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ABSTRACT

This paper studies dynamic labor demand by private and public manufacturing plants in China. It contributes along two dimensions. First, it uncovers the objectives of public enterprises and compares them to private enterprises. Second, it estimates adjustment costs of these plants and thus their (dynamic) labor demand. One of our principal findings is that public plants maximize the discounted present value of profits without a soft-budget constraint. There is strong evidence of both quadratic and linear firing costs at the plant level. Costs of adjusting hours are small and lower for private compared to public plants. The private plants operate with considerably lower quadratic adjustment costs. The higher quadratic adjustment costs of the public plants may reflect their internalization of social costs of employment adjustment. Domestic private plants and collective plants have about the same discount factor, much lower than state controlled plants.

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1 Motivation

Any analysis of the effects of government policy, such as labor market interventions, trade policy, environment reforms, must predict the response of private households and firms. For some economies, like China and many European countries, the presence of a large public sector adds another dimension: predicting the effects of policy on public firms.

In the absence of a large public sector, many analyses solve constrained optimization problems for agents and use the resulting policy functions as inputs into forecasting policy effects. The natural extension of this methodology is to do the same for public firms: use the solution of a constrained optimization problem to predict responses to policy interventions. While it is natural to use utility and profit maximization as the objectives of private households and firms respectively, what are the objectives and constraints of public firms? Answering that question is one goal of this paper.

The paper contributes to the broad literature linking ownership to performance. In our analysis, ownership varies between public plants and private plants. The private plants are assumed to be profit maximizing, facing costs of adjusting labor. The public firms maximize a more flexible objective and may face constraints different from the private plants. Our results are best interpreted as comparative: how does the behavior of the public plants differ from the private ones?

Historically, the nature of public firms in China was distinct from those in capitalist countries. In the US and other countries with free markets, public firms arose either because of natural monopoly, like electric utility and telegraph industries, or because of the need to provide public goods. The former sectors are under rate-of-return regulation and the objective of public firms under this regulatory constraint has been tested empirically. For instance, using the operation data of utility firms in the US between 1965 and 1970, Pescatrice and Trapani (1980) show that public utilities behave as cost minimizers with zero profit. Meanwhile, the public good sectors are commonly under output price control and are subsidized by the government. The objective of these public firms is mainly to provide community benefits.

Prior to the economic reform, the public firms in China dominated the economy, accounting for over 95 percentage of total industrial output.[1] The public firms acted more like public

[1] Reported by China government media internet: news.Xinhuanet.com at 2004. 07.08.

good providers. These public firms, especially the medium and large-sized ones, established a resident community or small society providing all kinds of social services and facilities to its community members. The public firms had multiple objectives including expansion of social employment, and provision of various social services and securities, such as housing, education, hospital care, health insurance, and pensions. In the middle of 1990s, about half of industrial public firms were unprofitable.

China's state-sector reforms began in the 1990s, aiming at increasing the efficiency of public firms and promoting economic growth. The reforms broke the lifetime employment system, the so-called 'iron rice bowl', encouraging labor mobility. Over the past two decades, the labor market has been transformed to an increasingly market-driven system. The reforms changed the incentive system, allowing firm autonomy and linking managerial pay and promotion to firm's profit. The public firms have been pushed into the market place to either compete or go bankrupt. Private firms, including foreign firms and joint-ventured firms, have developed rapidly and have contributed more than 60 percentage to China's total industrial output since 2002.[2] As competition among firms increases and the transformation toward a market oriented system has occurred, one might expect that the difference in behavior among public firms and private firms would narrow.

With our question and this background in mind, this paper studies dynamic labor demand for private and public manufacturing plants in China.[3] To do so, we estimate the costs of labor adjustment and the objectives of private and public plants using a simulated method of moments (SMM) approach. The idea is to use key moments of labor input, output and productivity at the plant level to infer the parameters of the dynamic optimization problems. Our approach is to specify a couple of alternative objectives and determine which one better matches pertinent data facts.[4] One contribution of this paper is to use the SMM methodology to infer the objectives of the public plants.

In looking at the behavior of private and public plants, there are some striking similarities. First, the public plants, like the private plants, appear to be maximizing the discounted expected value of profits. Importantly, labor demand is not a static decision: adjustment

[2] Source: China Statistical Yearbook 2012.

[3] As discussed in section 3, a public plant is determined by share holdings rather than registration. Public plants are then decomposed into state controlled and collectively controlled plants.

[4] A similar approach underlies Gowrisankaran and Town (1997) who study the behavior of not-for-profit hospitals, and estimate an objective function which includes both profits and quality.

costs are present and imply forward looking behavior by plants. Second, the best fitting model entails a non-convex firing cost along with linear and quadratic adjustment costs.

However, there are some notable differences. The estimated quadratic adjustment costs are much larger for the public plants, perhaps reflecting an internalized gain to employment stability. The cost of adjusting hours is also higher for the public plants. Finally, private plants discount future slightly more than public plants, but domestic private and collective plants have about the same discount factor, much lower than state controlled plants.

In terms of the objective of the public plants, they are best described as profit maximizers with an added quadratic cost of employment adjustment. We allow public plants to operate under a soft budget constraint where profits are non-negative. This does not improve the fit of the model.

2 Dynamic Optimization Problem

This section discusses the dynamic optimization problems for the private and public plants. The generic dynamic optimization problem is

$$V(A, e_{-1}) = \max_{h,e} \Gamma(A, e, h, e_{-1}) + \beta E_{A'|A} V(A', e) \quad (1)$$

for all (A, e_{-1}). Employment adjustment is assumed to be completed within a period. The function $V(A, e_{-1})$ is the value function of a plant continuing in operation.[5] The state vector contains two elements: A is the stochastic profitability of the plant and e_{-1} is the stock of workers in the previous period. The control variables are the hours worked per worker, h, and the number of workers for the current period, e.

The function $\Gamma(A, e, h, e_{-1})$ represents the current payoff to the plant. Imbedded in this function are the adjustment costs as well as the objective function. Ultimately, the differences in adjustment costs between private and public plants are captured by this function.

While there is no physical capital, it is important to be clear the sense in which this is not a static optimization problem. With costs of adjusting labor, the stock of workers at the start of a period is a state variable for a plant. Hires and fires made during the period are reflected in the value of the state variable in the next period. Unlike capital, this dependence

[5] At this stage, we do not consider entry and exit decisions.

over time is not due to time-to-build: labor hired in a period are used in that period. Rather, the dynamics come solely from the presence of adjustment costs.

Given that this is an intertemporal decision, the discount factor, β, will indeed play an important role in determining the response of firms to variations in the profitability of their operations. To the extent public and private firms discount at different rates, their behavior will differ.

In solving (1), the plant takes as given the cost of inputs, principally labor. Thus we view the labor market as a spot market. Once the profitability of a plant is observed, it is able to hire labor, on both the extensive and intensive margins, as needed. The model abstracts from *ex ante* contracts that might arise between firms and workers as well as search frictions. As presented in Cooper, Haltiwanger, and Willis (2007), the frictions we identify here as hiring and firing costs can be included in a search and contracting model of the labor market.

2.1 Private Plants

The generic model in (1) can be tailored to study privately-owned profit maximizing plants. The objective function for a privately-owned plant is

$$\Gamma(A, e, h, e_{-1}) = R(A, e, h) - \omega(e, h) - C\left(A, e_{-1}, e, h\right). \tag{2}$$

Here $R(A, e, h)$ is the revenue flow of a plant employing e workers, each working h hours in profitability state A. The revenue function has the form

$$R(A, e, h) = A(eh)^{\alpha}. \tag{3}$$

This revenue function is the product of a production function, defined over the total labor input eh, and the demand curve facing the plant. The parameter α captures the curvature of the production process along with the elasticity of demand. Other factors of production, which are assumed not to entail any adjustment costs, are chosen optimally as well but are implicit in revenue and thus in the optimization problem.[6]

[6] That is, one can think of $R(A, e, h)$ as the revenue obtained less the costs of the other inputs. Since the quantities of those other inputs are dependent on (A, e, h), the $R(A, e, h)$ captures these choices. The functional form in (3) can be derived from a plant optimization problem over flexible factors with a constant returns to scale technology and a constant elasticity demand curve for plant output.

The function $\omega(e,h)$ in (2) is total compensation paid to the e workers each working h hours. The compensation function takes the form

$$\omega(e,h) = e(\omega_0 + \omega_1 h^{\zeta}). \tag{4}$$

The parameters characterizing this function will be part of our estimation.

The cost of adjusting the stock of workers is given by $C(A, e_{-1}, e, h)$. A general cost of adjustment function is:

$$C(A, e_{-1}, e, h) = F^{+} + \gamma^{+}(e - e_{-1}) + \frac{\nu^{+}}{2}\left(\frac{e - e_{-1}}{e_{-1}}\right)^2 e_{-1} \tag{5}$$

if there is job creation $e > e_{-1}$. Similarly

$$C(A, e_{-1}, e, h) = F^{-} + \gamma^{-}(e_{-1} - e) + \frac{\nu^{-}}{2}\left(\frac{e - e_{-1}}{e_{-1}}\right)^2 e_{-1} \tag{6}$$

if there is job destruction $e < e_{-1}$. If $e = e_{-1}$, so there are no net changes in employment, then $C(A, e_{-1}, e, h) \equiv 0$.

There are three forms of adjustment costs, with differences allowed for the job creation and job destruction margins. The first is a quadratic adjustment cost, parameterized by ν. A second, parameterized by F, is a fixed cost of adjusting the work force.[7] In general, these costs can vary depending on whether the plant is creating or destroying jobs. Finally, we allow linear adjustment costs, parameterized by γ to capture, for example, severance payments to workers.

In addition to the differences in adjustment costs of hiring and firing workers, this study adds another feature: the use of thresholds for the non-convex adjustment costs. So, as a leading example, the fixed cost of firing (F^{-}) may apply only if the job destruction rate exceeds a bound. Through this modification of (6), we are able to capture certain institutional features that may generate nonlinearities in adjustment costs.

The optimization generates choices along a couple of dimensions. First there is the discrete choices of job creation, job destruction or inaction. The latter is an important option given plant-level observations of no net employment changes. Second, there is the

[7] In previous work on labor adjustment, Cooper, Haltiwanger, and Willis (2004) found evidence in U.S. plants in favor of an opportunity cost model relative to the fixed cost form of non-convex adjustment costs. There was no evidence in favor of this form of adjustment cost in the Chinese data and it was dropped from consideration in what follows.

continuous choice of job creation (destruction). If the job creation (destruction) rates exceed the threshold, additional non-convex adjustment costs might apply. Third, there is the adjustment of hours. Variations in hours will reflect both the state of profitability and the choices on the extensive and intensive employment margins.

2.2 Public Plants

The dynamic optimization problem for a public plant is potentially different from (1). The key difference is in the objective function of the public plant which might reflect social objectives. Of course, the public plants are not operated directly by the government. Operational decisions are made by managers who may also have aspirations for promotion within the structure of state controlled enterprises or even in the private sector. The objective function for the plant reflects the desires of the government insofar as the manager is motivated to pursue these goals.

In general, the current payoff of the public plant is given by:

$$\Gamma(A, e, h, e_{-1}) + S(A, e, h, e_{-1}). \tag{7}$$

Here $\Gamma(A, e, h, e_{-1})$ is the same as in (2). Profits are included both because a public firm could be interested in maximizing profit *per se* and also because tax revenues flow to state and local governments.[8] Further, a manager wishing to signal ability to the market could gain through higher profits.[9]

The second term in the objective function, $S(A, e, h, e_{-1})$, covers objectives of the public plant beyond profit maximization. A public plant undergoing mass job destruction will impose big social pressure on governments and government officials at all levels. For example, by 2009, in most governments, as well as in important organizations and enterprises, an "Office of Social Stability" has been established to evaluate, resolve, and monitor social unrest, big criminal events, and terrorism. To the extent these events are triggered by employment adjustment, they are captured in our objective.

[8] Lee (2009) discusses the review of managers at public enterprises which includes an assessment of how well the firm is achieving the goals of the state as laid out in the overarching five-year plan and industry-specific development plans.

[9] Groves, Hong, McMillan, and Naughton (1995) discusses incentives for profit maximization by managers in public plants in the 1980s.

We consider a couple of models of $S(A, e, h, e_{-1})$. The first, termed the "employment stabilizer", asserts that the public plant is interested in employment stability. Thus there is an additional cost, beyond the adjustment cost already included in $\Gamma(A, e, h, e_{-1})$, of employment variability. In this case,

$$S(A, e, h, e_{-1}) = -\frac{\nu^S}{2}\left(\frac{e - e_{-1}}{e_{-1}}\right)^2 e_{-1}. \tag{8}$$

In this specification, the cost of employment adjustment is parameterized by ν^S. This term is exactly like the quadratic adjustment cost term already included in $\Gamma(A, e, h, e_{-1})$ through $C(A, e, e_{-1})$. Hence the quadratic cost of adjustment for a public plant is straightforward to estimate and compare to the adjustment costs for private plants.

A second model, termed the "job creator" adds a benefit of job creation to the public plant's objective function and penalizes the public plant for job losses. In this case,

$$S(A, e, h, e_{-1}) = \tilde{F}^+ \tag{9}$$

when $e > e_{-1}$ and

$$S(A, e, h, e_{-1}) = -\tilde{F}^- \tag{10}$$

when $e < e_{-1}$. If there are gains to job creation and costs to destruction, we would expect: $\tilde{F}^+ > 0$ along with $\tilde{F}^- > 0$.

In many descriptions of public plants, the theme of a "soft budget constraint", hereafter SBC, arises. One interpretation of this is that by following other objectives, imbedded in $S(\cdot)$, the public plant may in fact operate in an non-profitable fashion.[10] In that case, the government may provide a subsidy.

We model this by assuming that the first term in the objective function (1) is given by

$$\tilde{\Gamma}(A, e, h, e_{-1}) = max\{0, \Gamma(A, e, h, e_{-1}) + S(A, e, h, e_{-1})\} \tag{11}$$

where $\Gamma(A, e, h, e_{-1})$ is defined in (2). With this subsidization, the public plant can undertake other objectives, such as employment stability, without incurring sustained losses. Further, under this objective, the public plant has no incentive to shut down temporarily

[10] This draws upon the discussion of soft budget constraints in Lin and Li (2008). In that analysis, the state imposes a "policy burden" on a public plant, such as employment stability, and must support the public plant in order for it to remain in operation.

or even permanently. Without a SBC, a public plant with extremely low profitability may choose to close temporarily, and perhaps retain its workers but not paying them. With this subsidization, a public plant with very low profitability may still produce and pay its workers at least a base wage.

Our approach is to estimate the parameters for these specifications of the public plant objective. We use the estimates from the profit maximizing plants to create a baseline and to attribute public plant patterns of dynamic labor demand that differ from those of private profit maximizing plants to these difference in objectives.

As with the private plants, we assume that the public plant takes as given the cost of labor. The estimation will uncover a compensation function for public plants that differs from that of the private plants.

3 Data

The data are from Annual Surveys of Industrial Production (1998-2007), conducted by the National Bureau of Statistics (NBS) of China. [11] The raw data consist of all private plants with more than five million Yuan in revenue (about $700,000) and all public plants.[12]

The number of plants in the survey increased from over 160,000 in 1998 to above 330,000 in 2007. Since there are numerous mergers, acquisitions, entry and exit, and public-to-private transformations in the earlier years of the survey, we focus on a balanced panel of plants excluded from the above changes and in operation during the period 2005-2007.[13] We choose to study three years of data to smooth away year-over-year aggregate fluctuations. Indeed, the moments we use for the period 2005-2006 do not differ systematically from those for the period 2006-2007. Another reason to look at the data after 2005 is the presence of numerous macroeconomic policies undertaken in 2004 to prevent the overheating of the economy.

[11] Each observation in the raw data has a unique physical address. For example, in 2006, 17 observations in 17 different locations, share the brand name of one of the biggest dairy product makers, Mengniu. Brandt, Biesebroeck, and Zhang (2012) study productivity at the firm level over the 1998-2006 period. The data are similar though since they note that about 95% of the firms own a single plant.

[12] The five million Yuan threshold is not a "hard rule". About 5% of the private plants in the sample have revenue below this threshold. From Brandt, Biesebroeck, and Zhang (2012), the cut-off on private plants of five million Yuan in revenues is likely to eliminate less than 1% of the private plants.

[13] This transformation in manufacturing is summarized in `http://www.carnegieendowment.org/publications/?fa=view&id=22633`.

The classification of the plants as public or private is an important element in our analysis. The Annual Surveys of Industrial Production has two variables defining whether an enterprise is public or private. One is “enterprise type”, representing state-owned, collective, domestic private, joint venture, and foreign (including Hong Kong, Macao and Taiwan) private enterprises. State-owned means the enterprise is owned by all the people in the country, while collective means the enterprise is owned by a group of local people. According to the Chinese constitution, both state-owned and collective enterprises are classified as public. An enterprise is termed as a joint venture if part of its shares is owned by foreign investors or companies, no matter how big the fraction is. Enterprise type is how an enterprise is registered with the Administration of Business and Commerce, as well the Administration of Taxation. It does not have any information on who among shareholders makes decisions.[14] The decision maker of a joint venture can be either public shareholders or private shareholders.

The other variable is “control of shares”, representing state controlled (SCE), collectively controlled, domestically privately controlled, and foreign (including Hong Kong, Macao and Taiwan) privately controlled enterprises. “Control” means holding over 50% of total shares, or being pivotal in decision making if not holding over 50% of total shares. By this standard, a joint venture is public if it is state controlled or collectively controlled, even if it is not registered as a state-owned or collective enterprise according to the enterprise type criterion. For example, Volkswagen, Ford, and Honda in mainland China are all state controlled enterprises, registered as private joint ventures. There are also a large fraction of enterprises that are registered as collective but are controlled by domestic private shareholders.

To make a clear distinction between public and private, we rely on the variable **control of shares** to determine the type of an enterprise. To deal with outliers, we remove the top and bottom 2.5% of the plants, by employment size. This trimmed sample is the basis of our analysis. In the balanced panel, there are 12,432 state-controlled enterprises and 13,893 collectively-controlled enterprises, both classified as public. Our private category consists of 115,581 domestically privately controlled enterprises and 32,809 foreign (including Hong

[14] Before January 2008 when China began to adopt the unified tax scheme, foreign companies were enjoying preferential corporate tax rates compared to domestic companies, and companies may be inclined to be registered as ”foreign” for tax avoidance consideration. Thus ”ownership type” may not reflect actual decision-making. See: `http://english.peopledaily.com.cn/90001/90778/90860/7216695.html`.

Kong, Macao and Taiwan) privately controlled enterprises.

Table 1 summarizes capital (Ca.), employment (number of workers employed, denoted as Emp., revenue (Rev.), and value-added (Va.) by enterprise type for the 2005-2007 period.[15] All nominal terms are deflated to thousand Yuan in 2005. Capital (plant and equipment) is calculated by the book value of fixed capital net of depreciation. Hours information is not available.

About 85% of the sample consists of private plants, most of them are domestic not foreign owned. Of the public plants, about 47% are SCE. Of the four types of plants, the SCE are the largest in terms of value-added, employment and capital. On these measures the collective plants lie between the foreign plants and domestic ones. The SCE plants are also considerably more capital intensive on average.

In terms of average revenue per worker, the SCE public plants and the foreign private plants are more productive than the other types of plants on average. In terms of average revenue per unit of capital, the collective public plants are the most productive, while the large SCE have the lowest revenue per capital ratio. These statement mirror the high capital intensity of the SCE compared to other plants.

4 Quantitative Analysis

We first obtain reduced form estimates of the curvature of the revenue function, (3), and the properties of the profitability shock from data on labor input and revenues. These are then used as moments to estimate the structural curvature of the revenue function, the serial correlation of the shock and the standard deviation of the profitability shock as part of a simulated method of moments approach. The adjustment cost parameters are estimated in this second stage as well.

4.1 Parameter Estimates of Revenue Function

Using data on revenues and the labor input at the plant level for the trimmed sample, we can obtain an OLS estimate of α from $R_{it} = A_{it} L_{it}^{\alpha}$, where L_{it} is the total labor input at plant i

[15] Because the Annual Surveys of Industrial Production is a census conducted by the NBS and not by the Administration of Taxation, we believe the information reported is unlikely to be contaminated by tax evasion incentives.

Table 1: Characteristics of Plants by Type, 2005-2007 Balanced Panel

	Public			Private		
	All Public	SCE	Collective	All Private	Domestic	Foreign
# plants	26,325	12,432	13,893	148,390	115,581	32,809
Value added	48,656.89	77,857.02	22,527.48	17,664.57	14,714.56	28,057.01
	(361,262)	(518,860.5)	(70,345.40)	(53,061.78)	(34,793.98)	(91,273.67)
Revenue	152,328.8	234,293.80	78,983.33	64,290.03	53,412.09	102,611.30
	(718,711.6)	(1,004,154.0)	(255,158.2)	(205,842.2)	(123,399.3)	(368,930.1)
Employment	337.25	475.37	215.07	172.02	152.14	246.73
	(503.52)	(618.85)	(327.45)	(190.25)	(169.05)	(240.32)
Capital	89,995.48	167,278.50	20,839.57	15,396.70	11,552.97	28,937.56
	(582,535.90)	(834,704.30)	(97,105.70)	(69,207.47)	(34,536.60)	(131,246.80)
Cap./Emp.	242.20	406.84	96.56	88.11	77.41	128.33
	(4,757.08)	(6,922.56)	(459.77)	(429.51)	(417.76)	(468.90)
Va./Emp.	159.98	190.92	132.60	126.63	120.78	148.62
	(1,323.95)	(1,911.17)	(266.03)	(309.14)	(253.81)	(460.48)
Va./Cap.	5.44	4.08	6.65	5.28	5.32	5.15
	(108.57)	(128.44)	(87.00)	(88.79)	(75.64)	(124.50)
Rev./Emp.	507.96	542.38	477.50	461.03	440.53	538.06
	(2260.99)	(2,908.39)	(1,466.19)	(1,018.13)	(785.25)	(1,614.86)
Rev./Cap.	22.71	17.19	27.65	22.16	22.81	19.86
	(491.25)	(557.97)	(422.67)	(311.55)	(322.96)	(267.48)

Notes: All monetary terms are in 1,000 RMB Yuan, deflated to 2005 level. Standard deviations are given in parentheses.

in period t. The AR(1) process for the profitability shocks, A_{it}, has a serial correlation of ρ. The standard deviation of the innovation to this process is denoted σ.

Table 2: OLS Revenue Function Estimation

	$\hat{\alpha}$	$\hat{\rho}$	$\hat{\sigma}$
private	0.726	0.874	0.875
	0.002	0.001	0.002
public	0.836	0.916	1.018
	0.003	0.002	0.005

The dependent variable is the log of revenue and the independent variable is the log of employment. Here $\hat{\alpha}$ is the estimated coefficient on log employment, $\hat{\rho}$ is the estimated serial correlation of the profitability shock and $\hat{\sigma}$ is the standard deviation of the profitability shock. Other regressors were year, location and industry to remove heterogeneity from the estimates. Standard errors are reported below the estimates.

The results of this part of the estimation, summarized in Table 2, reveal a couple of key points. First, the curvature of the revenue functions are both less than one. A curvature less than one is interpreted either as reflecting market power or diminishing returns to scale. Second, though the profitability shocks are highly serially correlated for both types of plants, the processes are stationary. Given the costs of hiring and firing workers, the serial correlation of these shocks is important for the choice between adjusting hours and the number of workers in response to variations in profitability.

As is well understood, these OLS reduced estimates are biased due to endogenous factor inputs. In our application, this problem is magnified by the unobserveability of hours. For different values of the adjustment costs for workers and hours, the covariance of hours with both the profitability shocks and employment will vary.

Consequently, in the following analysis, the OLS reduced form estimates, $(\hat{\alpha}, \hat{\rho}, \hat{\sigma})$, are moments to estimate the structural parameters of the revenue function and the shock process in a simulated method of moments routine. By including the estimation of (α, ρ, σ) in the moments estimation, we allow an interaction between these parameter estimates and the adjustment costs for both workers and hours.[16] Thus, this approach will help to overcome

[16]To be clear, the notation distinguishes the OLS estimates from the structural parameters. For example, $\hat{\alpha}$ is the OLS estimate of the curvature of the revenue function. The structural parameter is denoted α.

the problem of hours not being observed and thus concerns that reduced form estimates are not uncovering structural parameters.

4.2 SMM Estimation Approach

The parameters are estimated via SMM. This approach finds the vector of structural parameters, denoted Θ, to minimize the weighted difference between simulated and actual data moments: The estimation procedure solves $min_{\Theta}\pounds(\Theta)$ where

$$\pounds(\Theta) \equiv (M^d - M^s(\Theta))W(M^d - M^s(\Theta))'. \tag{12}$$

The weighting matrix, W, is obtained by inverting an estimate of the variance/covariance matrix obtained from bootstrapping the data 1000 times. The resulting estimator is consistent.[17]

In this expression, M^d are the data moments and $M^s(\Theta)$ are the simulation counterparts. The moments are listed as the columns in Table 4. The $std(r/e)$ is the standard deviation of the log of revenue per worker. The moment sc is the serial correlation in the log of employment. The distribution of the job creation (JC) and job destruction (JD) as well as the inaction rate (zero net employment change) summarize the employment growth distribution. These are averages across plants and years, weighted by employment. The inaction rate of nearly 40% for the private plants and 28% for the public plants motivates the inclusion of non-convex adjustment costs. The OLS estimates of $(\hat{\alpha}, \hat{\rho}, \hat{\sigma})$ are contained in the set of moments.

The data moments are from the Annual Surveys of Industrial Production described above. These moments are annual averages over the 2005-2007 period. These moments do not change very much across years implying that we are matching the cross sectional variation in the data. This is appropriate as our model contains cross sectional differences rather than time series variation.

The simulated moments are obtained by solving the dynamic programming problem in (1) for a given value of Θ. The resulting decision rules are used to to simulate a panel data set. The simulated moments are calculated from that data set.[18]

[17] See, for example, the discussion and references in Adda and Cooper (2003).

[18] The simulated panel has 350 time periods and 400 plants. As the process is ergodic (after dropping the first 50 periods), the simulated microeconomic moments are determined by the total observations.

The parameters estimated by SMM are $\Theta \equiv (\zeta, \nu, F^+, F^-, \gamma^+, \gamma^-, \beta, \alpha, \rho, \sigma)$. Note that we impose symmetry between the quadratic costs of hiring and firing. With the inclusion of linear hiring and firing costs, asymmetries in the quadratic costs, which will provide another source for inaction, will be very difficult to identify.

The moments, listed at the top of Table 4, were selected in part because they are informative about these underlying parameters. Roughly speaking, the curvature of the compensation function is identified from the standard deviation of the log of revenue per worker.[19] An increase in ζ will lead to a larger variation in employment relative to hours and thus a reduction in this moment. The quadratic adjustment cost parameter, ν, is identified largely from variations in the serial correlation of employment and from the prevalence of employment adjustments in the 10% range. The distribution of employment changes, particularly the inaction and the large adjustments, act to pin down the non-convex adjustment costs. Finally, variations in β influence all the moments, particularly the standard deviation of the log of revenue per worker. When, for example, β is low, the future gains from employment adjustment are more heavily discounted and so the plant relies more on hours adjustment.

The fixed and linear adjustment costs provide a basis for inaction as well as the large values of job creation and destruction. As noted earlier, we estimate a critical level of job destruction such that the fixed cost applies only when job changes exceed this bound. As the estimate of this bound is not zero, the linear adjustment costs are responsible for the inaction. Importantly, with these linear costs rather than the fixed cost explaining the inaction, it is possible to also obtain small values of job creation and destruction, as in the data. To be more precise, the difference in the linear costs of hiring and firing produce inaction. If instead the inaction was produced by a fixed cost, the model would not generate small employment adjustment.

As noted earlier, the curvature of the revenue function, $\hat{\alpha}$, as well as the estimated persistence of the profitability shock, $\hat{\rho}$, from the OLS estimation are included in the moments. These are informative about the structural curvature of the revenue function as well as the serial correlation of the shocks. The standard deviation of the profitability shocks, $\hat{\sigma}$, is included in the moments to help identify σ.

Relative to others studies, our approach is more flexible in that we allow for asymmetric adjustment costs and, as just noted, allow for the non-convex costs to apply only after critical

[19]We do not have direct information on hours in the data set.

Table 3: Parameter Estimates: Private Plants

	ζ	ν	F^{+}	F^{-}	γ^{+}	γ^{-}	β	α	ρ	σ
All Private	1.069	0.228	0.000	0.010	-0.009	0.142	0.929	0.621	0.989	1.804
	(0.003)	(0.002)	(0.003)	(0.000)	(0.001)	(0.002)	(0.015)	(0.002)	(0.000)	(0.003)
Domestic	1.074	0.201	0.000	0.010	-0.009	0.143	0.903	0.623	0.989	1.848
	(0.001)	(0.011)	(0.002)	(0.000)	(0.001)	(0.002)	(0.007)	(0.002)	(0.000)	(0.007)
Foreign	1.065	0.198	-0.000	0.010	-0.009	0.138	0.952	0.641	0.989	1.949
	(0.001)	(0.004)	(0.010)	(0.000)	(0.001)	(0.003)	(0.009)	(0.001)	(0.000)	(0.007)

Notes: Standard errors are given in parentheses.

levels of employment adjustment. Further, our study includes the estimation of the discount factor, which is potentially different between public and private plants.

Two parameters of the compensation function, (ω_0, ω_1) are set in the estimation to guarantee the model matches median plant size and 40 hours per week in steady state. Through this calibration we set the state space for the problem in accord with the data.

5 Private Plants

This section provides the results from our estimation. It also includes discussion of sensitivity of our results as well as other implications.

5.1 Parameter Estimates

Results for private plants are summarized in Tables 3 and 4. The first table presents parameter estimates and the second contains the moments for employment and the revenue function (including the shock process) respectively. The rows refer to the entire (trimmed) sample of plants and then a split between domestic and foreign privately controlled plants, as defined earlier.

The structural parameter estimates are given in Table 3. In reading this table, the parameters with a $^{+}$ refer to hiring costs and those with a $^{-}$ are firing costs. The standard errors are reported in parentheses.[20]

For the sample of all private plants, the most important employment adjustment cost is the linear firing cost, γ^{-}. The fixed cost of hiring is zero and the fixed firing cost is very small.[21] The linear cost of hiring is actually negative, though also quite small, indicating a tiny gain to hiring. One interpretation is that this is capturing some type of political credit for private job creation.

As noted earlier, part of the estimation included a level of job destruction before incurring the fixed firing cost. The motivation was to consider some of the institutional ramifications of large job destruction rates. These might range from the need to justify these adjustments to government authorities, labor unrest in response to large firings and future effects on government regulation from large job destruction rates.[22]

In our estimation, we experimented with a number of critical values, ranging from 0 to 25% job destruction rate. The results reported here are for a 5% critical job destruction value which fits the all of the private data best.[23] For the domestic and foreign private plants, the fit was slightly better at 10%.

The linear adjustment cost is estimated to be 0.142 which is about 17% of average annual compensation per worker. Since the fixed cost is small and only applies for job destruction in excess of 5%, the linear cost is important for obtaining inaction in adjustment since the adjustment cost function is not differentiable at zero net employment growth. There is also a cost of adjusting hours as $\zeta = 1.07$ that is near the typical estimate for US plants.[24] Finally, the model allows for some quadratic adjustment cost but the estimate of ν is very small.

As noted earlier, one important feature of our estimation is that we include estimates of the discount factor. The estimate of $\beta = 0.93$ for the best fitting model implies a marginal borrowing cost of about 7.5%.

The curvature of the revenue function is 0.621. This structural estimate is distinct from

[20]The standard errors are computed using numerical derivatives of the moments with respect to the parameters combined with the estimated variance-covariance matrix.

[21]The fixed costs are reported as a fraction of average revenues. The costs incurred relative to revenue during adjustment states are reported in Table 9.

[22]The extend of labor unrest in China is well documented at `http://factsanddetails.com/china.php?itemid=363\&catid=9\&subcatid=60\#06` and `http://www.solidarity-us.org/current/node/26`.

[23]To be precise, we estimated the model for these different critical values $(0, 0.05, 0.10, 0.15, 0.2, 0.25)$ and are reporting the best fitting model.

[24]See the discussion in Cooper and Willis (2004) and the references therein.

Table 4: Moments for Private Plants

										OLS			
	std(r/e)	sc	JC30	JC1020	JC10	inaction	JD10	JD1020	JD30	$\hat{\alpha}$	$\hat{\rho}$	$\hat{\sigma}$	fit/1000
1. All Private													
Data	0.974	0.922	0.151	0.073	0.119	0.370	0.101	0.051	0.056	0.726	0.874	0.875	na
Model	0.863	0.994	0.066	0.077	0.150	0.418	0.122	0.035	0.049	1.011	0.826	0.853	29.11
2. Domestic													
Data	0.939	0.915	0.151	0.068	0.115	0.387	0.098	0.050	0.055	0.704	0.867	0.841	na
Model	0.862	0.993	0.077	0.069	0.146	0.424	0.109	0.035	0.060	1.016	0.806	0.847	24.35
3. Foreign													
Data	1.096	0.932	0.150	0.085	0.129	0.332	0.107	0.052	0.056	0.739	0.900	0.955	na
Model	0.943	0.992	0.082	0.082	0.154	0.362	0.125	0.041	0.061	1.004	0.822	0.938	6.71

Notes: std(r/e) is the standard deviation of the log of revenue per worker, sc is the serial correlation in employment, JC30 is a job creation rate in excess of 30%, JC1020 is a job creation rate between 10% and 20% and JC10 is a job creation rate greater than 0 and less than 10%. The job destruction (JD) moments are defined symmetrically. The entries are the fractions of observations with these rates of job creation and job destruction. The data moments $\hat{\alpha}$, $\hat{\rho}$ and $\hat{\sigma}$ are the OLS estimates from Table 2. Their model counterparts are obtained from OLS estimation using the simulated data.

the reduced form OLS estimate of 0.726 reported in Table 2. The difference between the structural parameter and the reduced form OLS estimate reflects the endogenous employment choice and the fact that hours, which covary with employment, are not observed. With $\alpha = 0.621$ in the model, the OLS estimate of the curvature of the revenue function, from Table 4, is 1.011. The estimated serial correlation for the profitability shock of 0.989 is much higher than the reduced form estimate of 0.874 reported in Table 4.

The results for the breakdown of the plants into domestic and foreign are not that different with one important exception. The estimated discount factor is larger for the foreign compared to domestic plants, perhaps reflecting easier access to capital markets. The point estimates imply a marginal borrowing cost of 5% for foreign controlled private plants against a marginal borrowing cost of 10.75% for domestic private plants.

Looking at the moments in Table 4, a couple of key features stand out. First, there is ample evidence of inaction: in 37% of the plant-year observations, there is zero net employment change. Second, there is also evidence of large job creation and destruction rates with about 15% of the observations entailing job creation in excess of 30% and over 5% with job destruction over 30%. Third, there are also relatively small variations in employment as indicated by the 20% or so observations of job creation and job destruction rates below 10%. It is precisely these dimensions of employment adjustment that help to identify the structural parameters.

The final column in Table 4 reports the fit of the model, divided by 1000. The models are rejected. This is not surprising given that the moments are very precise and consequently the weighting matrix has very large values.[25] Further, this estimation imposes identical structural parameters across plants in different sectors. This is a very strong restriction. We explore below estimation on a sectoral basis.

5.2 Sensitivity

Here we explore the sensitivity of our findings to parameter variations. The goal is to appreciate how our results change as we vary the estimates of adjustment costs and the discount factor. For these exercises, the baseline estimation is for all private plants. Table 5 contains our results.

[25] For the baseline private estimates, the diagonal elements of the weighting matrix are: $1.3534, 1.5724, 2.1994, 3.0870, 2.6173, 1.8018, 2.8196, 4.0350, 4.9736, 0.2208, 0.6019, 1.5183$ times 10^6.

Table 5: Sensitivity of Moments for Private Plants

										OLS			
	std(r/e)	sc	JC30	JC1020	JC10	inaction	JD10	JD1020	JD30	$\hat{\alpha}$	$\hat{\rho}$	$\hat{\sigma}$	fit/1000
Data	0.974	0.922	0.151	0.073	0.119	0.370	0.101	0.051	0.056	0.726	0.874	0.876	na
Baseline	0.863	0.994	0.066	0.077	0.150	0.418	0.122	0.035	0.049	1.011	0.826	0.853	29.11
No Quad	0.690	0.985	0.131	0.000	0.002	0.726	0.031	0.000	0.047	1.047	0.735	0.660	111.23
Linear Only	0.443	0.987	0.130	0.000	0.000	0.738	0.000	0.000	0.052	1.062	0.574	0.439	200.35
$\beta = 0.95$	0.827	0.993	0.069	0.078	0.154	0.413	0.118	0.037	0.054	1.019	0.811	0.809	30.85
$\zeta = 1.465$	0.334	0.989	0.143	0.090	0.153	0.287	0.076	0.039	0.088	1.037	0.543	0.313	182.72
$\nu = 2.897$	1.572	0.999	0.003	0.055	0.277	0.242	0.374	0.041	0.000	0.874	0.925	1.658	398.7

Notes: The table reports simulation results based on perturbations to the baseline parameterization.

The rows of the tables indicate the data, the baseline results, followed by three experiments. The first shuts down the quadratic adjustment cost by setting $\nu = 0$. The second puts all but the linear firing cost to zero. The final row uses the baseline adjustment costs but sets $\beta = 0.95$, a more standard value.

The effects of the small quadratic adjustment cost is seen by comparing the second and third rows of the table. Without the quadratic adjustment cost, the dynamic demand for labor displays more inaction and more adjustments in the tail of the job creation distribution. Further, the relatively small adjustments between inaction and 10% from the baseline are gone without the quadratic adjustment cost. The fit without this cost is about 4 times worse than the baseline.

Setting the fixed costs to zero, worsens the fit further. Since the fixed firing cost applies for job destruction greater than 5%, eliminating this cost produces an outcome with only inaction and large adjustments. The fit with only the linear costs is about 8 times worse than the baseline. Clearly the quadratic and fixed costs are needed to produce the observations of intermediate adjustment.

If β is increased from its baseline value of 0.929 to 0.95, there is a response in the moments of the employment distribution. In the presence of adjustment costs, changes in the stock of workers is an intertemporal choice with current as well as future costs and consequences. Not surprisingly, variations in β influence those choices. From Table 5, an increase in β reduces inaction and increases the frequency of large job creation and destruction rates. As employment is more responsive to shocks, the standard deviation of revenue per worker is lower. The fit of the model worsens by about 6%.

6 Public Plants

The same estimation approach is applied to public plants. But, as discussed earlier, the parameterization and specification of the objective and constraints is allowed to differ. The estimation results are presented first, followed by a sensitivity analysis.

6.1 Results

Tables 6 and 7 present results for public plants. The tables include results for all public plants as well as the state controlled enterprises and collectively controlled enterprises separately.

Table 6: Parameter Estimates: Public Plants

	ζ	ν	F^+	F^-	γ^+	γ^-	β	α	ρ	σ
All Public	1.465	2.897	0.001	0.181	0.131	0.516	0.940	0.646	0.971	1.548
	(0.025)	(0.263)	(0.018)	(0.016)	(0.016)	(0.045)	(0.025)	(0.007)	(0.002)	(0.066)
SCE	1.446	2.871	0.004	0.197	0.102	0.512	0.972	0.648	0.970	1.547
	(0.138)	(0.859)	(0.007)	(0.049)	(0.063)	(0.135)	(0.164)	(0.013)	(0.007)	(0.114)
Collective	1.544	2.806	0.009	0.083	0.171	0.536	0.902	0.633	0.971	1.554
	(0.094)	(0.159)	(0.006)	(0.011)	(0.041)	(0.038)	(0.060)	(0.006)	(0.001)	(0.012)
SBC	1.183	2.917	0.005	0.173	0.140	0.520	0.940	0.616	0.980	1.584
	(0.038)	(0.095)	(0.008)	(0.06)	(0.05)	(0.17)	(0.03)	(0.02)	(0.032)	(0.05)

Notes: The SBC treatment estimates parameters for all public plants allowing a soft budget constraint. Standard errors are given in parentheses.

For all public plants, we report results with and without a soft-budget constraint.

The parameter estimates are reported in Table 6. The first row is for all public plants and the next rows are for the state controlled enterprises and for the collectively controlled plants. These estimates were obtained without a soft budget constraint.

The parameter estimates indicate that the most significant adjustment cost is the linear firing cost. There is support for a small fixed firing cost as well. The fixed hiring cost is not significant. This pattern is true for the collectively controlled plants as well. The SCE sub-sample has no significant adjustment costs other than the quadratic cost, the fixed firing cost and the linear firing cost. We estimate that the fixed firing cost applies at a job destruction rate in excess of 10% for all of the public plants as well as the sample splits. In contrast to the private plants, there are larger quadratic adjustment costs and a larger cost to hours variation.

Comparing the collective and state controlled enterprises, a prominent feature is the difference in the discount factor. The SCE do not discount as much as collective plants. This is consistent with the view that the SCE are linked to state-owned banks and thus receive favorable treatment in financial markets. In fact, many SCE are publicly traded. Collective

Table 7: Moments for Public Plants: Employment

	std(r/e)	sc	JC30	JC1020	JC10	inaction	JD10	JD1020	JD30	OLS $\hat{\alpha}$	OLS $\hat{\rho}$	OLS $\hat{\sigma}$	fit/1000
1. All Public													
Data	1.118	0.952	0.085	0.068	0.173	0.278	0.227	0.063	0.044	0.836	0.916	1.018	na
Model	1.000	0.991	0.045	0.094	0.185	0.264	0.254	0.021	0.043	0.999	0.827	1.001	4.34
2. SCE													
Data	1.185	0.961	0.071	0.069	0.193	0.237	0.267	0.066	0.040	0.931	0.920	1.068	na
Model	1.027	0.991	0.042	0.095	0.182	0.268	0.261	0.020	0.041	0.978	0.835	1.044	2.402
3. Collective													
Data	1.052	0.934	0.112	0.066	0.133	0.359	0.148	0.059	0.051	0.732	0.908	0.944	na
Model	0.917	0.992	0.047	0.093	0.146	0.341	0.189	0.049	0.038	1.011	0.808	0.909	2.55
4. SBC													
Data	1.118	0.952	0.085	0.068	0.173	0.278	0.227	0.063	0.044	0.836	0.916	1.018	na
Model	0.731	0.949	0.033	0.085	0.232	0.601	0.000	0.000	0.037	1.002	0.715	0.731	19.86

Notes: std(r/e) is the standard deviation of the log of revenue per worker, sc is the serial correlation in employment, JC30 is a job creation rate in excess of 30%, JC1020 is a job creation rate between 10% and 20% and JC10 is a job creation rate greater than 0 and less than 10%. The job destruction (JD) moments are defined symmetrically. The entries are the fractions of observations with these rates of job creation and job destruction. The data moments $\hat{\alpha}$, $\hat{\rho}$ and $\hat{\sigma}$ are the OLS estimates from Table 2. Their model counterparts are obtained from OLS estimation on the simulated data.

enterprises, which are largely owned at a more local level, do not have such favorable access, as reflected in higher borrowing costs.

Table 7 reports the employment moments for the public plants. These are the same moments reported for private plants. As with the private plants, there is substantial inaction in employment adjustment. This is much higher for collectively controlled public plants than for the SCE, presumably because the collective plants are smaller. As with the private plants, there is considerable action in the tails of the job creation distribution, with more job creation in excess of 30% for the collectively controlled enterprises.

Table 7 also reports the moments for the revenue function and the stochastic process of the profitability shocks. The $(\hat{\alpha}, \hat{\rho}, \hat{\sigma})$ estimates termed "data" come from OLS regressions on the actual data. The other entries are from OLS regressions run on simulated data. The curvature of the revenue function is much lower for collective enterprises, though the structural estimates are close for all types of plants. The serial correlation and standard deviation of the shocks are about the same across types of public plants.

The estimated model with the soft-budget constraint (SBC) is in the last row of Table 6. It has a lower cost of hours variation and slightly higher quadratic and linear firing costs. From Table 7, the model with the soft-budget constraint does not fit the data nearly as well as the model without this constraint.[26] From Table 7 the model with the soft-budget constraint produces too much inaction.

6.2 Sensitivity

As with the private plants, we explore the sensitivity of our findings on the public plants to parameter variations, focusing again on the adjustment costs and the discount factor. For these exercises, the baseline estimation is for all public plants. Table 8 contains our results.

As we saw with the private plants, removing the quadratic adjustment costs has large effects on the moments and hence the fit of the model. The inaction rate increases and the serial correlation of employment falls without the quadratic adjustment cost.

The model with only linear adjustment costs fits even worse. With only the linear adjustment costs, the model again produces either inaction or large adjustments. It misses the small labor adjustments and produces low serial correlation in employment.

[26] This is also true for the SBC models estimated for the SCE and collectively controlled plants independently.

Table 8: Sensitivity of Moments for Public Plants

										OLS			
	std(r/e)	sc	JC30	JC1020	JC10	inaction	JD10	JD1020	JD30	$\hat{\alpha}$	$\hat{\rho}$	$\hat{\sigma}$	fit/1000
Data	1.118	0.952	0.085	0.068	0.173	0.278	0.227	0.063	0.044	0.836	0.916	1.018	na
Baseline	1.000	0.991	0.045	0.094	0.185	0.264	0.254	0.021	0.043	0.999	0.827	1.001	4.34
No Quad	0.617	0.957	0.168	0.001	0.012	0.660	0.108	0.000	0.045	1.069	0.598	0.582	31.70
Only Linear	0.422	0.968	0.173	0.004	0.000	0.690	0.000	0.004	0.065	1.084	0.507	0.409	47.80
$\beta = 0.95$	0.989	0.991	0.047	0.095	0.188	0.259	0.253	0.021	0.045	1.001	0.820	0.988	4.50

Finally, the increase of β to 0.95 reduces the fit of the model by about 4%. There are lower deviations in revenues relative to employment and slightly less inaction caused by this change in β.. But these effects on the moments are not large and this is reflected in the standard errors around the point estimate of β.

7 Comparing Public and Private Plants

The paper asked the question: what do public plants maximize? The model assumes that these plants have a well specified objective function and thus we assume that these plants maximize a return each period which is naturally termed "profits". But what constitutes "profits" for the public plants? We answer that question by comparing the results for public and private plants.

For both public and private plants, linear firing costs are a prominent form of adjustment costs. The parameters estimates are larger for the public than for the private plants. As noted earlier, γ^- is only about 17% of the annual compensation to a worker in the private sector. For the public sector, the linear firing cost is considerably larger, 161% of annual compensation.

For the fixed and quadratic costs, the magnitude of these costs relative to revenue depends upon the endogenous adjustment decisions of the plants. For example, the fixed cost of firing workers relative to revenues will depend on the revenues when those workers were fired. Table 9 reports the average quadratic and fixed adjustment costs actually paid as a fraction of plant revenue.

Overall, the estimated adjustment costs are considerably larger for the public plants relative to the private ones. This is particularly true of the fixed firing costs. As a fraction of revenue, though, all the adjustment costs except for the fixed firing costs in the public sector seem small. Yet, as demonstrated in the sensitivity analysis, these apparently small costs do influence the choices of the private and public plants.

It is important to consider how these higher adjustment costs translate into employment decisions. All else the same, one would conjecture that the higher adjustment costs of the public plants would imply more inaction and more bursts of job creation and job destruction. Yet, from Tables 4 and 7, it is the private plants that have more inaction and slightly more action in the tails of the job creation and job destruction distribution. This is true in the

Table 9: Adjustment Costs Paid as a Fraction of Revenue

	Quadratic	Fixed Hiring	Fixed Firing
1. Private Plants			
All Private	1.94e-04	1.75e-04	0.007
Domestic	2.11e-04	3.48e-04	0.008
Foreign	2.36e-04	0	0.008
2. Public Plants			
All Public	3.43e-04	0.003	0.100
SCE	2.5e-04	0.007	0.101
Collective	5.22e-04	0.016	0.035

Notes: This table reports the average adjustment costs paid by type of adjustment cost and type of plant as a fraction of revenue.

actual as well as the simulated data using the estimated parameters. As shown later, this finding is true in the sectoral data as well.

There are two other parameters that help account for these differences between public and private plants. First, the estimated costs of adjusting hours, ζ, is considerably higher for the public plants compared to the private ones. A higher cost of hours adjustment implies that the public plants rely more on adjustment in the number of workers, despite the higher costs. This translates into less inaction. As shown in Table 5, if the estimated ζ for the public plants is used in the private plant's problem, the moments for the private plants would exhibit considerably less inaction. In addition, the quadratic adjustment cost is considerably larger for the public plants. Using this higher cost in the private plant's problem generates less inaction, as shown in Table 5.

Returning to our discussion of the objectives of public plants, we find some support for the "employment stabilizing" objective. The adjustment costs are larger for public compared to the private plants.

The quadratic adjustment costs are an order of magnitude larger for public plants. In this sense, the public plants are penalized for employment variations. Note that these costs are a bit smaller for SCEs than the collectively controlled public plants.

Further, the public plants face fixed firing costs that differ from those incurred by private plants in two respects. First, the public plants firing costs are much larger as a fraction of revenues. Second, as indicated by the calculations in Table 9, these larger parameters translate into larger costs actually incurred.

Finally, the analysis uncovers important differences in discounting. While the discount factors for all public plants and all private plants are not much different, the SCEs discount considerably less than the domestic private plants and collective public plants. This is consistent with numerous accounts of financial frictions within China.

For example, Hale and Long (2011) look at interest expenses relative to debt and argue that the cost of capital for state firms is considerably lower than that for private firms. For their sample, collective firms lie between the state and private firms.

Poncet, Steingress, and Vandenbussche (2010) use an Euler equation approach to study the capital investment decisions at the firm level. They argue that domestic private firms face borrowing constraints while SOEs and the foreign private firms do not.[27] Though these results are obtained from a very different economic model, they coincide with our findings on dynamic labor demand.

8 Sectoral Results

Our estimates thus far pertain to all manufacturing plants. This approach constrains the parameters to be the same across sectors. Further, the comparison of private and public plants may reflect their different sectors of operation rather than differences in adjustment costs and/or discount factors. We now study a couple of specific sectors: autos parts, steel and iron, machinery and apparel.

Table 11 and 12 in the Appendix are comparable to Table 1 in terms of providing some basic statistics on the (trimmed) public and private plants in these sectors. Most of the plants in these sectors are private. The public plants are considerably larger than the private ones. This is true in terms of value added, revenues, employment and the capital stock. Public plants are more capital intensive, particularly in steel and iron, except for the machinery

[27] For their study, a firm is classified as a state-owned enterprise SOE if state ownership exceeds 25%. They pool collectively owned firms with the SOEs.

Table 10: Parameter Estimates by Sector

	ζ	ν	F^+	F^-	γ^+	γ^-	β	α	ρ	σ
1. Auto Parts										
Private	1.0684	0.2068	-0.0000	0.0141	-0.0104	0.1340	0.9312	0.6451	0.9900	1.9532
Public	1.5268	2.9577	-0.0000	0.1831	0.1000	0.4432	0.9447	0.6542	0.9871	1.7781
2. Steel and Iron										
Private	1.0905	0.1604	-0.0000	0.0099	-0.0042	0.1726	0.9212	0.6184	0.9890	2.4638
Public	1.1985	2.9417	-0.0001	0.1855	0.0999	0.4766	0.9503	0.6463	0.9830	1.5340
3. Machinery										
Private	1.0952	0.2018	-0.0000	0.0119	-0.0171	0.1483	0.9297	0.5909	0.9900	2.1254
Public	1.5527	3.0079	-0.0000	0.1818	0.1000	0.5408	0.9334	0.6225	0.9811	1.6620
4. Apparel										
Private	1.0963	0.2195	-0.0000	0.0085	-0.0014	0.1265	0.9312	0.6149	0.9899	1.7956
Public	1.7718	1.2217	-0.0000	0.1877	0.1000	0.6058	0.9450	0.6128	0.9744	1.6605

sector. The revenue and value added per unit of capital are generally higher in public compared to private plants, except for apparel. In contrast, the revenue and value added per worker measure of productivity are all higher in the private plants, except for steel and iron. Difference in productivity is most evident in the revenue per capital measure in steel and iron.

The same estimation approach applied to all plants was used for the sectoral estimation. The results for these sectors are provided in Table 10 and the moments are in Table 13 in the Appendix.

Most of the basic patterns from total manufacturing appear in the sectoral results as well. The public plants have significantly larger estimated quadratic adjustment costs and higher linear firing costs. The costs of hours variation is considerably higher for the public plants than the private ones, as was the case with the full sample. Fixed hiring costs are negligible for all plants in all sectors and fixed firing costs are small for private plants.

One interesting difference from the previous results is in the discount factors. For all of manufacturing, we found that the private and public discount factors were overall about the same. But, the SCE had a much higher discount factor than did the collective enterprises. Looking at these sectors, the private plants discount more than the public sector plants in all sectors.

Looking at the moments in Table 13, there is more inaction by the private sector plants compared to the public plants in all of these sectors. This is the same pattern as in total manufacturing. Further the private plants exhibit more frequent bursts of job creation and job destruction in excess of 30%.

These patterns of higher inaction and more frequent bursts are normally explained by larger non-convex adjustment costs and lower quadratic costs. As noted earlier, the public plants have higher quadratic and higher linear costs in all of these sectors. As was the case in the comparison of public and private plants for all of manufacturing, the differences in employment adjustment also reflect the higher costs of hours variation for public plants as well as larger quadratic adjustment costs.

As indicated in Table 13, the sectoral models fit better than those for overall manufacturing. This is partly because the parameter estimates are sector specific. In addition, with a smaller number of observations, the terms in the variance/covariance matrix are larger and thus the terms in the weighting matrix are smaller.

From this table, the public plants in both the auto parts and steel and iron sectors exhibited “increasing returns” with the OLS estimates of α in excess of 1.0. Yet, from Table 10, the estimated curvature of the revenue functions are less than unity, though higher than the private sector counterparts.

9 Conclusion

This paper estimates labor adjustment costs for private and public plants. For all of these plants, we find evidence of adjustment costs in the form of fixed and linear firing costs along with quadratic adjustment costs. These fixed firing costs apply when the job destruction rate exceeds 5% for the private plants and 10% for the public ones. The quadratic adjustment costs for public plants are larger than those for the private plants. Importantly, we also find that hours variation in more costly for public plants and this has an impact on their demand for labor.

In addition, we uncover differences in discount rates across types of plants. In particular, the SCEs discount the future least. The private plants discount more than the SCEs but less than collectively owned plants. In the presence of adjustment costs, hiring is like an investment activity so that discount factors matter for employment decisions.

Turning specifically to the objectives of the public plants, we see no evidence of soft-budget constraints influencing the labor demand of public plants. We do see evidence of higher adjustment costs in the public plants. This amounts to support for public plants acting to stabilize employment, as reflected by differences in estimated quadratic and non-convex adjustment costs.

As argued in the introduction, an estimation exercise such as this is needed to evaluate the impact of a number of interventions. While this paper refrains from analyzing any specific interventions, it is clear that any policy analysis requires the ability to predict the response of firms.

For example, this analysis uses data prior to the introduction of worker protection regulations in China. That intervention, in part, reflected concerns about hours variation and the lack of severance pay to workers. One interpretation of the fixed firing costs for excessive job destruction was a political one that may have been manifested in the recent regulations.[28] Studying the impact of those new regulations on labor demand using our estimated model is of considerable interest.

The results are also useful as inputs into an analysis of gains to reallocation. Given our focus on private versus public plants, reallocation can occur within and across ownership classes. We plan to use our model to study productivity implications of reallocation, both in the present and in the earlier years of our sample. The theme of reallocation is clearly important as well in considering the effects of the introduction of worker protection regulations.

[28] See the discussion of the motivation for current regulations in `http://www.carnegieendowment.org/publications/?fa=view&id=22633` and `http://www.law.com/jsp/law/international/LawArticleIntl.jsp?id=1202430131324`.

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10 Appendix

10.1 Measurement

"Revenue" in (3) refers to output price times quantity of output, net of variable costs on inputs excluding labor. The data provide direct measures of output in monetary terms, i.e. output price times quantity of output, which can be deflated to base-year measures.

Although the "revenue" (hereafter referred to as "net revenue") in (3) is not directly observed from the data, we can use the output price times quantity (hereafter referred to as "gross revenue") in the data to estimate the curvature of the net revenue function (α) and back out the profitability shock. This approach is common in the dynamic factor demand literature. The appendix of Cooper and Haltiwanger (2006) presents a detailed discussion of the derivation and measurement issues in the context of a capital adjustment problem.

10.2 Sectoral Analysis

Statistics Tables 11 and 12 provide some basic statistics on the (trimmed) public and private plants in the four sectors.

Moments from Estimation The following tables are the moments used in the sectoral estimation.

Table 11: Types and Characteristics of Plants by Sector: 2005-2007

	Auto Parts		Steel and Iron	
	Public	Private	Public	Private
# plants	580	3,319	539	3,237
Value added	33,099	18,878	268,128	36,341
	(86,123)	(47,749)	(1,024,121)	(78,114)
Revenue	114,039	68,031	1,092,618	151,529
	(243,882)	(187,805)	(3,548,125)	(334,305)
Employment	351	170	1,110	168
	(430)	(163)	(2,899)	(207)
Capital	42,421	18,377	380,198	21,248
	(91,692)	(46,712)	(1,432,630)	(58,250)
Cap./Emp.	88.36	83.91	342.52	126.48
	(117)	(149)	(509)	(198)
Va./Emp.	100.83	114.45	234	229
	(182)	(269)	(559)	(507)
Va./Cap.	3.69	3.22	20.9	8.9
	(24)	(16)	(543)	(86)
Rev./Emp.	354	402	1,169	955
	(478)	(827)	(5,838)	(1,940)
Rev./Cap.	18.39	14.08	78.4	38.8
	(201)	(84)	(1,942)	(517)

Notes: All monetary terms are in 1,000 RMB Yuan, deflated to 2005 level. Standard errors are given in parentheses.

Table 12: Types and Characteristics of Plants by Sector: 2005-2007

	Apparel		General Machinery	
	Public	Private	Public	Private
# plants	468	7,900	1,977	11,619
Value added	13,552.39	12,560.92	24,326.38	12,375.56
	(20,365.32)	(30,902.73)	(70,099.59)	(24,851.57)
Revenue	45,481.38	42,468.63	84,111.09	44,573.03
	(67,142.18)	(72,945.05)	(229,979.80)	(82,482.48)
Employment	346.22	270.75	267.87	130.32
	(308.28)	(246.99)	(350.80)	(123.95)
Capital	9,100.19	6,711.54	21,333.42	9,102.14
	(17,264.35)	(12,090.78)	(49,644.07)	(19,343)
Cap./Emp.	27.93	25.04	59.35	62.59
	(47.66)	(52.76)	(90.67)	(89.02)
Va./Emp.	50.04	53.59	99.03	107.04
	(80.90)	(146.93)	(179.41)	(211.22)
Va./Cap.	5.11	6.25	5.79	4.25
	(15.66)	(38.46)	(40.94)	(44.79)
Rev./Emp.	179.53	185.20	341.74	382.99
	(350.13)	(325.93)	(605.37)	(593.84)
Rev./Cap.	20.38	25.44	25.13	17.40
	(79.16)	(172.49)	(252.55)	(126.19)

Notes: All monetary terms are in 1,000 RMB Yuan, deflated to 2005 level. Standard deviations are given in parentheses.

Table 13: Employment Moments: By Sector

										OLS			
	std(r/e)	sc	JC30	JC1020	JC10	inaction	JD10	JD1020	JD30	$\hat{\alpha}$	$\hat{\rho}$	$\hat{\sigma}$	fit/1000
1. Auto Parts													
a. Private													
Data	0.8425	0.9323	0.1896	0.0995	0.1372	0.3024	0.1040	0.0387	0.0364	0.8997	0.8596	0.7800	na
Model	0.7769	0.9950	0.0984	0.0869	0.1687	0.3177	0.1088	0.0460	0.0301	1.0464	0.7342	0.7440	0.72466
b. Public													
Data	0.8826	0.9513	0.0915	0.1176	0.1889	0.2206	0.2129	0.0574	0.0301	0.9533	0.8730	0.7977	na
Model	0.7906	0.9962	0.0393	0.0996	0.2291	0.2573	0.2423	0.0151	0.0317	1.0295	0.8422	0.7637	0.07622
2. Steel and Iron													
a. Private													
Data	0.9435	0.9335	0.1723	0.0748	0.1073	0.3609	0.0981	0.0496	0.0534	0.9521	0.8132	0.9340	na
Model	0.9384	0.9938	0.1215	0.0759	0.1400	0.3722	0.0931	0.0349	0.0504	1.0081	0.7617	0.9282	0.26176
b. Public													
Data	1.1538	0.9814	0.0930	0.0579	0.2149	0.2540	0.2412	0.0626	0.0239	1.0184	0.9082	1.1491	na
Model	1.1157	0.9968	0.0233	0.0794	0.2065	0.2922	0.3506	0.0000	0.0110	1.0093	0.8777	1.1100	0.04129

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										OLS			
	std(r/e)	sc	JC30	JC1020	JC10	inaction	JD10	JD1020	JD30	$\hat{\alpha}$	$\hat{\rho}$	$\hat{\sigma}$	fit/1000
3. General Machinery													
a. Private													
Data	0.8132	0.9207	0.1509	0.0830	0.1319	0.3541	0.0970	0.0520	0.0432	0.7702	0.8799	0.7844	na
Model	0.7760	0.9954	0.0799	0.0790	0.1582	0.3711	0.0869	0.0586	0.0436	0.9928	0.7794	0.7826	2.1136
b. Public													
Data	0.9577	0.9469	0.0876	0.0667	0.1852	0.2439	0.2492	0.0725	0.0369	0.8348	0.9161	0.9373	na
Model	0.8826	0.9948	0.0302	0.0840	0.2164	0.2819	0.2422	0.0356	0.0271	0.9912	0.8602	0.8898	0.26761
4. Apparel													
a. Private													
Data	0.8038	0.9099	0.1336	0.0650	0.1142	0.3894	0.0993	0.0545	0.0616	0.7103	0.8527	0.7693	na
Model	0.7341	0.9942	0.0658	0.0840	0.1488	0.4208	0.1040	0.0476	0.0525	0.9793	0.8045	0.7546	0.971
b. Public													
Data	0.9485	0.8953	0.0984	0.0469	0.1550	0.3267	0.1521	0.0711	0.0709	0.6172	0.9299	0.8862	na
Model	0.7836	0.9912	0.0618	0.0718	0.1595	0.3936	0.2065	0.0000	0.0481	0.9549	0.8258	0.8222	0.14308

Notes: std(r/e) is the standard deviation of the log of revenue per worker, sc is the serial correlation in employment, JC30 is a job creation rate in excess of 30%, JC1020 is a job creation rate between 10% and 20% and JC10 is a job creation rate greater than 0 and less than 10%. The job destruction (JD) moments are defined symmetrically. The entries are the fractions of observations with these rates of job creation and job destruction. The data moments $\hat{\alpha}$, $\hat{\rho}$ and $\hat{\sigma}$ are the OLS estimates.