Is there unbalanced growth between investment and output in Latin America?

25TH Anniversary GGDC

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Introduction

Motivation

- The aggregate production function (APF) approach to TFP analysis is subject to the strict assumption that for all industries "value-added functions exist and are identical across industries up to a scalar multiple" and "the aggregation of heterogeneous types of capital and labor must receive the same price in each industry" (Jorgenson, Ho and Stiroh 2005).

- Markets are imperfect in Latin America for many reasons such as monopolistic or oligopolistic structures, heavy government interventions and other institutional problems and therefore the APF is inappropriate for a growth accounting exercise of the Latin American economy.

- This article uses the approach applied in Wu (2015) for the Chinese economy. Following Jorgenson, Ho and Stiroh (2005a), Wu adopts Jorgenson's aggregate production possibility frontier (APPF) framework that incorporates Domar weights to account for contributions of individual industries to the growth of aggregate inputs and output as well as the growth of aggregate total factor productivity (TFP). The aggregate production possibility frontier (APPF) approach in growth accounting was first developed by Jorgenson (1966).

Introduction

- This approach relaxes most of the restrictive assumptions of popularly used aggregate production function (APF) in growth accounting that all industries are homogenous, subject to the same value added function and facing the same input and output prices. It has been recently used in Jorgenson and Stiroh (2000), Jorgenson (2001) and Jorgenson, Ho and Stiroh (2005b) to quantify the role of information technology (IT)-producing and IT-using industries in the US economy. Jorgenson, Gollop and Fraumeni (1987) introduced Domar weights to the APPF framework to exercise direct aggregation across industries to account for the role of American industries in the changes of aggregate inputs.

- A consequence of the Domar-aggregation is that the weights do not sum to unity, implying that aggregate productivity growth amounts to more (less) than the weighted average of industry-level productivity growth. This reflects the fact that productivity change in the production of *intermediate inputs* do not only have an "own" effect but in addition they lead to reduced or increased prices in downstream industries, and that effect accumulates through vertical links.

There are two realities in Latin America, North and South. Distinct productive structures and distinct evolutions
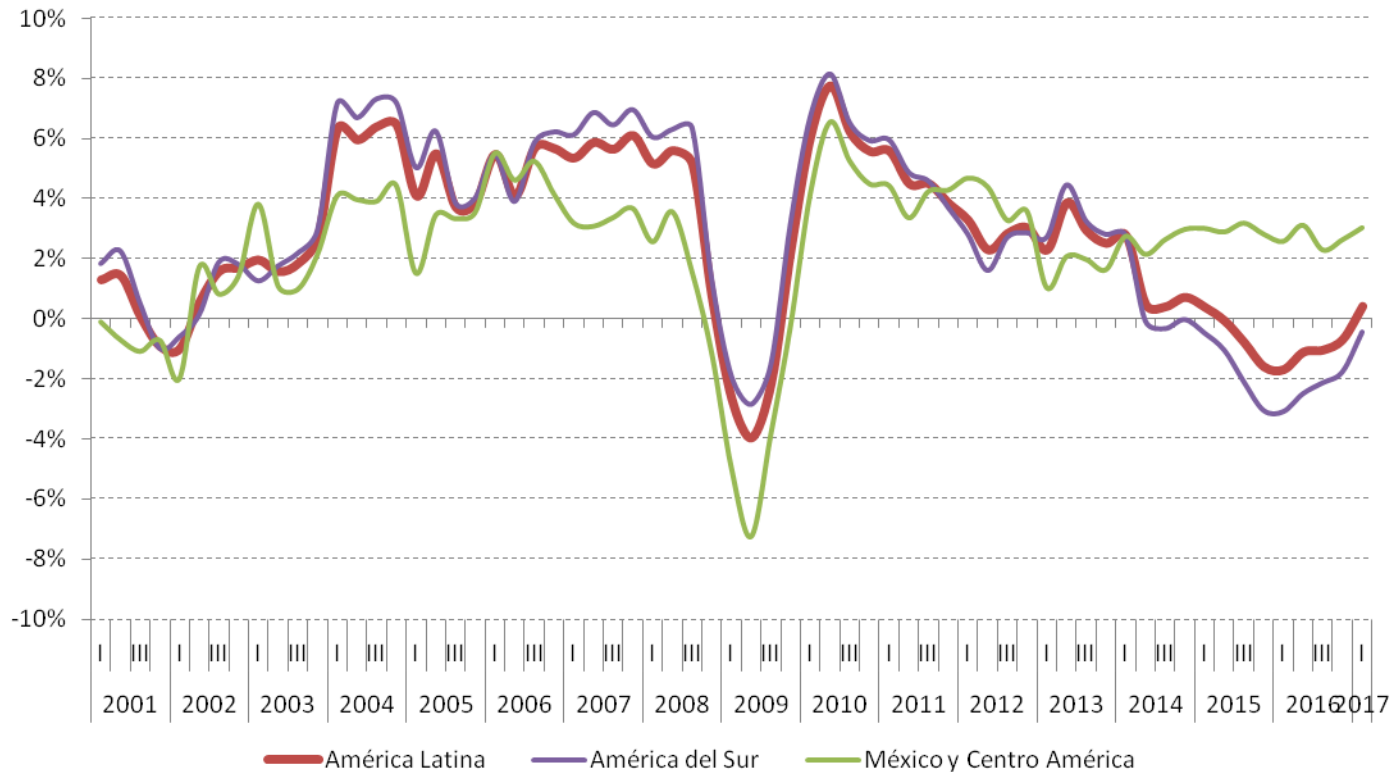
Data set-up

Observations of the aggregate economy:

- The performance of the real growth (Y), did not proportionally match the growth of the net capital stock. An increasingly faster capital stock growth was required to maintain the same rate of output growth in Chile and Colombia.

- In terms of capital deepening of Chile and Colombia's labor productivity growth has become increasingly "costly", especially post 2008.

- Mexico experienced balanced growth between investment and output.

- We show how changes in labor productivity (Y/L) responded to changes in capital deepening (K/L) overtime. It confirm our earlier observations from a different perspective. That is, an increase in K/L did not necessarily bring out the same increase in Y/L as indicated by a 45-degree diagonal. Sometimes, an increase in capital stock per worker could be accompanied by a much slower growth or even a decline in output per worker.

- Primera derivada de K>0 e Y > 0

- Segunda derivada de K>0 e Y<0

Chile
K / L is always greater than Y / L
There is no balanced growth either in the short term
or in the long term

Chile: annualized growth rate of gross value-add, hours worked, net capital stock, labor productivity, capital deepening and capital-output ratio

	Value added (Y)	Net capital stock (K)	Hours worked (H)	Y/L	K/L	K/Y
1991-1998	6.5%	7.2%	2.2%	4.4%	5.8%	1.4%
1999-2002	2.4%	5.3%	0.7%	1.8%	4.7%	3.0%
2003-2008	4.0%	7.1%	1.6%	2.4%	5.7%	3.3%
2009-2012	3.8%	7.4%	2.8%	1.1%	4.8%	3.6%
1991-2012	*4.6%*	*6.9%*	*1.8%*	*2.7%*	*5.4%*	*2.7%*

Colombia
K / L is always greater than Y / L
There is no balanced growth either in the short term or in the long term

	Value added (Y)	Net capital stock (K)	Hours worked (H)	Y/L	K/L	K/Y
1991-1998	3.7%	6.4%	2.8%	1.9%	4.4%	2.5%
1999-2002	0.2%	2.9%	2.5%	-4.0%	-0.6%	3.5%
2003-2008	4.9%	7.2%	-0.8%	6.2%	7.7%	1.5%
2009-2010	2.7%	9.1%	6.5%	-0.9%	6.6%	7.5%
1991-2010	*3.3%*	*6.2%*	*2.0%*	*1.7%*	*4.6%*	*2.9%*

Mexico
Long term balance

Mexico: annualized growth rate of gross value-add, hours worked, net capital stock, labor productivity, capital deepening and capital-output ratio

	Value added (Y)	Net capital stock (K)	Hours worked (H)	Y/L	K/L	K/Y
1991-1998	3.7%	2.8%	2.3%	1.5%	0.7%	-0.8%
1999-2002	1.8%	2.9%	0.7%	0.9%	1.1%	0.2%
2003-2008	3.3%	2.8%	2.9%	0.7%	0.3%	-0.4%
2009-2015	2.0%	2.4%	0.8%	1.0%	1.7%	0.7%
1991-2015	*2.8%*	*2.7%*	*1.8%*	*1.1%*	*1.0%*	*-0.1%*

Chile: changes in labor productivity versus capital deepening
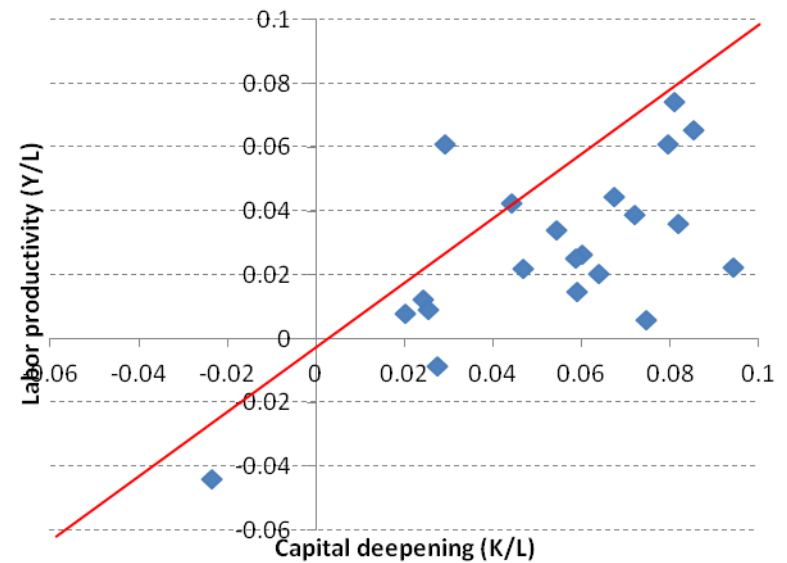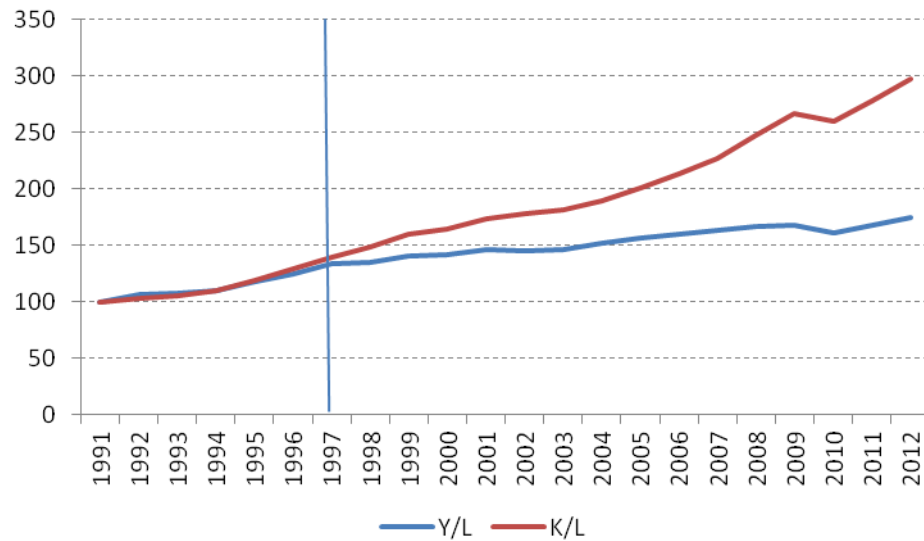
Colombia: changes in labor productivity versus capital deepening
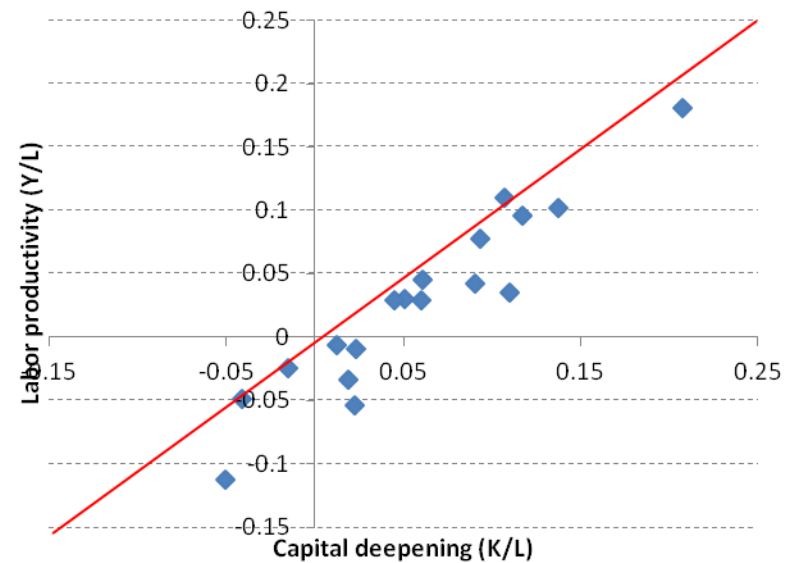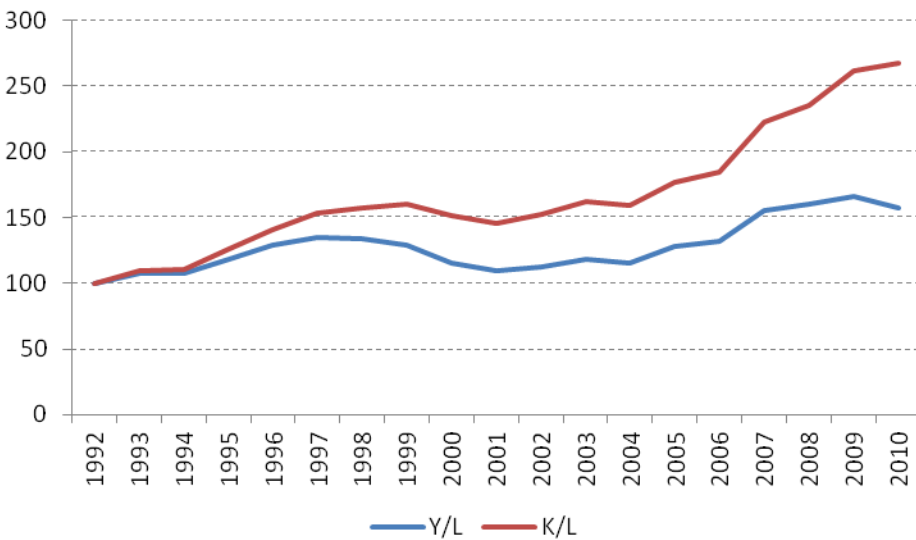
Mexico
There is a balance between labor productivity and K / L

Mexico: changes in labor productivity versus capital deepening
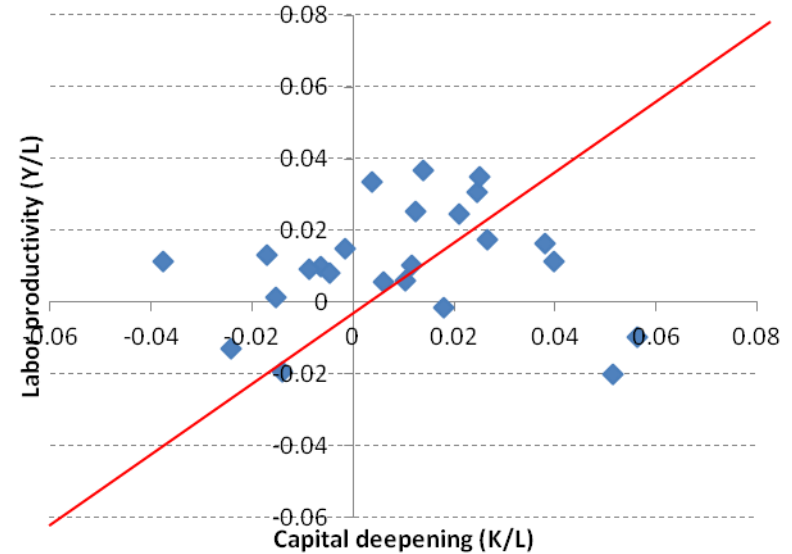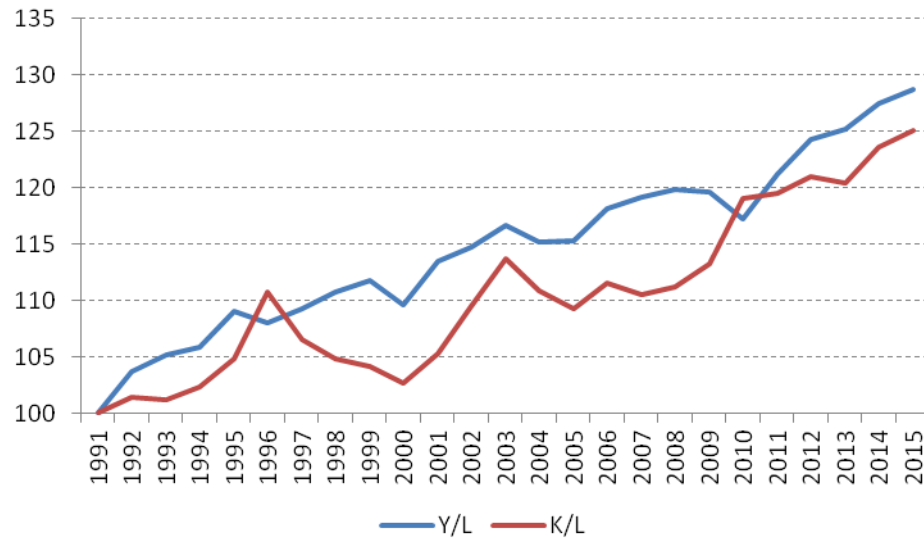
Results

Observations by industry group:

In the three countries the agricultural sector Y / L> K / L.

Chile always Y / L> K / L (less agriculture and mining until 2005).

Mexico, manufacture shows intensification in K / L Financial services shows intensification Y / L

Chile, manufacturing, transport and communications, energy, gas and water and mining shows intensification K / L

Mexico: indices of labor productivity and capital deepening by industry group
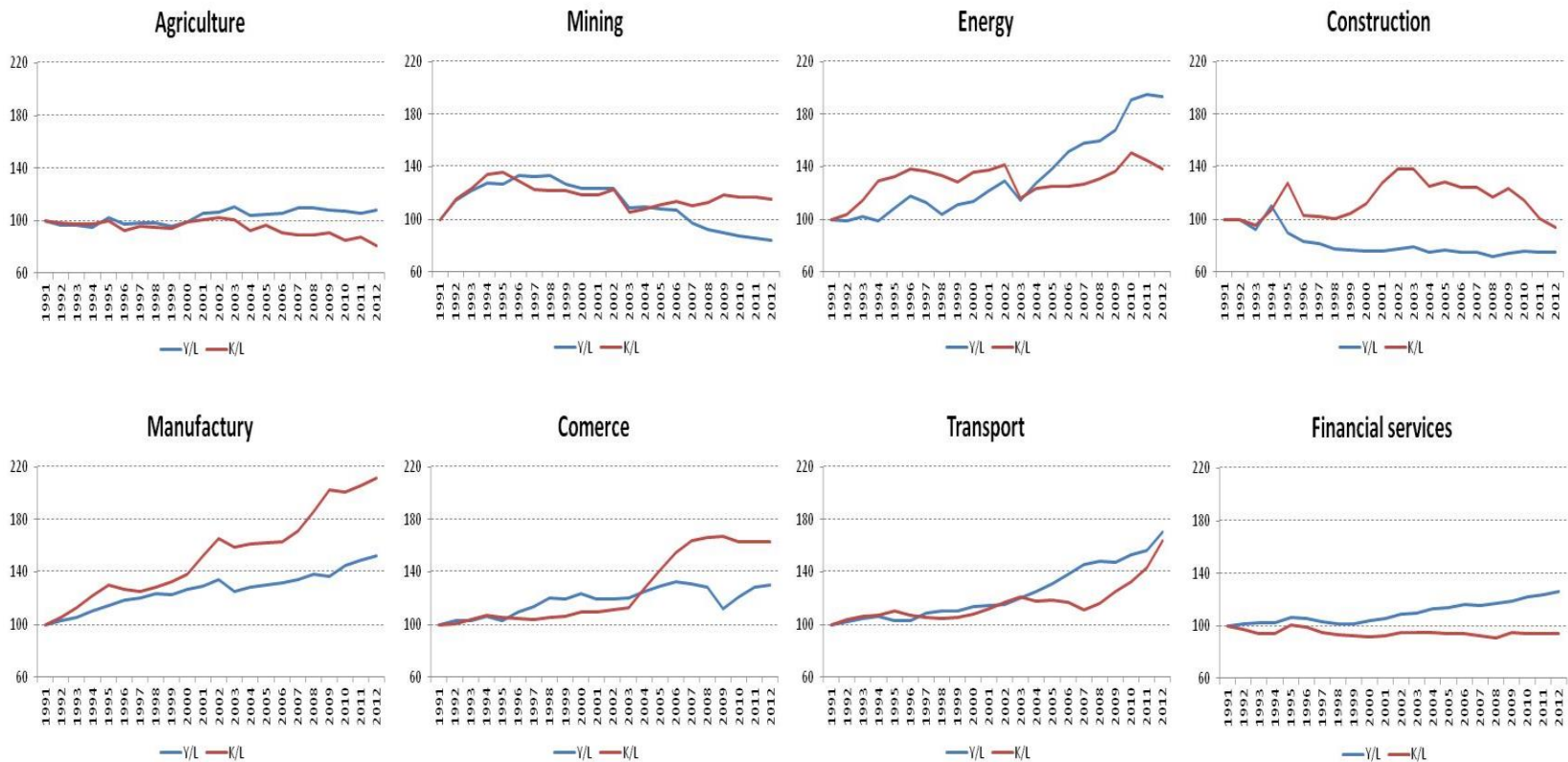
Chile: indices of labor productivity and capital deepening by industry group
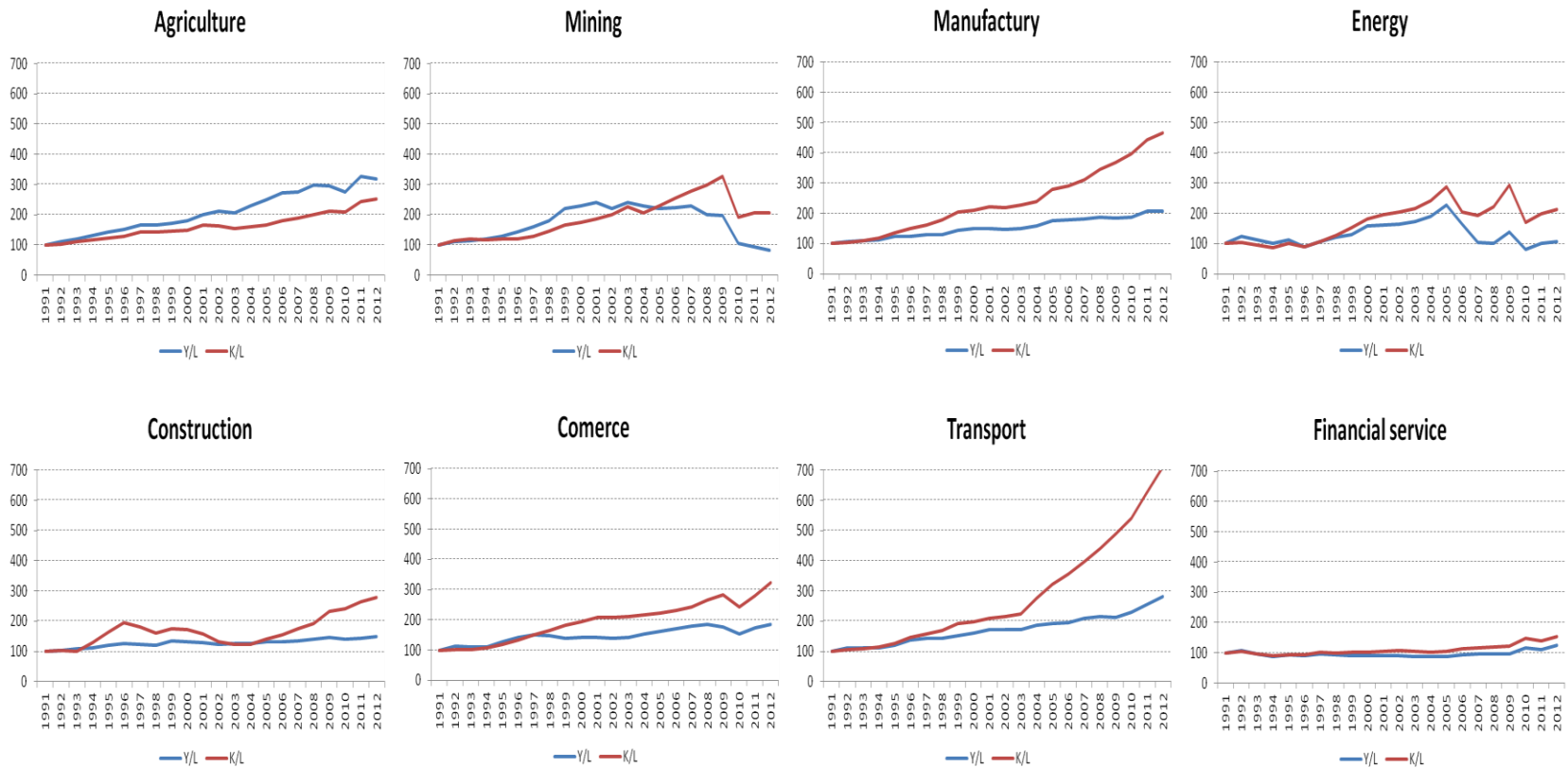
Colombia: indices of labor productivity and capital deepening by industry group
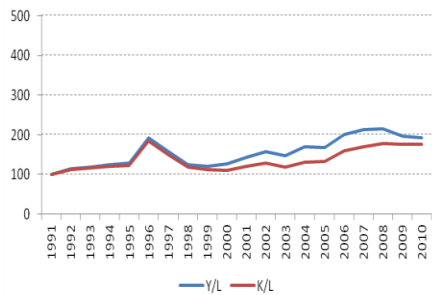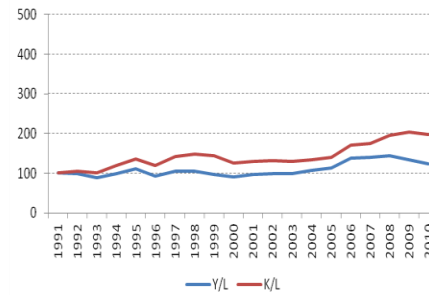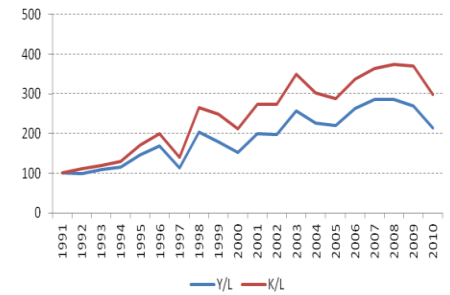

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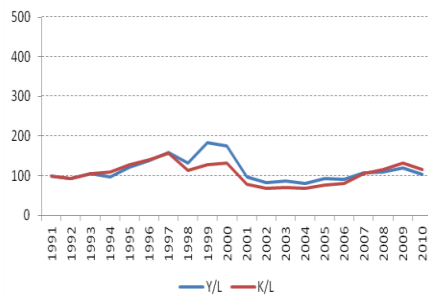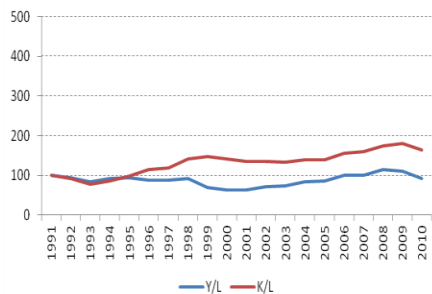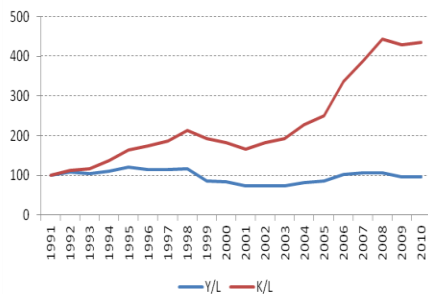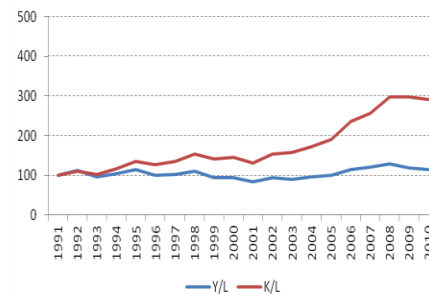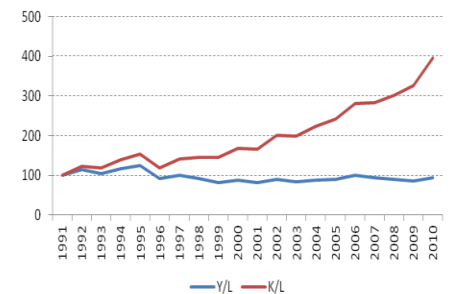
Mexico: changes in labor productivity versus capital deepening by industry group
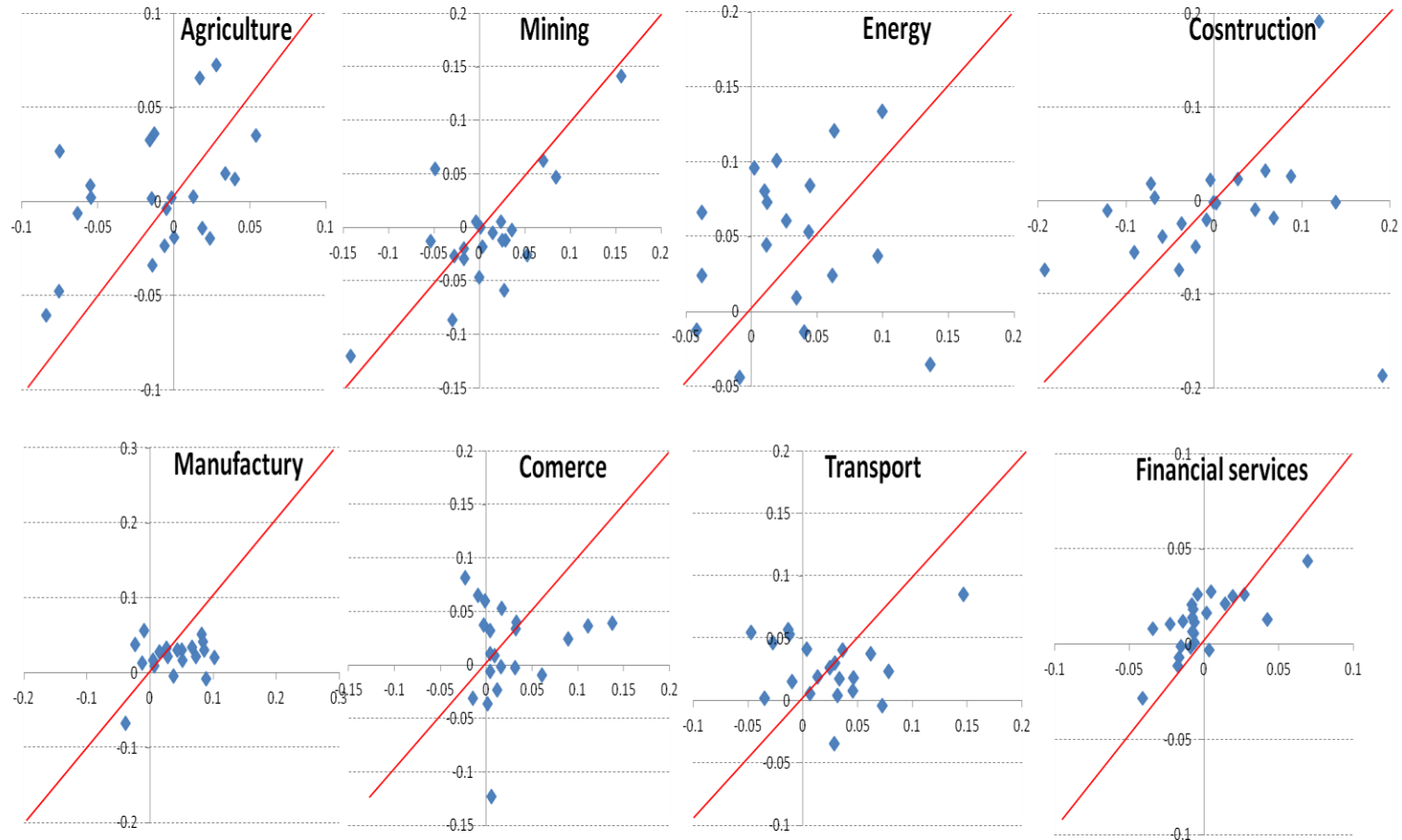
Chile: changes in labor productivity versus capital deepening by industry group
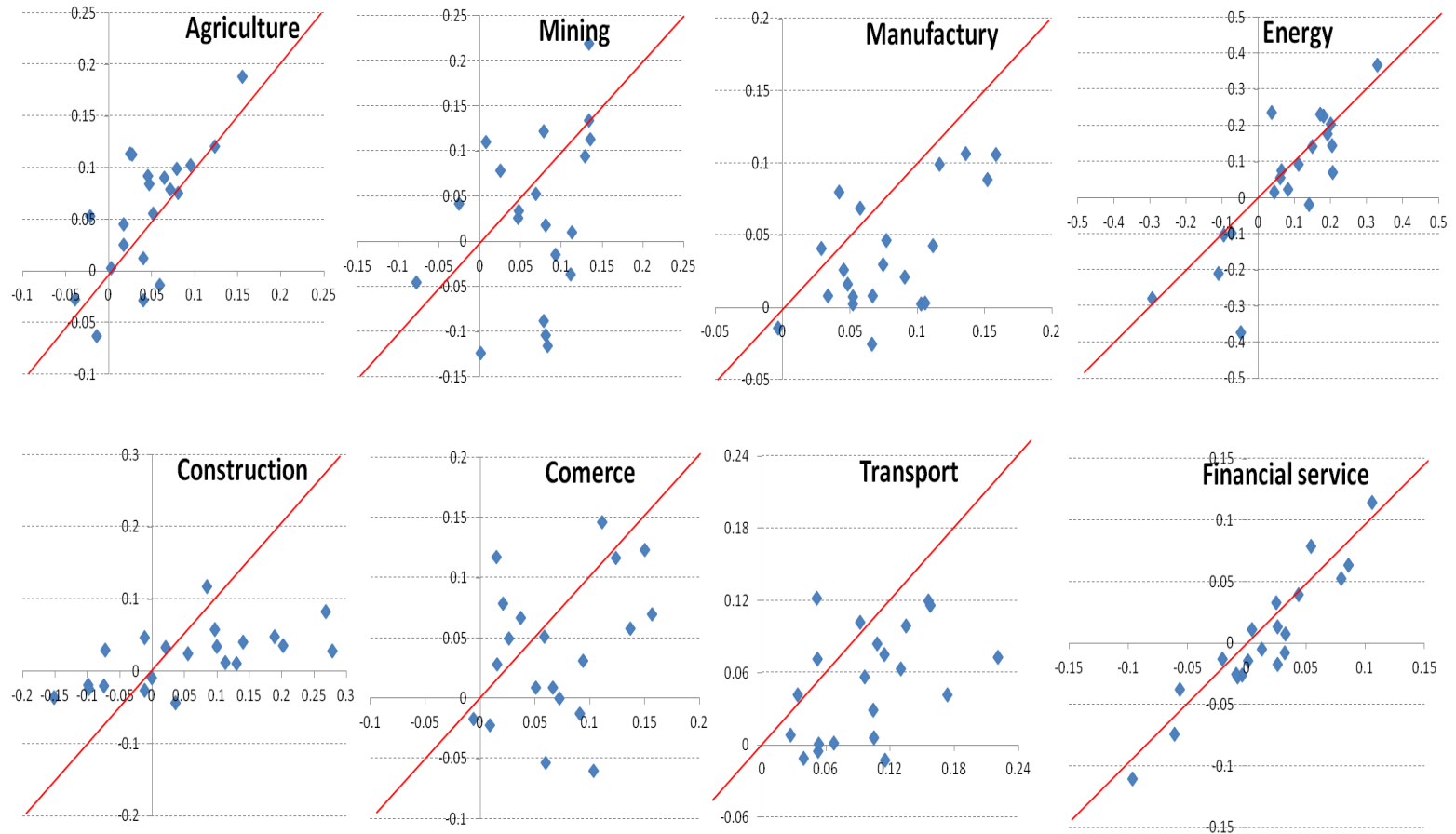
Colombia: changes in labor productivity versus capital deepening by industry group
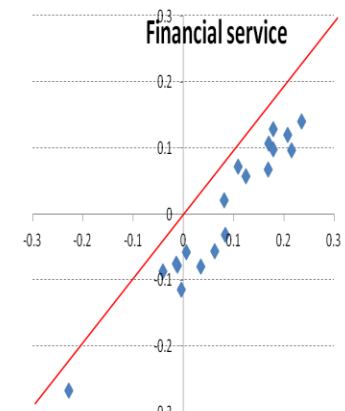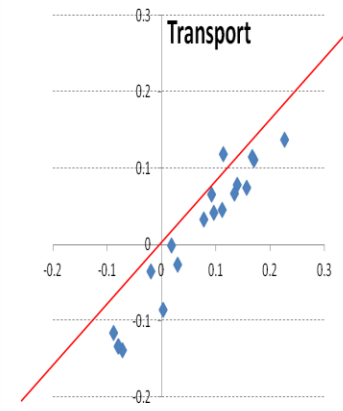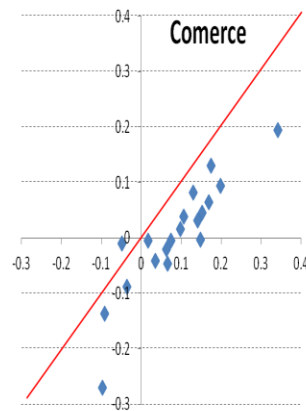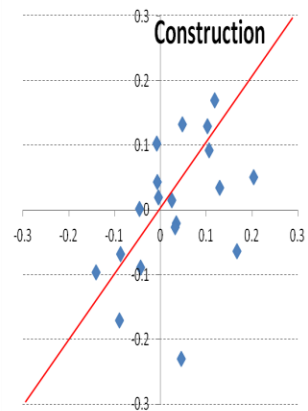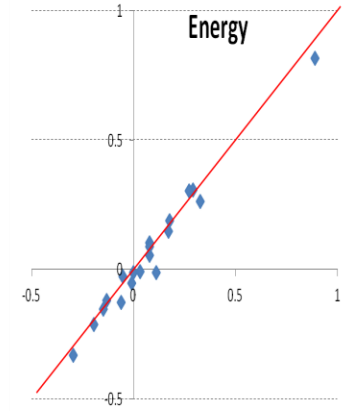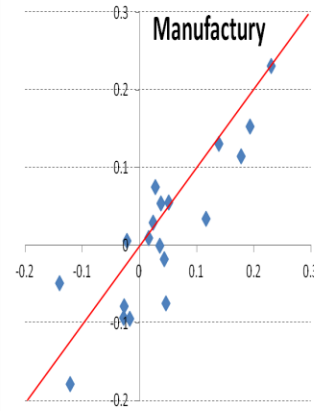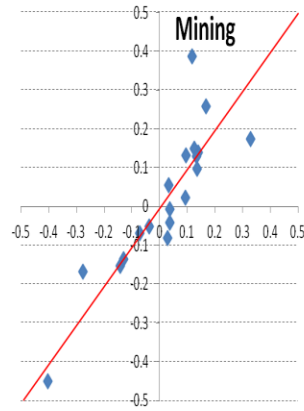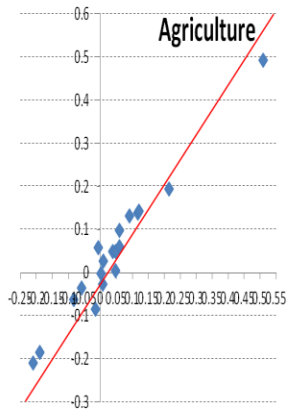
NAFTA could explain breakdown of energy, gas and water sector in 1994

Mexico: total factor productivity index by industry group
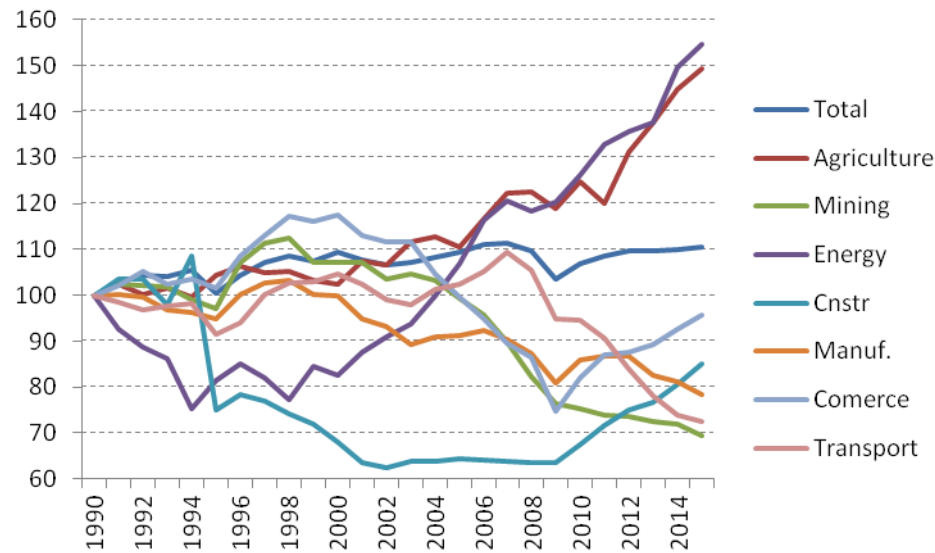
Chile: up to 2003 two sectors improve their TFP, agriculture and manufacturing

Chile: total factor productivity index by industry group
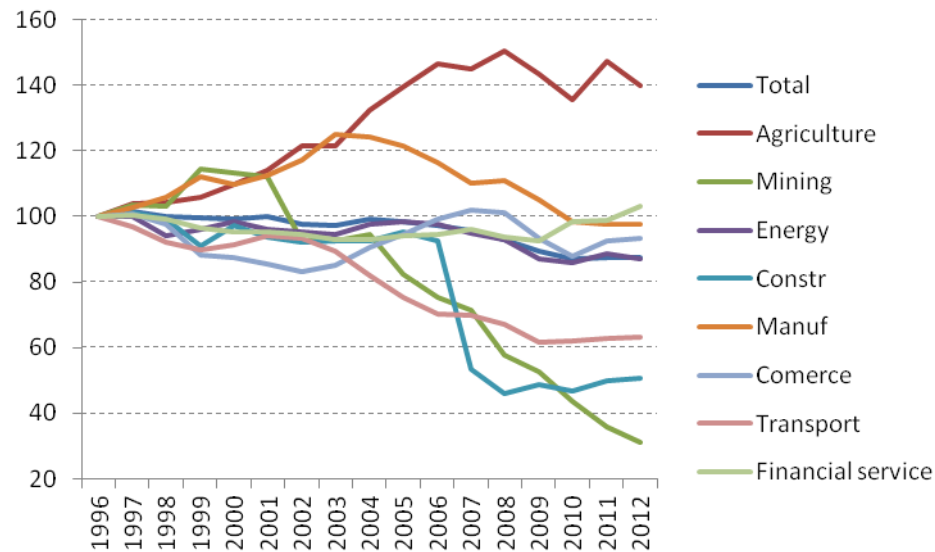
Colombia: PTF falls in all sectors of activity except agriculture

Colombia: total factor productivity index by industry group
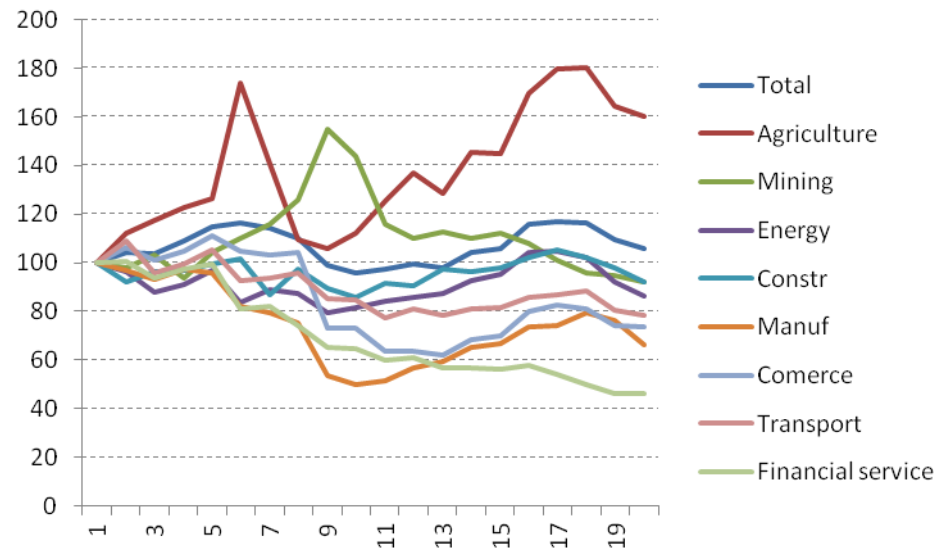
Comparisons

The next tables presents two important comparisons:

- Compare the real output growth rates estimated by APF (Aggregate Production Function) and Aggregate Production Possibility Frontier (APPF), wich can help identify the reallocation of value added across industries.

- Compare the agregate TFP growth rates estimated by APPF with those obtained by the direct aggregation across industries using Domar weights. This can help identify the TFP effect of capital and labor reallocation across industries. The reallocation terms quantify the impact of these restrictions and show to what extent their violations distort our view of aggregate economic growth and its sources.

Comparisons

We can see that the reallocation of value-added annual growth rate of Colombia and México is negative for the full period. Obtained by subtracting the APF from the APPF. There are however substantial variations over sub-periods. In Chile the value-added reallocation term is positive, it suggests that industries with relatively larger real-term shares would also have more rapid real value-added growth. This would usually be the case when prices were falling. If the value-added reallocation term is negative, suggesting that irrational resource moves happened that to some extent ignored underlying market incentives.

Comparisons

In the second panel of table, we compare TFP growth estimated by the APPF approach with that estimated using Domar weights. In the three countries, the TFP estimated without Domar weights is bigger than the TFP estimated with Domar. The much slower Domar-weighted TFP growth across industries indicates that there was accumulated inefficiency in the economy.

México: TFP and reallocation
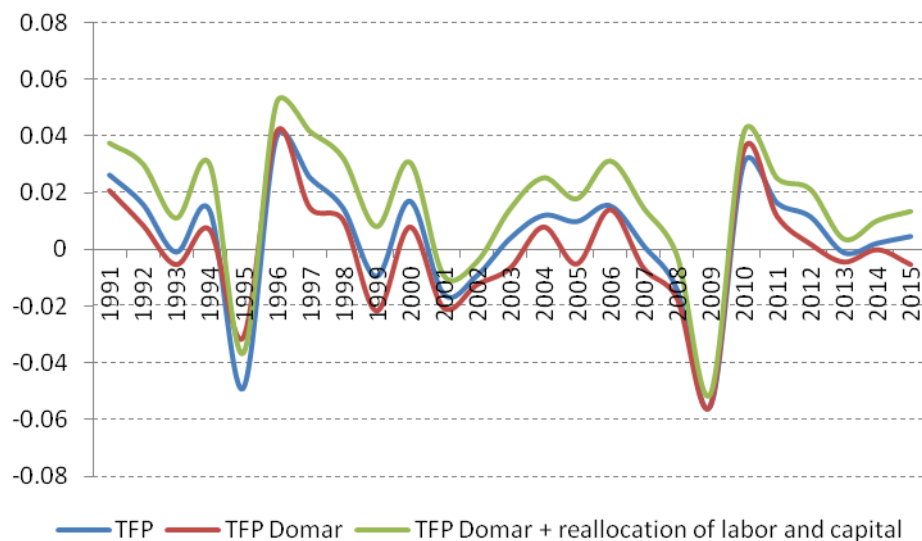
Chile: TFP and reallocation
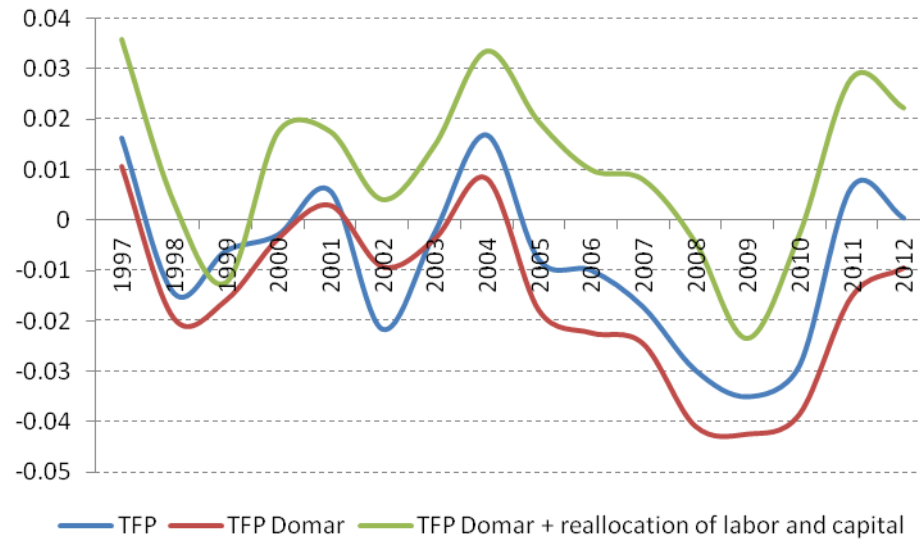
Colombia: TFP and reallocation
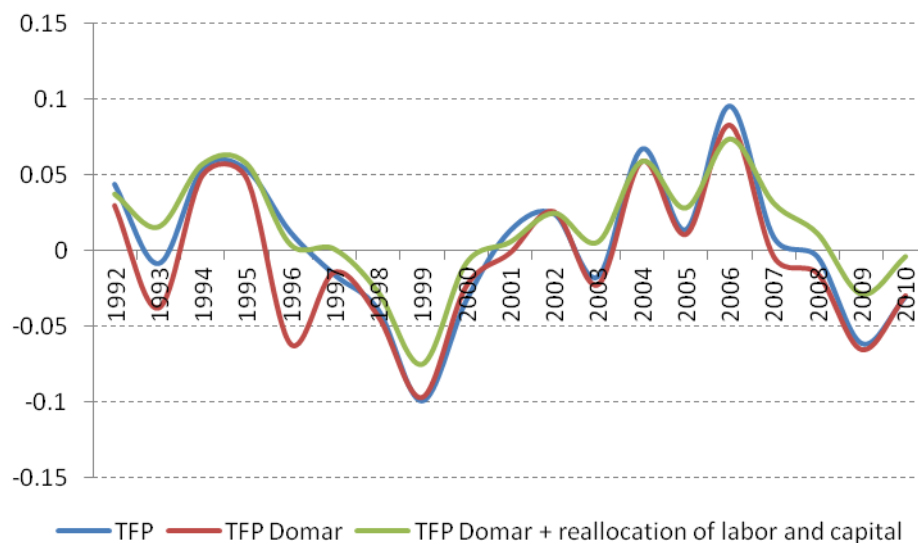
Mexico: aggregate reallocation effects

	1991-1998	1999-2008	2009-2015	1991-2015
Aggregate Production Possibility Frontier (APPF) vs Aggregate Production Function (APF)				
Value-added Growth (APPF)	3.73%	2.70%	2.01%	2.84%
Value-added Growth (APF)	3.96%	2.94%	2.01%	3.01%
Reallocation of Value-added	-0.23%	-0.24%	-0.01%	-0.17%
Aggregate Production Possibility Frontier (APPF) vs Direct Domar Aggregation Across Industries				
Agregate TFP Growth (APPF)	**2.46%**	**1.26%**	**0.90%**	**1.54%**
Domar- weighted TFP	***0.81%***	***-0.62%***	***-0.25%***	***-0.06%***
Agriculture	0.04%	0.05%	0.10%	0.06%
Mining	0.10%	-0.25%	-0.17%	-0.12%
Manufactury	0.12%	-0.31%	-0.25%	-0.16%
Energy	-0.03%	0.07%	0.07%	0.04%
Constr	-0.11%	-0.12%	0.33%	0.01%
Comerce	0.34%	-0.47%	0.34%	0.02%
Transport	0.04%	0.02%	-0.34%	-0.08%
Financial service	0.22%	0.49%	-0.31%	0.18%
General service	0.09%	-0.10%	-0.03%	-0.02%
Reallocation of Capital Input	***1.39%***	***1.56%***	***1.09%***	***1.37%***
Reallocation of Labor Input	***0.26%***	***0.33%***	***0.07%***	***0.23%***

Chile: aggregate reallocation effects

	1996-2002	2003-2008	2009-2012	1996-2012
Aggregate Production Possibility Frontier (APPF) vs Aggregate Production Function (APF)				
Value-added Growth (APPF)	3.83%	3.95%	3.84%	3.88%
Value-added Growth (APF)	3.58%	4.11%	3.73%	3.80%
Reallocation of Value-added	0.25%	-0.16%	0.12%	0.08%
Aggregate Production Possibility Frontier (APPF) vs Direct Domar Aggregation Across Industries				
Agregate TFP Growth (APPF)	**1.40%**	**1.36%**	**0.60%**	**1.14%**
Domar- weighted TFP	*-0.57%*	*-1.68%*	*-2.63%*	*-1.50%*
Agriculture	0.17%	0.15%	-0.04%	0.11%
Mining	-0.07%	-1.30%	-2.45%	-1.13%
Manufactury	-0.11%	-0.05%	-0.19%	-0.11%
Energy	-0.03%	-0.31%	0.05%	-0.12%
Constr	0.18%	-0.06%	-0.26%	-0.02%
Comerce	-0.40%	0.36%	-0.22%	-0.07%
Transport	-0.11%	-0.51%	-0.11%	-0.26%
Financial service	-0.27%	-0.05%	0.59%	0.03%
General service	0.07%	0.10%	0.01%	0.07%
Reallocation of Capital Input	***1.58%***	***2.53%***	***2.68%***	***2.17%***
Reallocation of Labor Input	***0.39%***	***0.51%***	***0.56%***	***0.47%***

Colombia: aggregate reallocation effects

	1992-1998	1999-2010	1992-2010
Aggregate Production Possibility Frontier (APPF) vs Aggregate Production Function (APF)			
Value-added Growth (APPF)	3.81%	2.96%	3.27%
Value-added Growth (APF)	3.98%	3.09%	3.42%
Reallocation of Value-added	-0.17%	-0.13%	-0.15%
Aggregate Production Possibility Frontier (APPF) vs Direct Domar Aggregation Across Industries			
Agregate TFP Growth (APPF)	**2.10%**	**1.05%**	**1.44%**
Domar- weighted TFP	***-0.40%***	***-0.65%***	***-0.56%***
Agriculture	0.12%	0.29%	0.23%
Mining	0.17%	-0.13%	-0.02%
Manufactury	-0.30%	0.02%	-0.10%
Energy	-0.03%	-0.01%	-0.02%
Constr	-0.28%	0.01%	-0.10%
Comerce	0.10%	-0.33%	-0.17%
Transport	-0.04%	-0.11%	-0.08%
Financial service	-1.20%	-0.89%	-1.00%
General service	1.05%	0.51%	0.70%
Reallocation of Capital Input	***1.47%***	***1.25%***	***1.33%***
Reallocation of Labor Input	***1.03%***	***0.45%***	***0.66%***