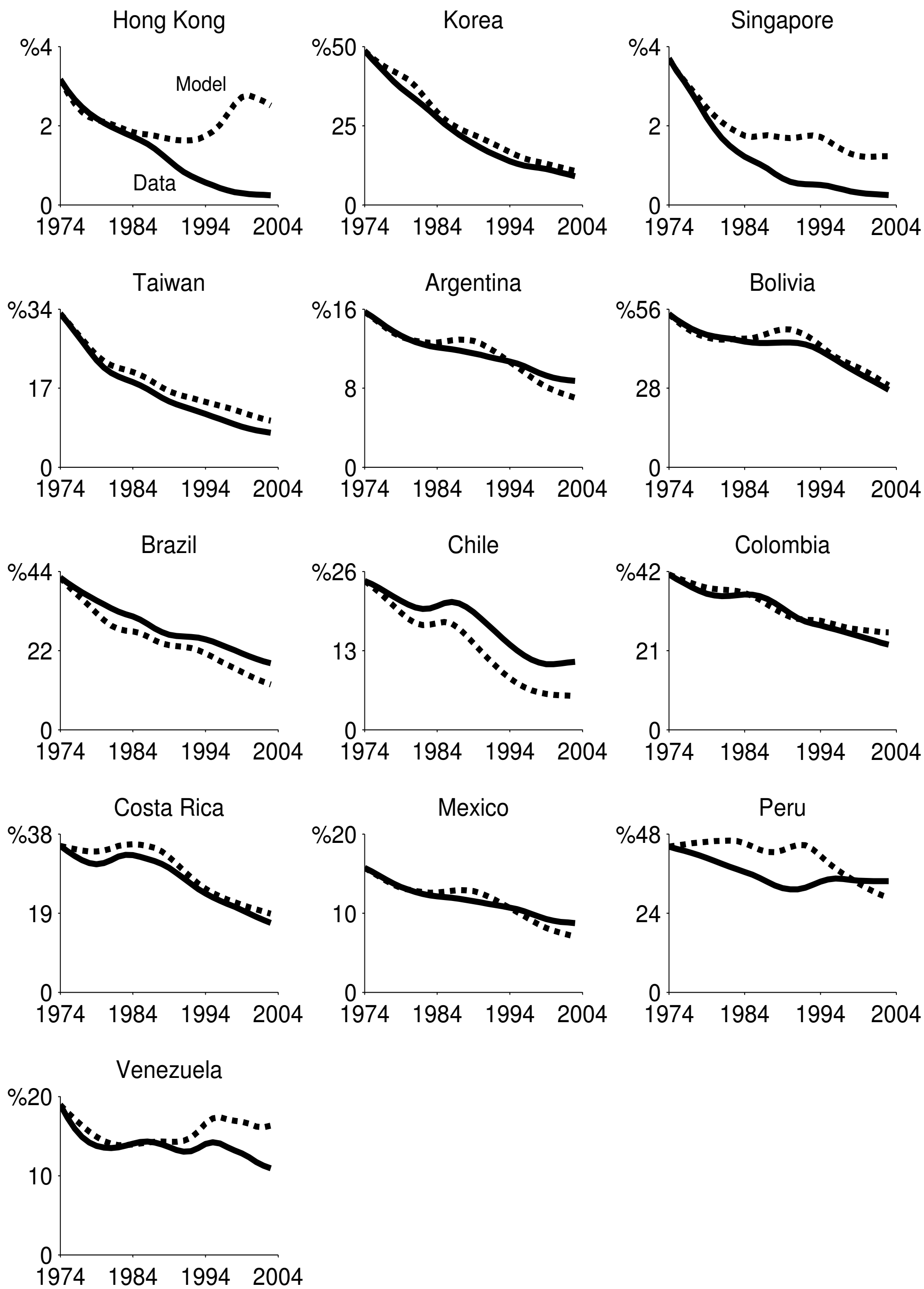

Figure 5: Employment Share in Agriculture, Data versus Model: 1974-2003

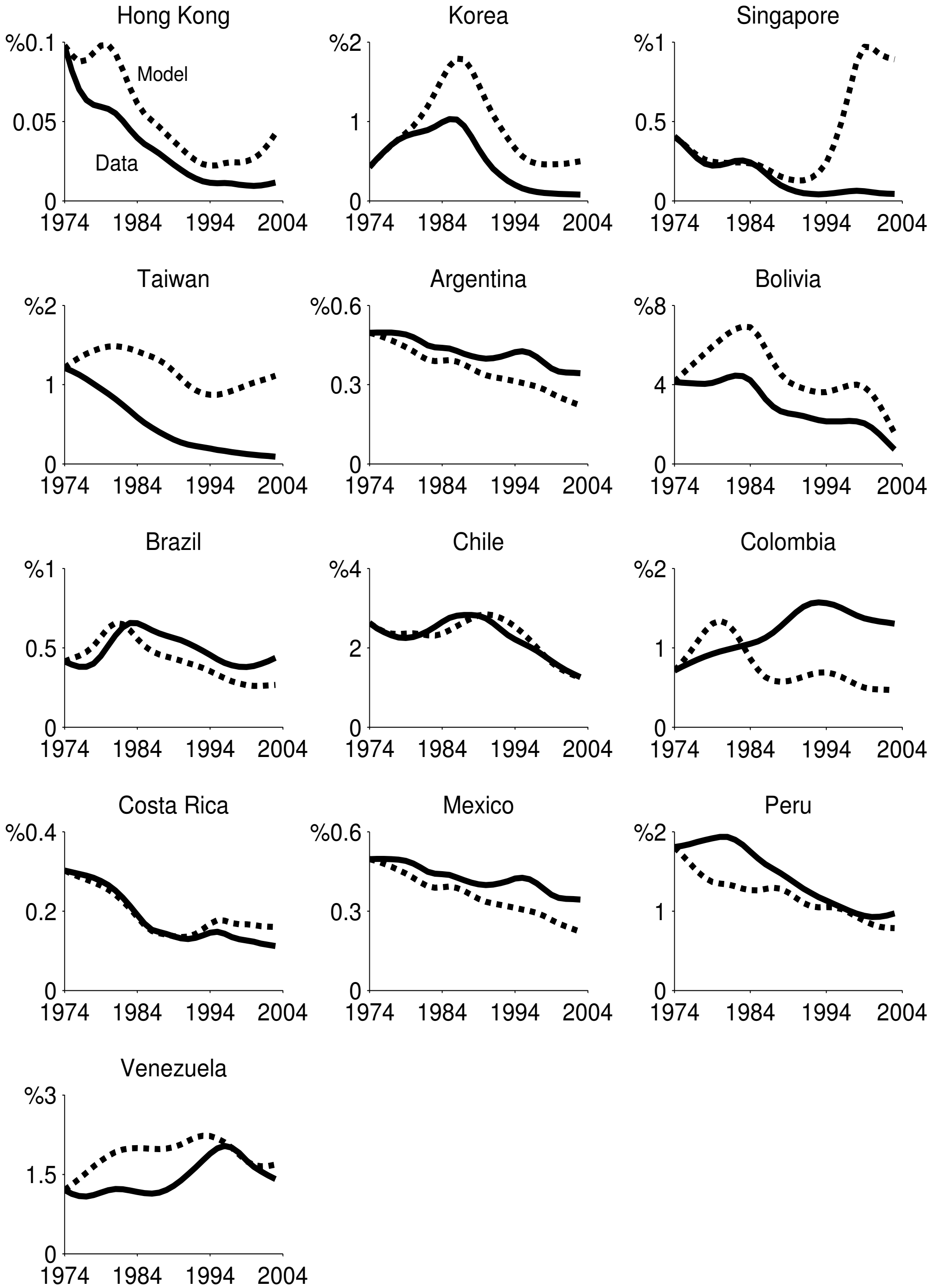

Figure 6: Employment Share in Mining and Quarrying, Data versus Model: 1974-2003

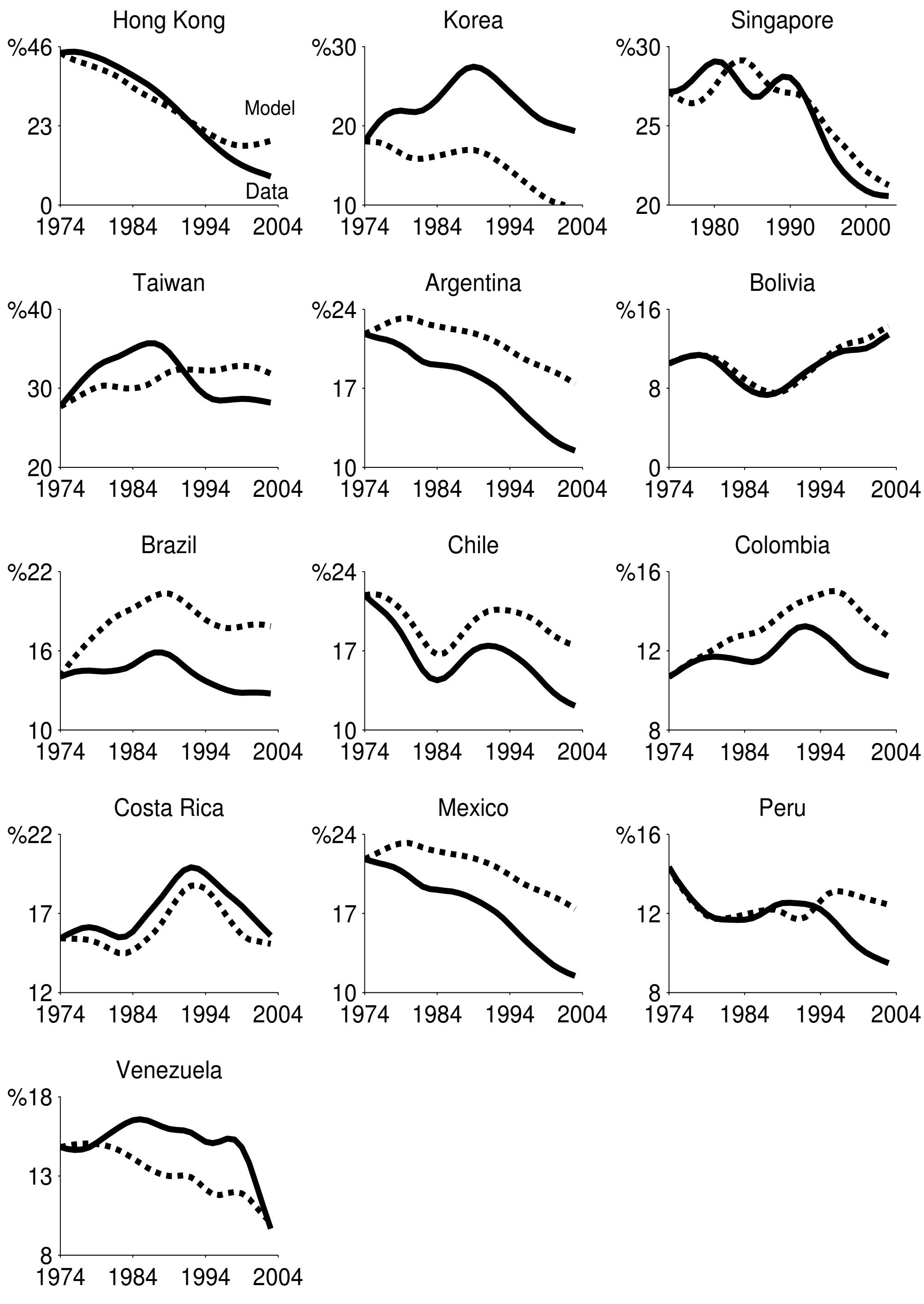

Figure 7: Employment Share in Manufacturing, Data versus Model: 1974-2003

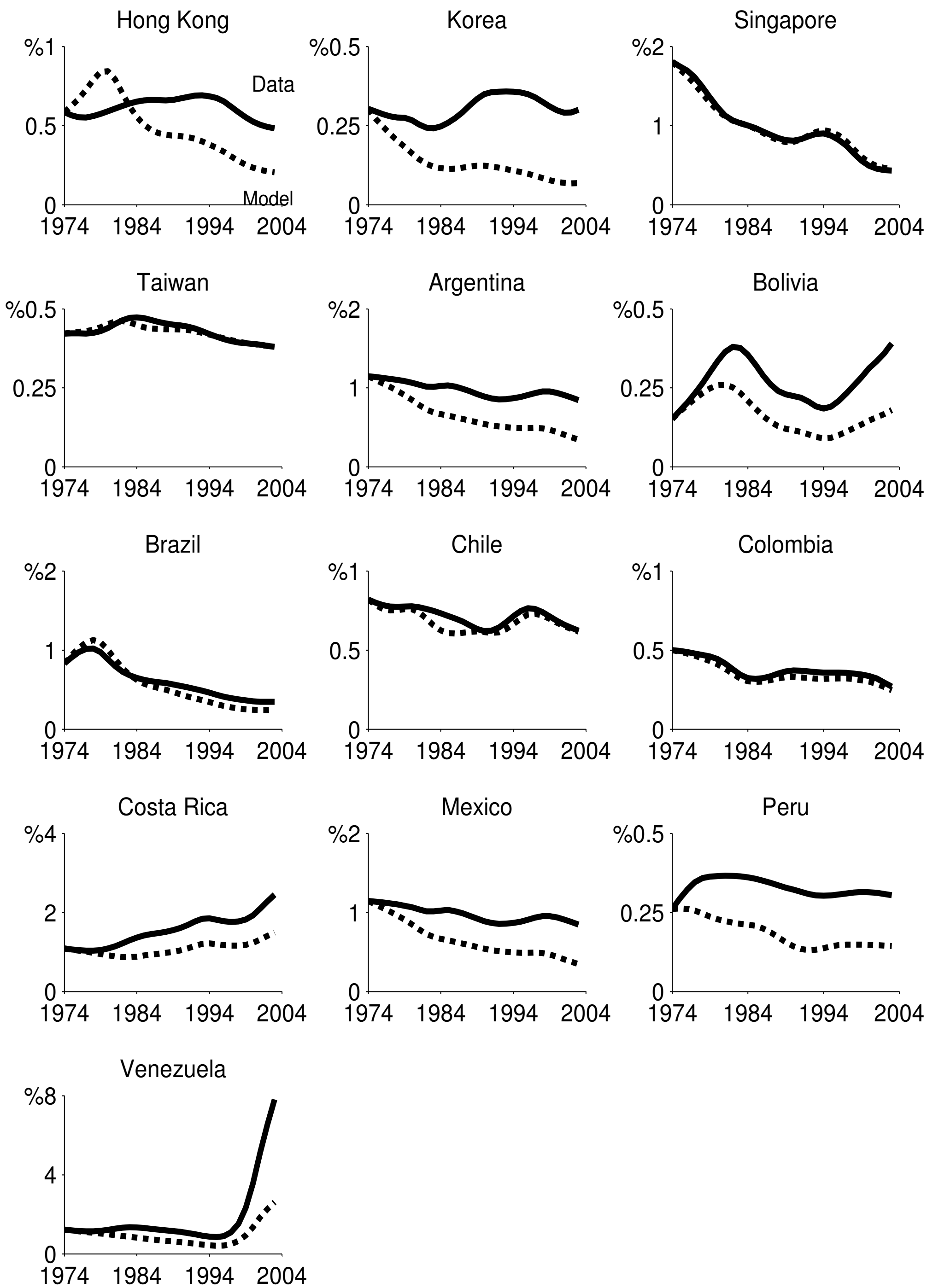

Figure 8: Employment Share in Utilities, Data versus Model: 1974-2003

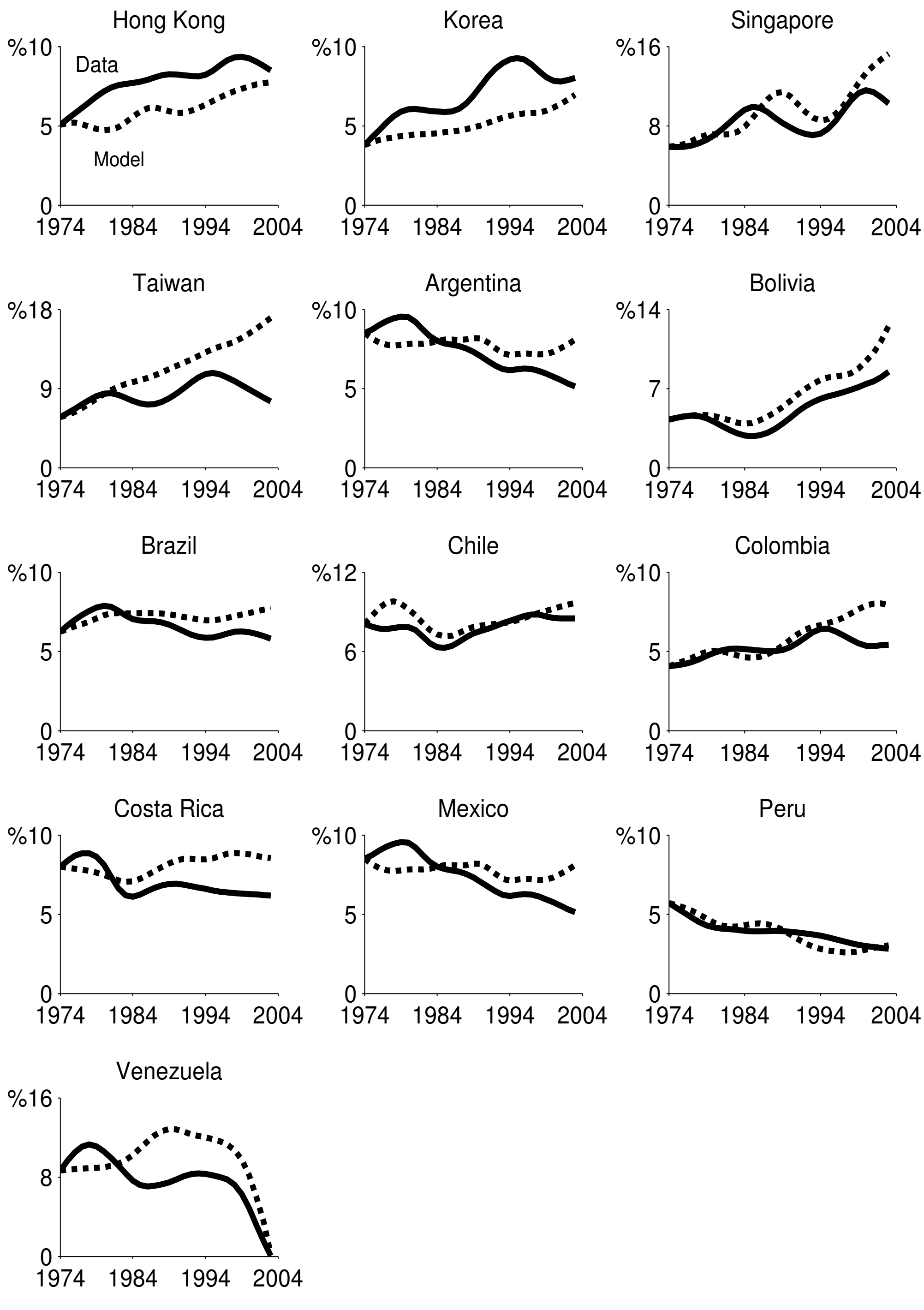

Figure 9: Employment Share in Construction, Data versus Model: 1974-2003

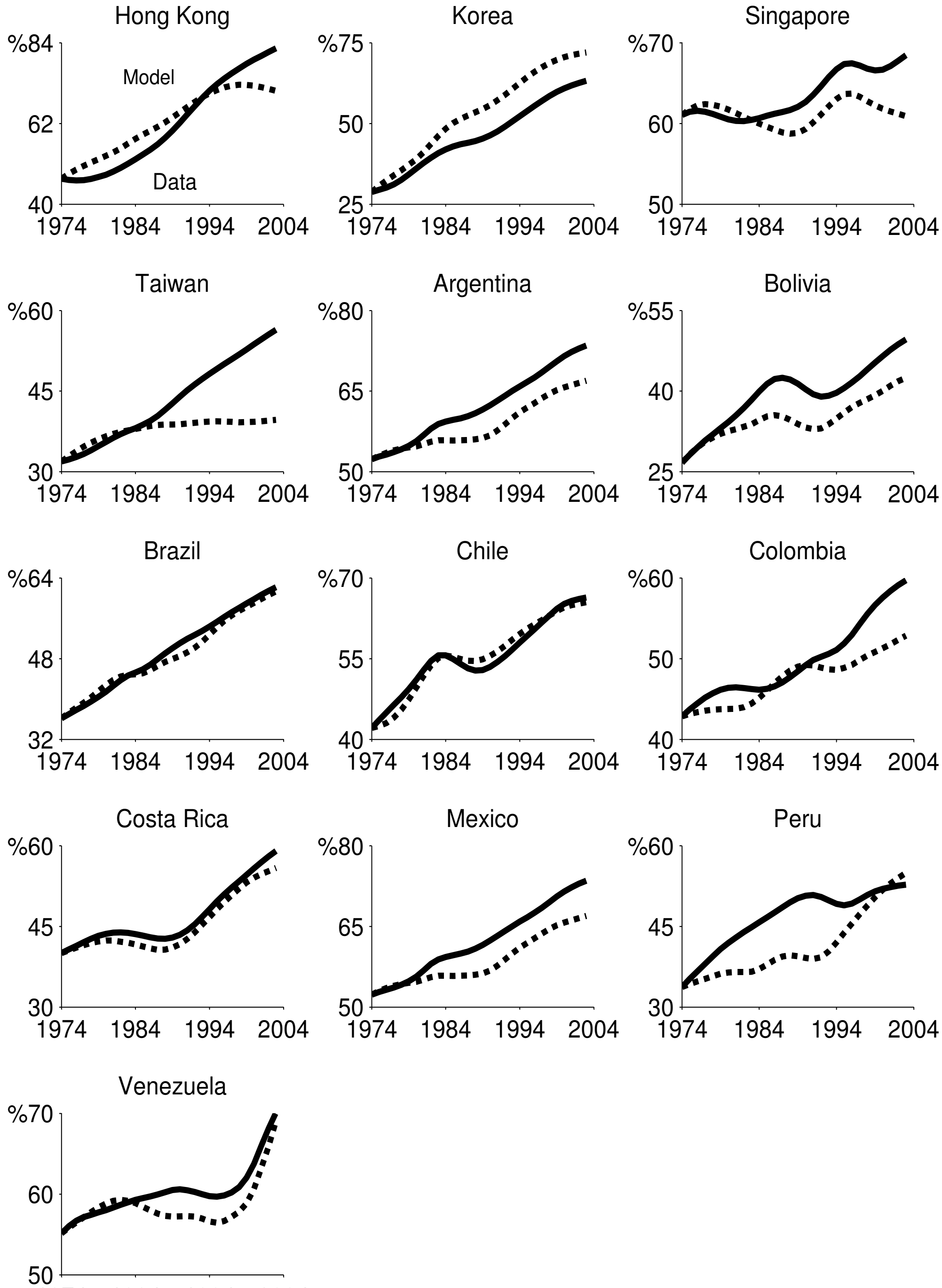

Figure 10: Employment Share in Services, Data versus Model: 1974-2003

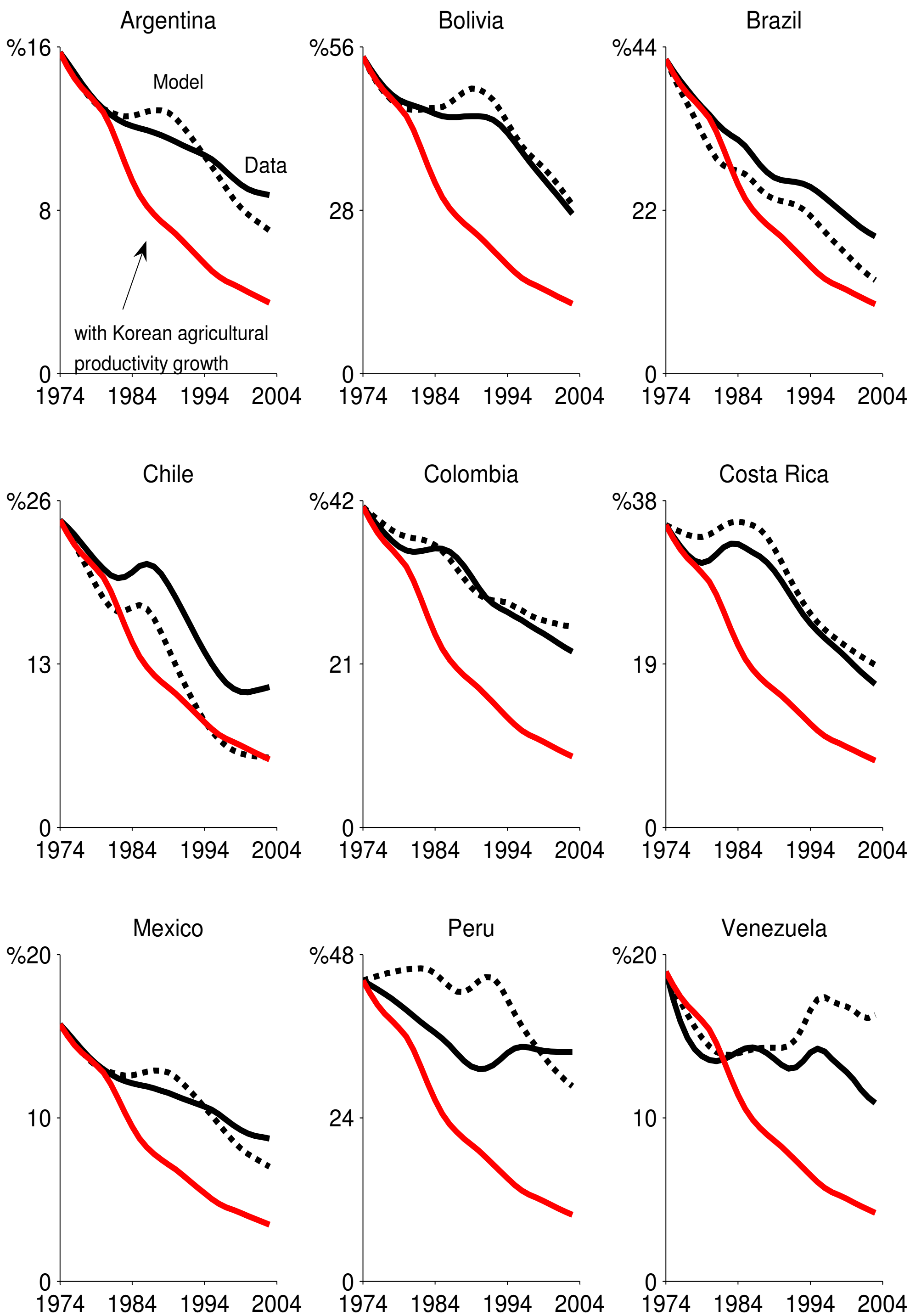

Figure 11: Employment Share in Agriculture in Latin America, Experiment using Korean Agricultural Productivity Growth: 1974-2003

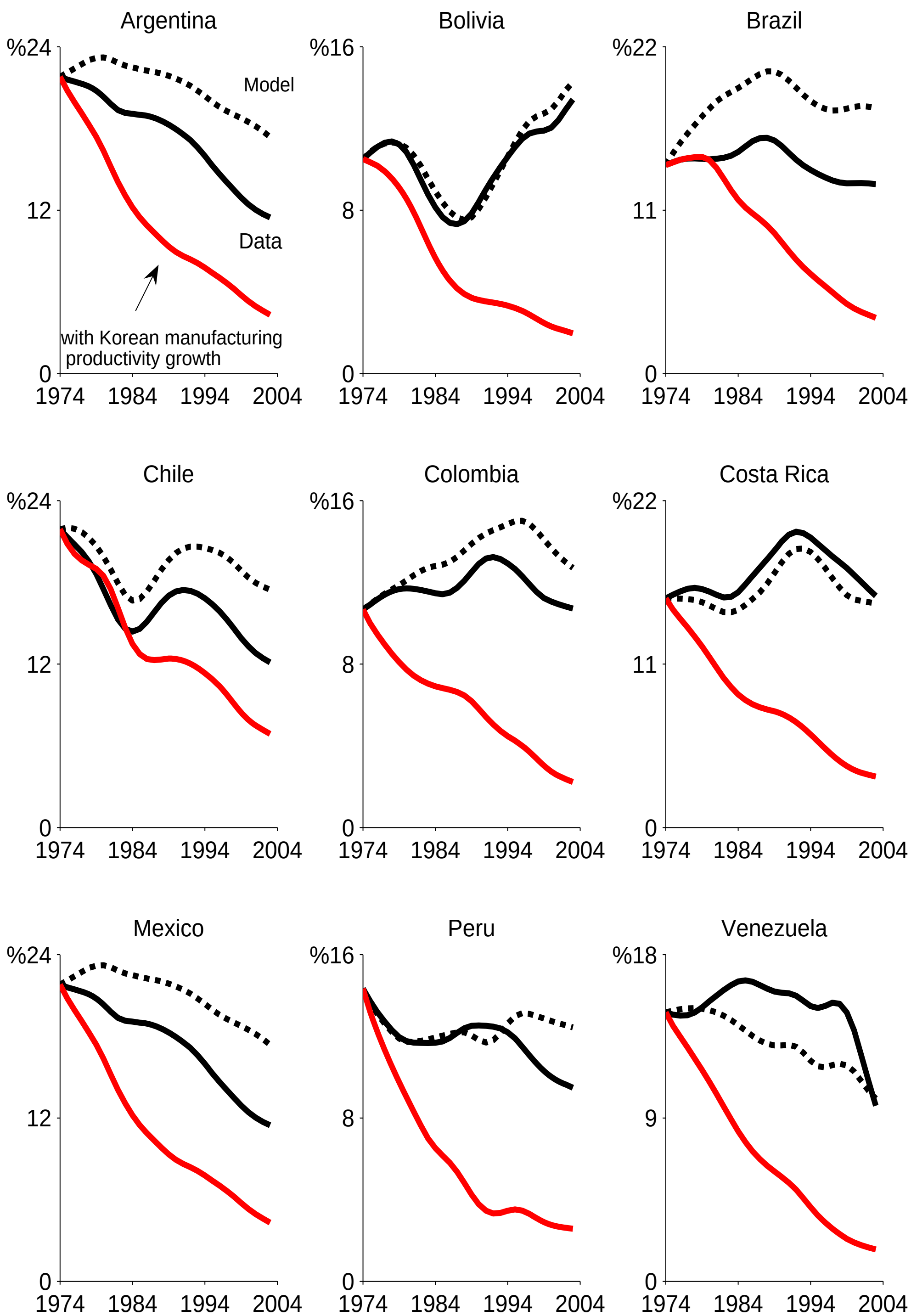

Figure 12: Employment Share in Manufacturing in Latin America, Experiment using Korean Manufacturing Productivity Growth: 1974-2003