Factor Market Distortions Across Time, Space and Sectors in China

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Abstract

In this paper we measure the distortions in the allocation of labor and capital across provinces
and sectors in China for the period 1985-2007. Most existing studies have measured factor
market distortions by using some index of dispersion in individual factor returns. However,
the map between these dispersion measures and the efficiency loss due to distortions is
not clear, especially when there is more than one factor. In this paper, we follow Hsieh
and Klenow (2009)'s strategy by measuring the factor market distortions as the reduction
in aggregate TFP due to distortions. We extend their analysis by decomposing the overall
distortions into between province and within-province intra-sectoral distortions. We find: (1)
For the period between 1985 and 2007, the distortions in factor allocation reduced aggregate
TFP by about 33% on average, with the between-province and within-province distortions
each accounting for half of the reduction; (2) the measure of between-province distortions was
relatively constant over the period; (3) the measure of within-province distortions declined
between 1985 and 1997, contributing to 0.96% TFP growth per year, but then increased
significantly in the last ten years, reducing the aggregate TFP growth rate by 1.41% a year;
and (4) almost all of the within-province distortions can be accounted for by the misallocation
of capital between the state and the non-state sectors.

1 Introduction

Some of the rapid growth that China has enjoyed the last three decades has likely come from reductions in distortions that we expect to accompany the processes of economic transition and development. In this paper, we measure the impact on aggregate TFP of distortions in factor allocation across provinces and sectors in China and investigate the contribution of changes in these distortions to aggregate TFP growth.

The period up through the early to mid-1990s in China is often characterized as one of important barriers and restrictions on resource mobility. In addition to restrictions through the hukou system on the movement (both intra- and inter-provincial) of labor out of the countryside (Chan, Henderson and Tsui, 2008), local protectionism and trade barriers also likely impeded the inter-regional flow of goods (Young, 2000; Poncet, 2003). The likely costs of these distortions were reinforced by those on the flow of capital across regions (Boyreau-Debray and Wei 2005, Dollar and Wei, 2007).

The general presumption is that many of these barriers have been significantly relaxed the last decade and a half. For example, migrant labor flows are now in upwards of 150 million, and there have been significant increases in inter-regional trade accompanying reduction in barriers (Holz, 2009). Things are less certain with respect to the behavior of capital flows, however. Reform in the banking system may be helping to allow a more efficient regional allocation of capital through the inter-bank market and other channels. Possibly offsetting some of this is the fact that a significant amount of investment resources continues to be directed by the state to state-owned firms and activity, e.g. infrastructure, or to activities in which the local state is often a beneficiary, e.g. real estate development through land sales. This suggests significant differences in the returns to capital between the state and non-state, which have recently been documented by Brandt and Zhu (2010)). Since the late 1990s, there have also been efforts, through such policies as the Xibu Kaifa (Develop the Great West), to eliminate perceived policy biases in favour of coastal provinces by reallocating investment resources towards the interior regions.

In figures 1 and 3, we plot the returns to labor and capital for the state and the nonagricultural nonstate sectors in 27 provinces of China over the period from 1985 to 2007. Two observations are noteworthy. First, within each province, there is a large gap in returns to capital between the state and the non-state sectors. However, within each sector, the cross-province differences in returns to capital are relatively small. And second, in contrast, there are large cross-province differences in returns to labor, but relatively small cross-sector

difference within each province. In a frictionless economy, the returns to labor and capital would be equalized across province and sectors. The observed differences in returns suggest that factor allocation in China is still highly distorted.

How should one measure the distortions in factor allocation? Existing studies of China's factor market distortions have used some measure of dispersion in the individual returns to labor and capital. Boyreau-Debray and Wei (2003), Dollar and Wei (2005), and Bai, Hsieh and Qian (2006), for example, examine the dispersion in returns to capital, while Gong and Xie (2006) and Zhang and Tan (2007) look at the dispersions in returns to labor as well as in returns to capital, but separately. While these dispersion measures are informative about factor market distortions, there is no clear link between these measures and the aggregate TFP. In this study, we follow the strategy of Hsieh and Klenow (2009) by examining the overall factor market distortions and linking them to aggregate TFP. More specificly, we measure the impact of factor market distortions as the reduction in aggregate TFP due to the distortions. This approach can help us not only to identify the sources of factor market distortions but also to measure the impact of distortions on aggregate efficiency in the economy. While Hsieh and Klenow investigate the misallocation of factors across manufacturing firms, we focus on the distortions in the allocation of factors across provinces and sectors.

Our main finds are:

- On average, the misallocation of factors across provinces and sectors resulted in a 33% reduction of aggregate TFP, with the within-province distortions and between-province distortions each accounting for half of the total reductions.

- The size of between-province distortions was relatively constant over the entire period.

- The measure of within-province distortions declined sharply between 1985 and 1997, contributing to 0.96% TFP growth per year, but then increased significantly in the last ten years, reducing the aggregate TFP growth rate by 1.41% a year.

- Almost all of the within-province distortions was due to the misallocation of capital between the state and the non-state sectors.

Our analysis in this paper is related to a recent literature that links the misallocation of factors, either across sectors, or across firms within a sector, to aggregate productivity. See,

e.g., Gollin, Parente and Rogerson (2004), Restuccia et. al. (2007) and Vollrath (2009) for sectoral analysis, and Banerjee and Duflo (2005); Restuccia and Rogerson (2008); Alfaro et. al. (2008), Bartelsman et. al (2008), Guner et. al. (2008) and Hsieh and Klenow (2009) for analysis of misallocation across firms.

The rest of the paper is organized as follows. In Section 2, we present the theoretical framework for measuring factor market distortions and in Section 3, discuss and data used for empirical analysis. We present the main empirical results in Section 4 and in the last section provide the concluding remarks.

2   A Framework for Measuring Factor Market Distortions

Consider an economy with m provinces, indexed by $i = 1, ..., m$, and two sectors, state and non-state, indexed by $j = n, s$, respectively. We assume Cobb-Douglas production technologies with constant factor income shares in all provinces and sectors:

$$Y_{ij} = A_{ij} L_{ij}^a K_{ij}^{1-a}, \, 0 < a < 1. \tag{1}$$

We also assume that the provincial GDP is a CES aggregate of goods produced in the two sectors and the aggregate GDP is a CES aggregate of provincial GDPs. Thus,

$$Y_i = \left(Y_{in}^{1-\phi} + Y_{is}^{1-\phi} \right)^{\frac{1}{1-\phi}} \tag{2}$$

and

$$Y = \left(\sum_{i=1}^{m} Y_i^{1-\sigma} \right)^{\frac{1}{1-\sigma}} \tag{3}$$

Here ϕ^{-1} and σ^{-1} are the elasticities of substitution among sectors and provinces, respectively. To avoid the result that, without distortions, all factors should be allocated to the province and sector with the highest TFP level, we will assume that the goods across sectors and regions are imperfect substitutes, i.e., positive ϕ and σ.[1]

Let

$$L_i = L_{in} + L_{is}, \, K_i = K_{in} + K_{is}$$

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[1]Alternatively, we could have assumed these goods are perfect substitutes but there is diminishing return in production.

be the employment and capital stock in province i and let

$$l_{j|i} = \frac{L_{ij}}{L_i}, k_{j|i} = \frac{K_{ij}}{K_i}$$

$$l_i = \frac{L_i}{L}, k_i = \frac{K_i}{K}$$

be the shares of employment and capital. Then, the provincial and aggregate TFP can be written as follows:

$$A_i = \left[Y_{is}^{1-\phi} + Y_{in}^{1-\phi}\right]^{\frac{1}{1-\phi}} / (L_i^a K_i^b) = \left[\left(A_{is} l_{s|i}^a k_{s|i}^b\right)^{1-\phi} + \left(A_{in} l_{n|i}^a k_{n|i}^b\right)^{1-\phi}\right]^{\frac{1}{1-\phi}}$$

$$A = \left[\sum_{i=1}^m Y_i^{1-\sigma}\right]^{\frac{1}{1-\sigma}} / \left(L^a K^b\right) = \left[\sum_{i=1}^m \left(A_i l_i^a k_i^b\right)^{1-\sigma}\right]^{\frac{1}{1-\sigma}}$$

So, for a given set of sector-province specific TFPs, A_{ij}, $i = 1, ..., m$, $j = n, s$, and given amounts of aggregate employment and capital stock, L and K, the provincial and aggregate TFPs are determined by the allocation of labor and capital across sectors and provinces.

2.1 Efficient Allocation

As a benchmark, we first examine the efficient allocation of factors when there is no distortion in the economy. To do so, we consider the following social planner's problem:

$$\max_{L_{ij}, K_{ij}} Y$$

subject to (1), (2), (3) and

$$\sum_{i,j} L_{ij} = L \tag{4}$$

$$\sum_{i,j} K_{ij} = K \tag{5}$$

Then, we have

Proposition 1. *For any given L and K, the allocation of labor and capital that maximizes the aggregate GDP is given by the following:*

$$\frac{L_{ij}}{L_i} = \frac{K_{ij}}{L_i} = \pi_{j|i},$$

$$\frac{L_i}{L} = \frac{K_i}{K} = \pi_i,$$

where

$$\pi_{j|i} = \left(\frac{A_{ij}}{A_i^*}\right)^{\frac{1-\phi}{1-(1-\phi)(a+b)}} = \frac{A_{ij}^{\frac{1-\phi}{1-(1-\phi)(a+b)}}}{\sum_{j=1}^{n} A_{ij}^{\frac{1-\phi}{1-(1-\phi)(a+b)}}}$$

$$\pi_i = \frac{(A_i^*)^{\frac{1-\sigma}{1-(1-\sigma)(a+b)}}}{\sum_{i=1}^{m} (A_i^*)^{\frac{1-\sigma}{1-(1-\sigma)(a+b)}}}$$

and

$$A_i^* = \left[\sum_{j=n,s} A_{ij}^{\frac{1-\phi}{1-(1-\phi)(a+b)}}\right]^{\frac{1-(1-\phi)(a+b)}{1-\phi}}$$

Proof: See Appendix.

Proposition 1 says that to maximize output, the share of capital and labor allocated to a sector and province should equal the TFP share in the sector and province, as defined by $\pi_{j|i}$ and π_i. Under the efficient allocation, it can be shown that A_i^* is the provincial TFP and the aggregate TFP is

$$A^* = \left[\sum_{i=1}^{m} (A_i^*)^{\frac{1-\sigma}{1-(1-\sigma)(a+b)}}\right]^{\frac{1-(1-\sigma)(a+b)}{1-\sigma}}$$

For any given allocation of capital and labor, we can then measure the overall distortion and distortion in a province as the proportional loss in TFPs:

$$D = -ln(A/A^*)$$

$$D_i = -ln(A_i/A_i^*)$$

If we just want to know how distorted the actual allocation is relative to the efficient allocation, we could use the measures above and stop here. To understand the sources of the distortions, however, a model is needed to help us identify them and to measure the impacts of the identified distortions.

2.2 Factor Allocation in a Competitive Market with Distortions

Inefficient allocation of factors could be a direct result of factor market distortions or an indirect result of product market distortions. For example, even without factor market distortions, the factors could be inefficiently allocated to a province or sector with low TFP if protections in product market artificially raise the province or sector's profits and therefore factor returns. We consider three distortions: province specific taxes on output and sector-province specific taxes on capital and labor.

2.2.1 Firms' Problem

The profit maximization problem for producing the aggregate GDP Y is

$$\max_{Y_i, i=1,\dots,m} \left\{ P \left(\sum_{i=1}^{m} Y_i^{1-\sigma} \right)^{\frac{1}{1-\sigma}} - \sum_{i=1}^{m} \tau_i^y P_i Y_i \right\}$$

which implies the following first order conditions:

$$\tau_i^y P_i = P \left(\frac{Y_i}{Y} \right)^{-\sigma}, \ i = 1, \dots, m \tag{6}$$

Here τ_i^y is the tax on output produced in province i.

Similarly, the profit maximization problem of producing Y_i is

$$\max_{Y_{is}, Y_{in}} \left\{ P_i \left(Y_{is}^{1-\phi} + Y_{in}^{1-\phi} \right)^{\frac{1}{1-\phi}} - P_{is} Y_{is} - P_{in} Y_{in} \right\}$$

and the corresponding first order conditions are

$$P_{ij} = P_i \left(\frac{Y_{ij}}{Y_i} \right)^{-\phi}, \ j = s, n; \ i = 1, \dots, m \tag{7}$$

Note that we have assumed that there is no sector-specific output tax. We make this assumption because we don't have data to separately identify the taxes.

Using the definition of Y_i and Y, it can be shown that

$$P_i = \left(P_{is}^{\frac{\phi}{\phi-1}} + P_{in}^{\frac{\phi}{\phi-1}} \right)^{\frac{\phi-1}{\phi}} \tag{8}$$

and

$$P = \left(\sum_{i=1}^{m} \widehat{P}_i^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}} \tag{9}$$

Here,

$$\widehat{P}_i = \tau_i^y P_i. \tag{10}$$

The stand-in firm's profit maximization problem in province i and sector j is

$$\max_{K_{ij}, L_{ij}} \left\{ P_{ij} A_{ij} L_{ij}^a K_{ij}^{1-a} - \tau_{ij}^l w L_{ij} - \tau_{ij}^k r K_{ij} \right\}$$

Here, w is the wage and r is the rental price of capital, and τ_{ij}^l and τ_{ij}^k are taxes on labor and capital, respectively. The standard first-order conditions of the problem are:

$$a P_{ij} A_{ij} L_{ij}^{a-1} K_{ij}^{1-a} = \tau_{ij}^l w \tag{11}$$

$$(1-a) P_{ij} A_{ij} L_{ij}^a K_{ij}^{-a} = \tau_{ij}^k r \tag{12}$$

Definition. *For any given set of taxes $\{\tau_i^y, \tau_{ij}^l, \tau_{ij}^k\}_{i=1,\ldots,m;j=n,s}$, the **competitive equilibrium** is a set of prices $\{P, P_i, P_{ij}\}_{i=1,\ldots,m;j=n,s}$, output $\{Y, Y_i, Y_{ij}\}_{i=1,\ldots,m;j=n,s}$, employments and capital stocks $\{L_{ij}, K_{ij}\}_{i=1,\ldots,m;j=n,s}$ such that equations (1) to (12) hold. The corresponding set of shares of employment and capital stock $\{l_i, k_i, l_{j|i}, k_{j|i}\}_{i=1,\ldots,m;j=n,s}$ is called the **competitive allocation implemented by the set of taxes** $\{\tau_i^y, \tau_{ij}^l, \tau_{ij}^k\}_{i=1,\ldots,m;j=n,s}$.*

Proposition 2. *(1) For any set of positive taxes $\{\tau_i^y, \tau_{ij}^l, \tau_{ij}^k\}_{i=1,\ldots,m;j=n,s}$, the competitive allocation implemented by the set of taxes exists and is unique. (2) For any allocation $\{l_i, k_i, l_{j|i}, k_{j|i}\}_{i=1,\ldots,m;j=n,s}$, there exists a set of taxes such that the allocation is the competitive allocation implemented by the set of taxes. (3) Two sets of taxes $\{\tau_i^y, \tau_{ij}^l, \tau_{ij}^k\}_{i=1,\ldots,m;j=n,s}$ and $\{\theta_i^y, \theta_{ij}^l, \theta_{ij}^k\}_{i=1,\ldots,m;j=n,s}$ implement the same allocation if and only if there exists some positive constants, α, β and γ such that $\theta_i^y = \alpha \tau_i^y$, $\theta_{ij}^l = \beta \tau_{ij}^l$ and $\theta_{ij}^k = \gamma \theta_{ij}^k$.*

Proof: See Appendix.

2.3   Identification of Distortion Taxes

Proposition 2 shows that we can identify the distortion taxes (up to a proportional constant) from the actual allocation of labor and capital in the economy. More specifically,

we can use equation (6), (11) and (12) to identify the output, labor and capital taxes as follows.

From equation (6), we have

$$\tau_i^y = \frac{PY}{P_i Y_i} \left(\frac{Y_i}{Y} \right)^{1-\sigma} \tag{13}$$

So the output tax in province i can be calculated using real and nominal GDP in province i and in the aggregate. From equation (11) and (12), we also have

$$\tau_{ij}^l \propto \frac{P_{ij} Y_{ij}}{L_{ij}} \tag{14}$$

$$\tau_{ij}^k \propto \frac{P_{ij} Y_{ij}}{K_{ij}} \tag{15}$$

From Proposition 2 we know that factor allocation is not affected by any proportional change in taxes that is common across all province and sectors. So we can simply set the labor and capital taxes as average products of labor and capital, respectively. In the following, we will use the framework developed in this section to measure factor market distortions in China.

3 Data

In order to generate the various measures of distortions within the Chinese economy that we derived in the previous section, sectoral and provincial data are required. Specifically, employment and real values of capital and output are required for both the state and non-state sectors of the non-agricultural economy. Unfortunately, official statistics are not provided for all the necessary variables and are provided with error for others. Consequently, we construct our own unique panel data set that incorporates both new variables and adjustments to currently reported variables. Overall, the data set is comprised of a panel of 27 provinces spanning 1985-2007[2]. This section highlights the specific procedures and sources[3].

First, consider the state and non-state employment data. Reported levels of total provincial employed persons[4] are available from official sources. Adjustments to the data, however, are required for a number of reasons, including: (1) shareholding corporation employment

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[2]Chongqing is merged with Sichuan; Tibet, Hainan, and Hunan are excluded for missing data; 1978-1984 contains certain missing observations for certain provinces (Tianjin and Inner Mongolia, mainly) and so results will be displayed only for the 1983-2007 period.

[3]Tables of raw data are provided in an appendix to this paper.

[4]"Employed persons" is distinct from "staff and workers," which only cover urban workers.

should be included in the state sector[5]; (2) sum of provincial employment not equaling reported national employment; (3) employed persons includes unemployed individuals and excludes workers of age 15; and (4) reported primary sector employment is likely overstated. The adjustments to correct these issues require the use of the census micro-data records from 1982, 1990, 1995, 2000, and 2005. Differences between total provincial employment and reported national employment are distributed amongst the provinces in a manner consistent with the distribution of employment found in the census. Furthermore, we determine the provincial unemployment rate and fraction of workers age 15 with the census and adjust the yearbook statistics accordingly[6]. Next, reported provincial primary employment data are re-scaled proportionately to match Brandt and Zhu (2010)[7]. Finally, note that all adjustments to the employment data, with the exception of the shareholding corporation employment, are adjustments to the non-state sector. Briefly put, state sector employment is what is reported as State or Shareholding and non-state sector employment is the residual from non-primary sector after subtracting the broadly defined state employment.

Second, sectoral capital stocks are constructed with a perpetual inventory method off the annual fixed asset investment data in the Statistical Yearbooks of China[8]. Investment data is deflated using the official province-specific price index of investment goods for the period 1993-2007. Prior to 1993, however, such provincial data are not available. Instead, we construct an out-of-sample forecast of principal asset deflators based on a regression of provincial asset price deflators on GDP deflators, the national asset price index, and year and province fixed effects. This estimate is conducted on all time periods for which provincial investment price data exists (normally 1992) and projected backwards based on the value of the covariates in the part. The price index series is then used to deflate the Fixed-Asset Investment series. Finally, non-agricultural investment is the fraction of fixed-asset investment that is not in the primary sector, where this fraction is determined by the primary

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[5]We include shareholding corporation employment within the state sector from 1993 onwards.

[6]Data is interpolated between census years and trends forecasted adjustments between 1978-1982 and from 2006-2007. Note also that census employment counts may capture migrant workers in a way that Statistical Yearbooks do not.

[7]Specifically, the correction factor applied to each province is based on the ratio of reported national reported primary sector employment share relative to the share in Brandt and Zhu (2010) arrived at through household-level surveys. Province-specific adjustment factors would be ideal but we lack appropriate data.

[8]Minor adjustments are made, such as including shareholding corporation investment (post-1993) and limited liability investment (post-2005). These subcategories of investment are found in the Fixed Asset Investment Yearbooks of China.

sector fraction of Gross Fixed Capital Formation (data from Moeller (2006))[9]. Assuming a depreciation rate of 7%, the perpetual inventory method is utilized that assumes the first year for which GFCF data exists, for each province, is an equilibrium level. Investment growth rate over the life of the province is used to generate the initial capital value according to $K_0 = I_0/(0.07+g)$[10]. The 1978 capital stock is then rescaled proportionately across provinces such that the total state and non-state capital stocks equal the total national levels as determined by Brandt and Zhu (2010) and evolved forward from there using the adjusted-investment levels.

Finally, GDP statistics by sector and provinces prove the most challenging. We begin with total non-primary GDP as reported in the statistical yearbooks – deflated using the above mentioned official province-specific GDP deflator. We then assume that the fraction of non-primary GDP accounted for in each sector is identical to that sector's share of total employee payroll. Essentially, this follows the methodology of Brandt and Zhu (2010) by assuming relative output-per-worker is identical to relative wages. To perform this decomposition, an estimate of sectoral wages is constructed from official sources.[11] State-sector wages are as reported until shareholding corporation employment is included, after which the broadly defined state sector wages are simply a weighted average of the two. Non-state sector wages are constructed from determining the total urban payroll plus total township-and-village enterprise payroll[12], less the state-sector payroll, per employee in urban and TVE less state. All employment adjustments described earlier in this section are not involved in this calculation of average non-state wages.

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[9]2005-2007 fraction is assumed identical to the 2004 fraction since this is the most recent year in the Moeller dataset. Years between 1978 and the first year of Moeller data is assumed identical to the closest available year.

[10]All provinces have an initial year of 1978, except for Tibet and Chongqing, which begin in 1992 and 1996, respectively.

[11]Labor Statistics Yearbook of China and the Statistical Yearbook of China, for the period 1993-onwards. Total and state-sector employment, by province, for years prior to 1995 are found in China Regional Economy Statistics.

[12]Reported provincial TVE payroll and employment data are adjusted proportionately such that the total of the provincial data is equal to their national counterparts. Official provincial TVE payroll and employment are reported in the Township and Village Enterprise Statistics volume, which covers 1978-2004. National yearbooks provide the data for the recent years.

4 Empirical Analysis

4.1 Parameter Choices

We set the labor share a to 0.5, as in Brandt and Zhu (2010). There are no available estimates of ϕ and σ in the literature. We choose 0.67 as the value for both parameters. This implies that the elasticity of substitution across provinces is 1.5, which is the value commonly used in the international real business cycle literature and is much lower than the values that are used in the trade literature. (See, e.g., Ruhl, 2004.) We choose this low value of elasticity to be on the conservative side in our estimate of distortions. With a higher value of elasticity (and therefore lower value for ϕ and σ), the estimated distortion in China would be larger.

4.2 Measuring TFP by Province and Sector

To measure distortions, we need to have measures of prvince-sector specific TFP A_{ij} for all provinces and sectors. To measure this directly, we would need to have province and sector specific deflators. However, we only have deflators by province. Furthermore, the provincial deflators are all normalized to one in 1978, which means that the real provincial GDPs may also reflect differences in prices in 1978. So, we need to adjust for both the initial provincial price differences and the sectoral price differences in each year. Let $Y_{ij}^{\text{measured}}(t)$ and $Y_{ij}(t)$ be the measured and actual real GDP for province i and sector j in year t. Then, we have

$$Y_{ij}^{\text{measured}}(t) = \frac{P_{ij}(t) Y_{ij}(t)}{(P_i(t)/P_i(1978))}.$$

So,

$$Y_{ij}(t) = \frac{Y_{ij}^{\text{measured}}(t)}{(P_{ij}(t)/P_i(t)) P_i(1978)}.$$

Using a method similar to Hsieh and Klenow (2009), we infer the price information from nominal GDP shares. With the CES aggregate production functions, it can be shown that the prices satisfy the following equations:

$$P_{ij}(t)/P_i(t) = \left(\frac{Y_{ij}^{\text{nominal}}(t)}{Y_{is}^{\text{nominal}}(t) + Y_{in}^{\text{nominal}}(t)} \right)^{-\frac{\phi}{1-\phi}}$$

and

$$P_i(1978)/P(1978) = \left(\frac{Y_i^{\text{nominal}}(1978)}{Y^{\text{nominal}}(1978)} \right)^{-\frac{\sigma}{1-\sigma}}$$

Here, $P(1978)$ and $Y^{\text{nominal}}(1978)$ are the national price index and nominal GDP, respectively. We normalize the national price index in 1978 to one. Then, we can calculate the real GDP in the following way[13]:

$$Y_{ij}(t) = Y_{ij}^{\text{measured}}(t) \left(\frac{Y_{ij}^{\text{nominal}}(t)}{Y_{is}^{\text{nominal}}(t) + Y_{in}^{\text{nominal}}(t)} \right)^{\frac{\phi}{1-\phi}} \left(\frac{Y_i^{\text{nominal}}(1978)}{Y^{\text{nominal}}(1978)} \right)^{\frac{\sigma}{1-\sigma}}$$

Figure 5 shows non-agricultural TFP of the state and the non-state sectors for each of the 27 provinces. As can be seen, the TFP levels in the non-state sector are generally higher than those in the state sector and the gaps have increased over time. There are also significant differences in TFP across provinces. Given these differences, it is clear that the allocation of capital and labor across provinces and sectors has important impacts on the aggregate TFP.

4.3   The Evolution of Factor Market Distortion Over Time

We now examine the impact of misallocation of factors on aggregate TFP. Figure 7 plots the actual and efficient aggregate TFP, A and A^*, respectively. Throughout the period between 1985 and 2007, there is a persistent and significan gap between the actual and efficient TFP, suggesting that there has been persistent misallocation of factors in China. The gap narrowed in the first decade or so, but widened afterwards. Tables 1 shows the growth rates of the efficient and actual TFPs for the entire period and two sub-periods, 1985-1997 and 1997-2007. Between 1985 and 1997, the actual annual TFP growth rate was 0.96% higher than the growth rate of the efficient TFP. In other words, there were improvements in factor alloaction in the first sub-period and their contribution to aggregate TFP growth was nearly one percent a year. In the last decade, however, the average annual growth rate of the actual TFP was 1.41% lower than that of the efficient TFP, implying that the overall factor maket distortion increased during the last decade, more than offsetting all the efficiency gains from reduced distortion in the first sub-period.

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[13]Note that when $\phi = \sigma = 0$, the case of perfect substitution, the actual GDP is simply the measured GDP and therefore, the measured TFP is also the actual TFP. For the cases of imperfect substitution, however, the two are not the same.

4.4 Evaluating the Impacts of With- and Betwee-Province Distortions

Next, we investigate the impacts of differente types of distortions on the aggregate TFP by conducting a series of counterfactual experiements in the model presented in Section 3. To evaluate the impact of within-province distortion in capital allocation, for example, we conduct a counterfactual experiemen in the model by setting the capital taxes of both the state and non-state to the average tax of the two sectors within each province. We then compare the resulting measure of the aggregate distortion to the original measure. The difference can be interpreted as the contribution of the within-province misallocation of capital on aggregate TFP.

The counterfactual experiments that we conduct are listed below:

- No within-province distortion:

  - No within-province distortion in capital allocation: Eliminating the within-province difference in capital returns by equalizing the taxes between the state and the non-state sector for capital only.

  - No within-province distortion in labor allocation: Eliminating the within-province difference in labour returns by equalizing the taxes between the state and the non-state sector for labour only.

- No between-province distortion:

  - No between-province product market distortion: Eliminating the cross-prinvice differences in output taxes.

  - No between-province distortion in capital allocation: Eliminating the cross-prinvice differences in capital taxes.

  - No between-province distortion in labour allocation: Eliminating the cross-prinvice differences in labour taxes.

4.4.1 Experiements with No Within-Province Distortion

Distortions within a province take the form of labor or capital market distortions between the state and nonstate sectors. Figures 8 and 9 display these distortions over time by plotting the percentage difference between efficient and actual TFP. Removing the capital market

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distortions within each province lowers the distortion to half its original value for 2007. Furthermore, the counterfactual level of aggregate distortions would have been relatively stable rather than increasing rapidly in the last decade. This implies that the rising cost of distortion in the last decade was mainly due to the worsening in capital allocation between the state and the non-state sectors. In contrast, shutting down the labour market distortions results in almost no impact on the aggregate TFP and overall distortion.

4.4.2 Experiments with No Bewteen-Province Distortion

Figures 10-12 plot the aggregate distortion measure under three scenarios: no distortion in capital allocation, labour allocation, or product market across provinces within each sector. In contrast to the within province results, the between province capital market distortion has little impact on aggregate TFP. Between province labour markets, however, contribute nearly ten percentage points to the 45% gap between efficient and actual TFP in 2007 and is fairly constant through time. The product market distortion has similar, though slightly smaller, impact. Overall, none of the between province distortions seems to be worsening or improving through time.

4.5 Discussion

Perhaps the most important result from our empirical analysis above is regarding the misallocation of capital between the state and non-state sectors. This distortion accounts for half of the overall impact of distortions on aggregate TFP and, more important, almost all the time variations in the impact of distortions. What drives the changes in capital market distortion? In particular, why has the distortion increased in the last decade? Here we provide some preliminary evidence showing that it may has to do with the Chinese government's regional policies.

Figure 13 shows the average output per worker for China's four geographical regions: East, Middle, Northeast and West. In 1997, among the four regions, the Eastern region, which includes all the coastal provinces, had the highest labor productivity and the Western region's labor productivity was the lowest. Around that time, many economists and policy makers argued that this disparity in performance was mainly due to the central government's preferential policies towards the Eastern provinces that allowed these provinces to attract more invsetments. To reduce the disparity, it was argued, the central government should adopt policies that would direct more investments to Western provinces, which had the

lowest labor productivity among the four regions. Thus, a policy initiative called Develop the Great West was introduced by the central government in the late 1990s.

In reality, was the lack of development in the Western region a result of capital scarcity? The answer is no. Figure 14 shows that the Western region actually had the highest capital-output ratio among the four regions. The Develop the Great West policy worked in one aspect: significantly higher Western capital-output ratio between 1997 and 2007. However, it failed in accomplish its (stated) ultimate objective of reducing regional income disparity: Between 1997 and 2007, the disparity in labor productivity between the Western and Eastern regions increased, not decreased. Why the increase in disparity despite the increase in capital intensity in the West? Because most of the increased investment was directd to the region's state sector, which had much lower TFP than that of the non-state sector. (See Figure 15 and 16 for capital-output ratio and TFP by sector and region.) Thus, misallocation of capital between the state and the non-state sector worsened as as result of the regional development policy. Table 2 shows the average impact of the increased within-province misallocation of capital on provincial TFP for the four regions during the period of 1997-2007. Within-province misallocation of capital had the largest negative impact on TFP growth in the Western region, reducing the potential TFP growth rate by 1.63% a year.

5   Conclusion

In this paper, we examine the impact of the misallocation of resources across provinces and sectors (state versus non-state) on aggregate TFP. Despite significant increases in factor mobility, our analysis suggests that China continues to suffer high costs arising from factor market distortions. Even as late as 2007, these distortions were lowering aggregate TFP by a third; alternatively, aggregate TFP would increase by a half without these distortions. Within province distortions arising from the favored treatment of the state-sector vis-a-vis the non-state are most important. After declining during the first decade and a half of reform, these distortions have increased significantly since 1997. There is also a marked "regional" dimension to them, with the distortions and their costs more severe in the central and western provinces. A case can be made that much of this is related to the central government's efforts to redistribute resources to these provinces through a highly inefficient state sector. With the opportunities for future increases in output on the extensive margin narrowing rapidly, these costs on aggregate TFP are likely to take on added importance.

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Table 1: TFP Growth Rates, Efficient and Actual

Period	1985-2007	1985-1997	1997-2007
Efficient	4.69%	4.43%	5.01%
Actual	4.58%	5.39%	3.60%
Impact of Distortion :			
Actual-Efficient	-0.11%	0.96%	1.41%

Table 2: Average TFP Growth Rates by Region

Period	1997-2007			
	East	Middle	Northeast	West
Actual	3.90%	3.71%	4.39%	2.48%
No Within-Province Distortion	4.85%	5.17%	5.98%	4.10%
Impact of Distortion:				
Change on TFP	-0.95%	-1.46%	-1.59%	-1.63%

Figure 1:

Returns to Labour, Box Plot

State Sector · Nonstate Sector
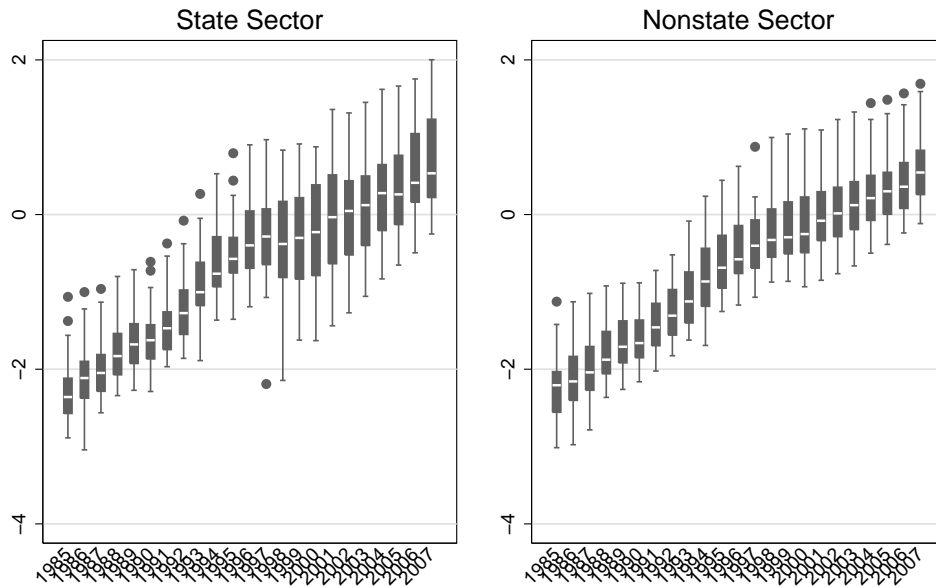
Log of nominal labour returns

Figure 2:

Log Differences, Nonstate–State, Labuor Returns
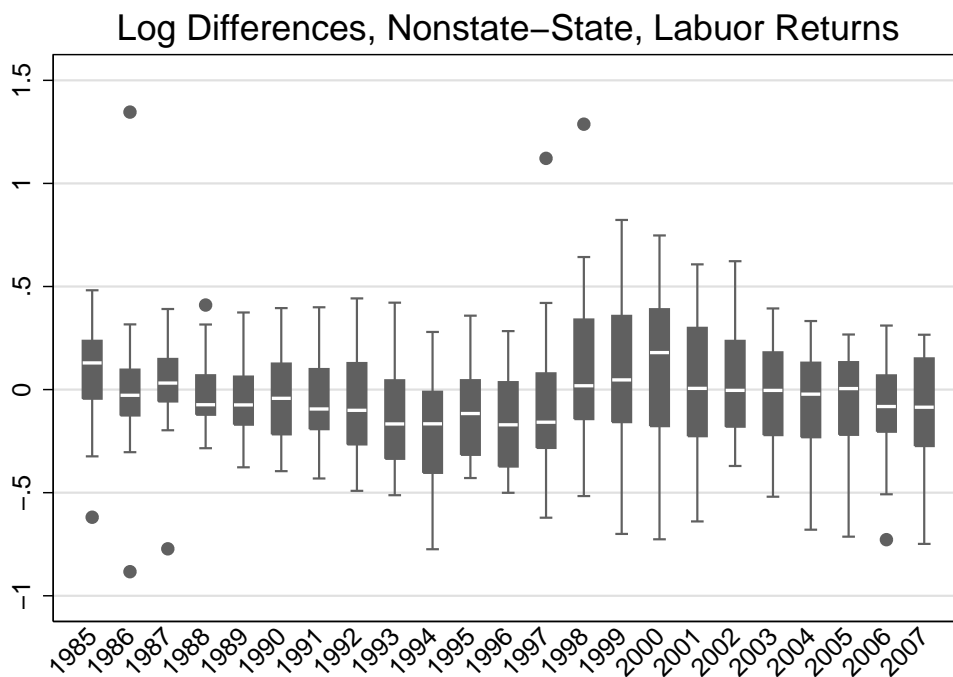
Figure 3:

Returns to Capital, Box Plot

State Sector
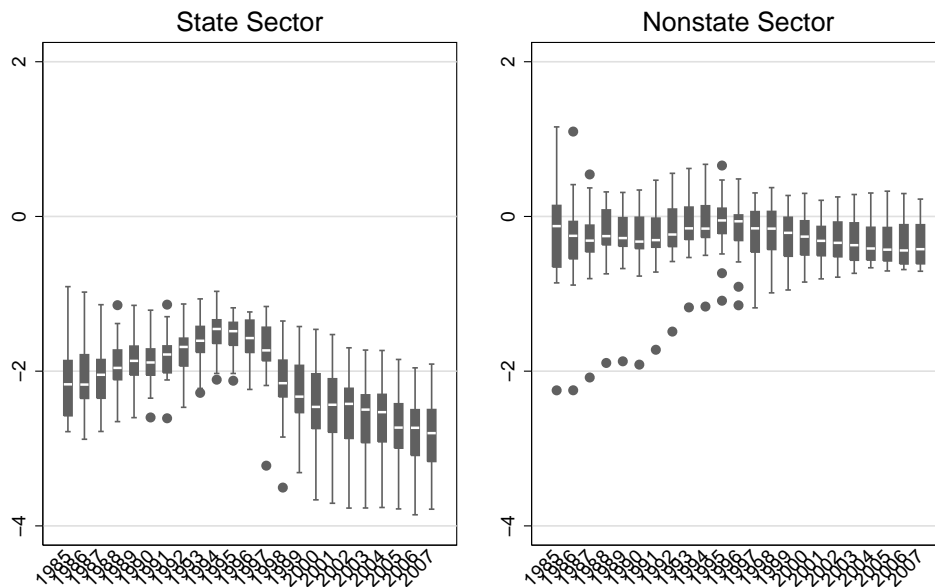
Nonstate Sector

Log of nominal capital returns

Figure 4:

Log Differences, Nonstate−State, Capital Returns

20
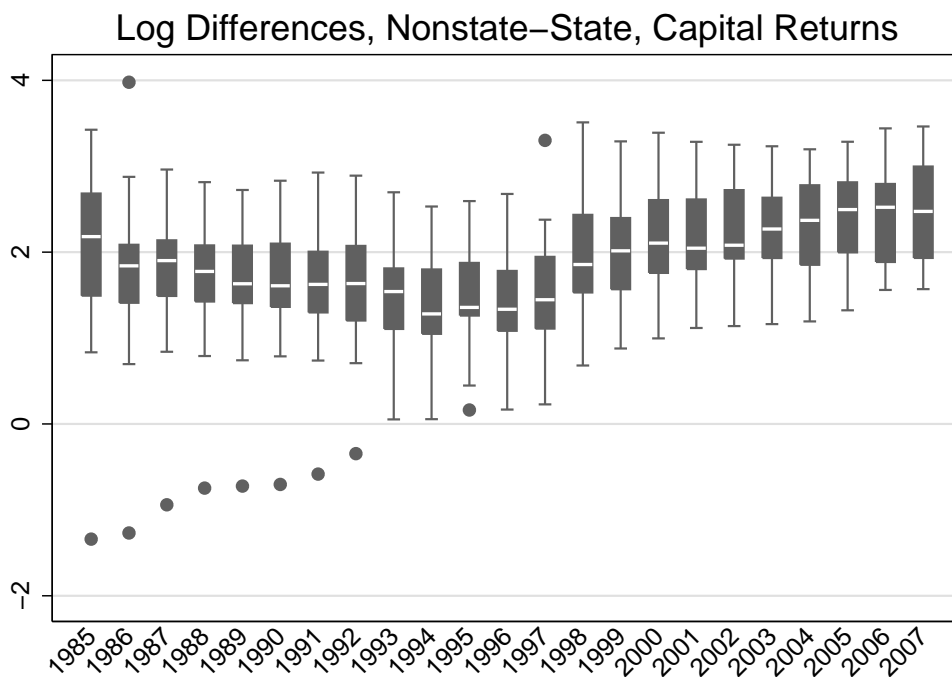
Figure 5:

TFP, Box Plot

State Sector   Nonstate Sector
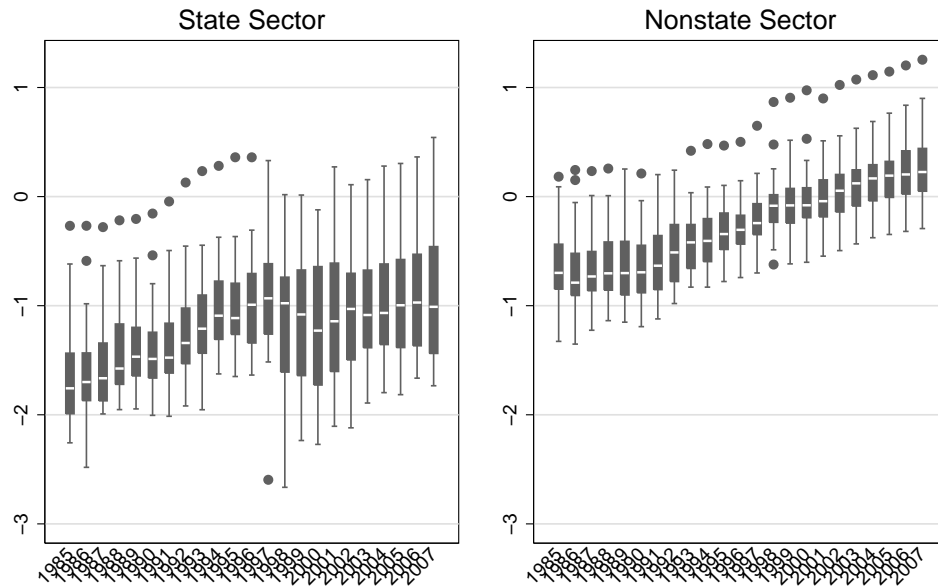
Log of total factor productivity

Figure 6:

Log Differences, Nonstate−State, Total Factor Productivity

21
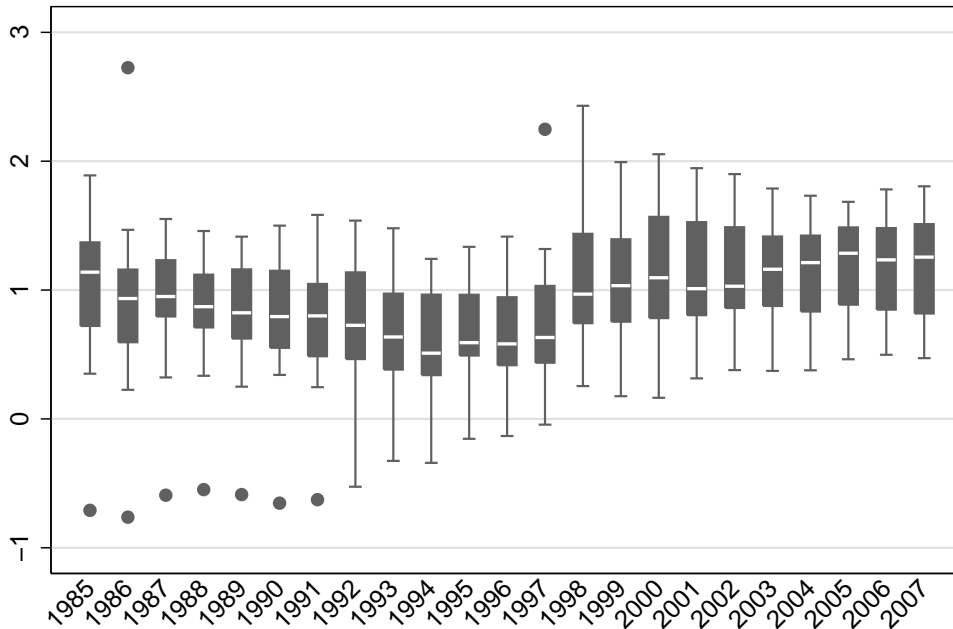
Productivity over Time
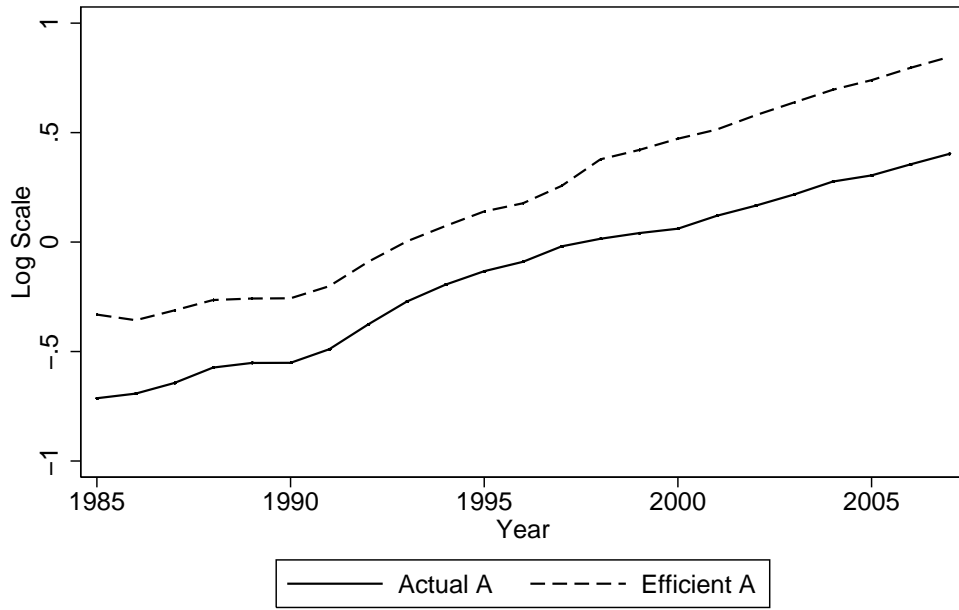
Note: Phi=.67 and Sigma=.67

Figure 8:

Within-Province Distortions Through Time
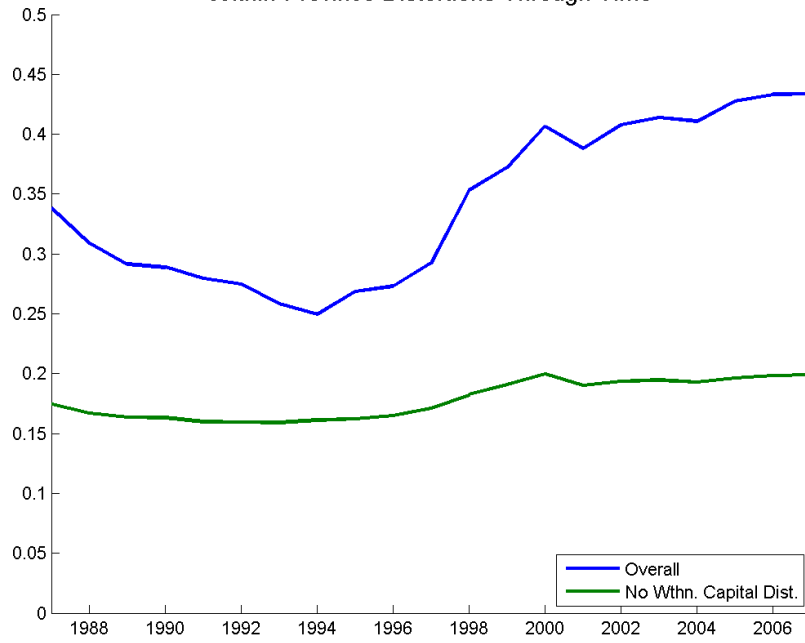
Figure 9:

Within-Province Distortions Through Time

Figure 10:

Between-Province Distortions Through Time

Figure 11:
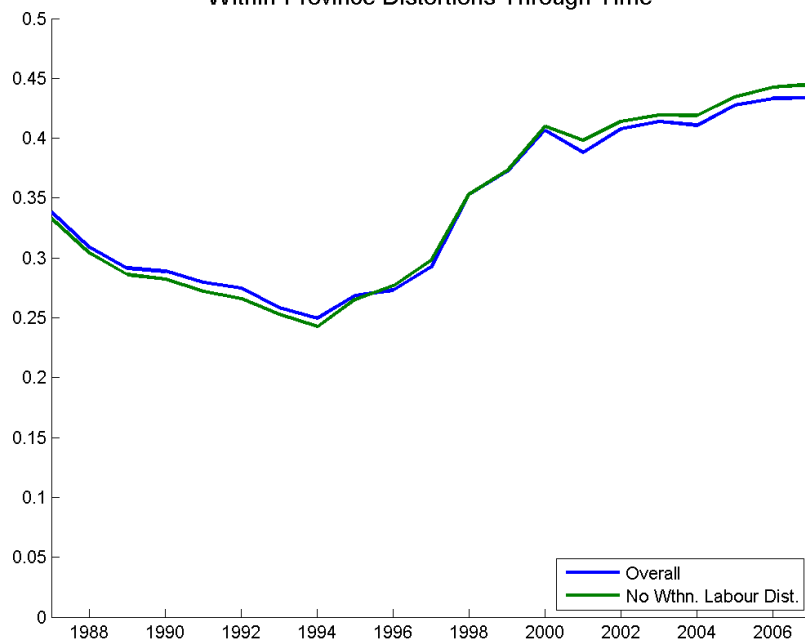
Between-Province Distortions Through Time
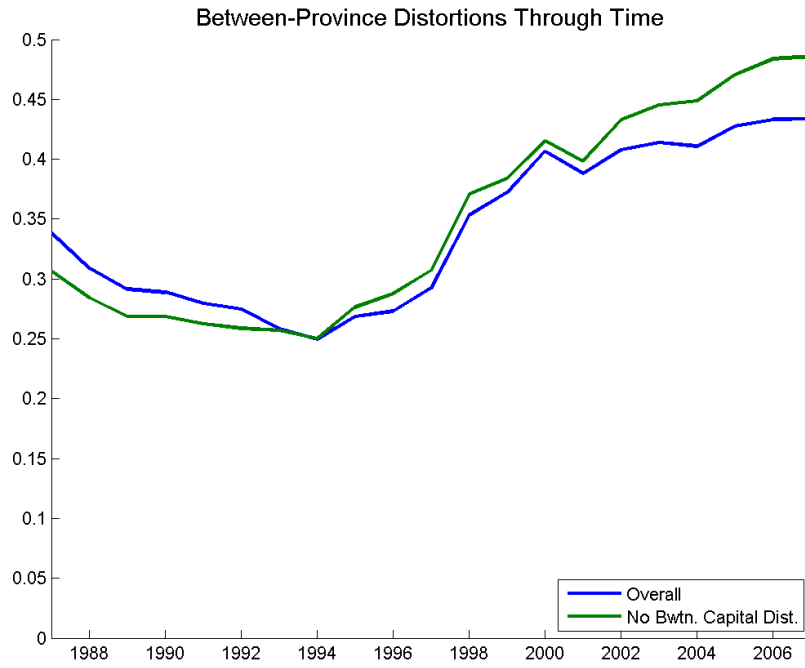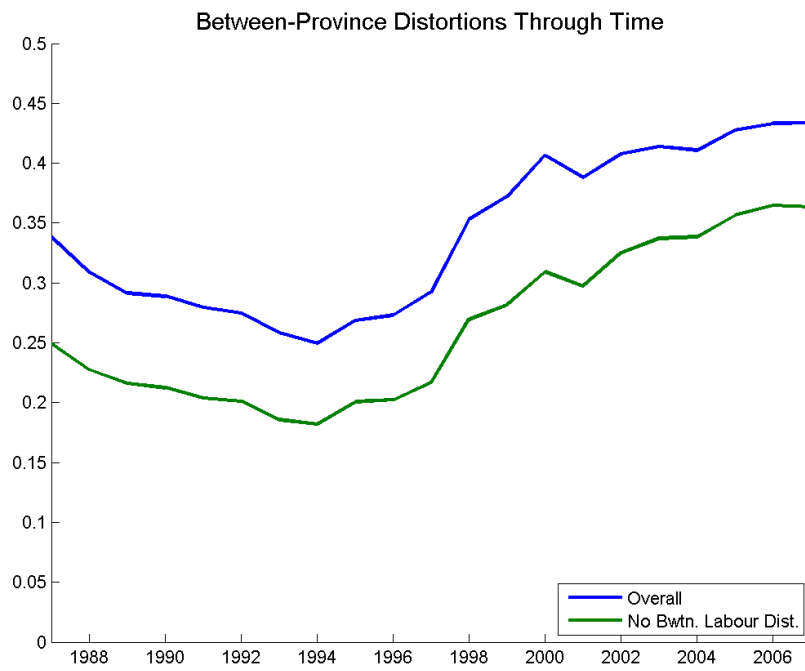
Between-Province Distortions Through Time
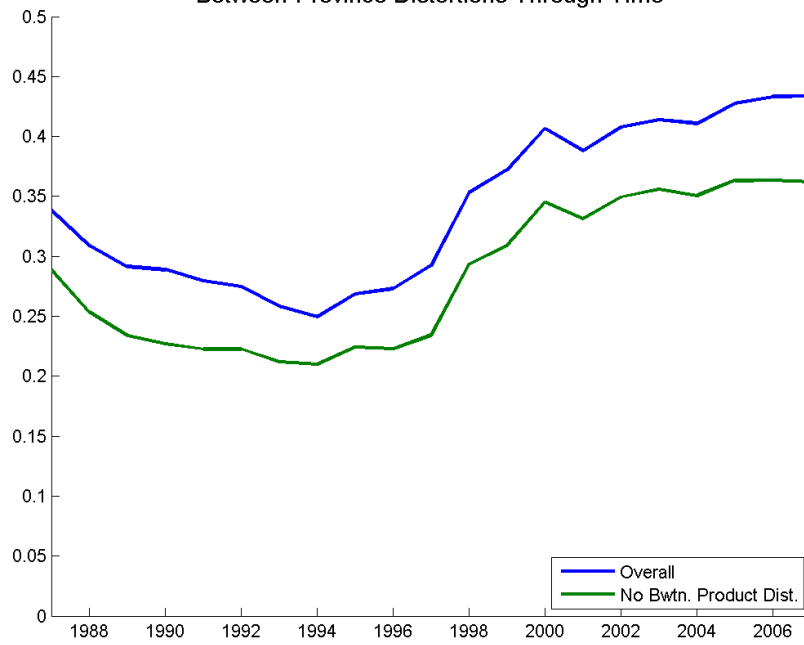
Figure 13:

Output per Worker, by Region
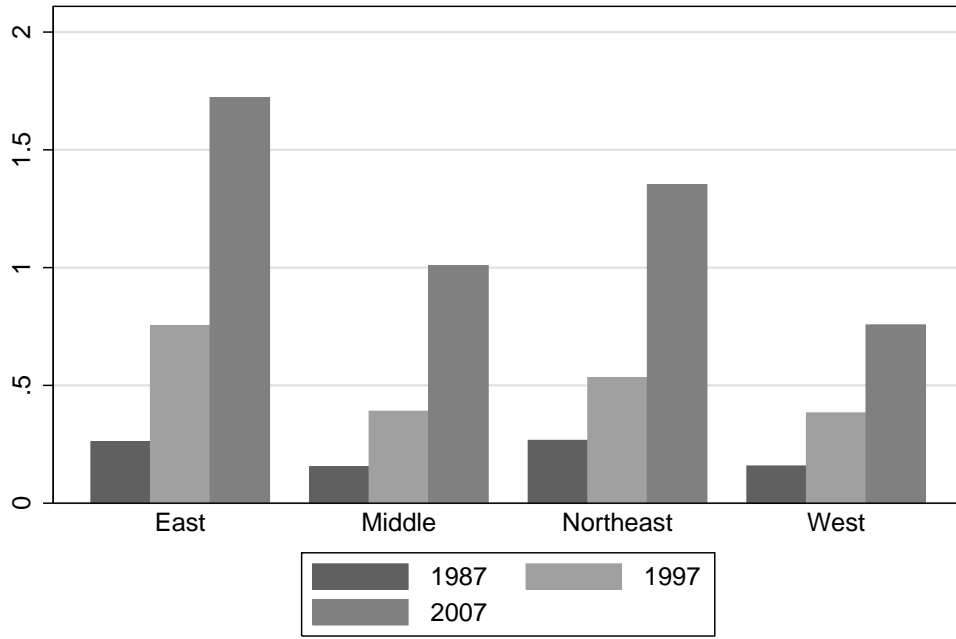
Figure 14:

Capital−Output Ratio, by Region

26

Figure 15:

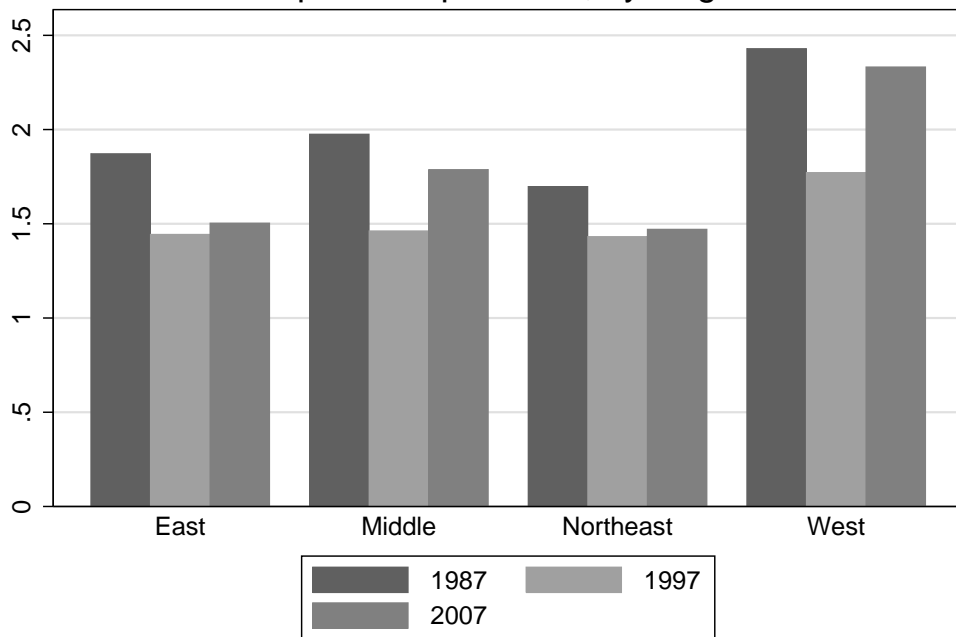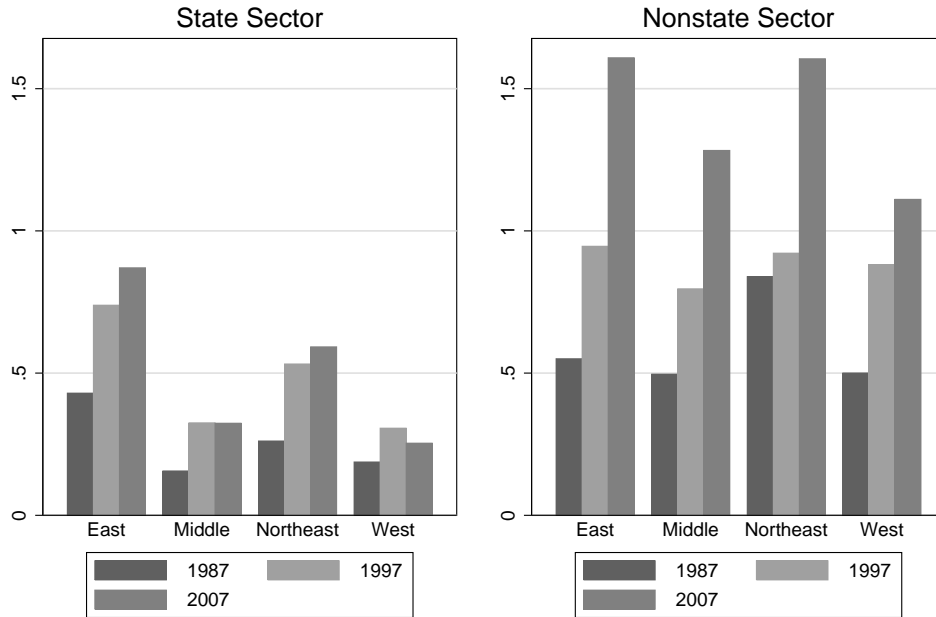## Total Factor Productivity, by Region

Figure 16:

Capital Output Ratio, by Region