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PRIVATIZATION, COMPETITION AND REFORM STRATEGIES: THEORY AND EVIDENCE FROM RUSSIAN ENTERPRISE PANEL DATA

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ABSTRACT

Privatization, Competition and Reform Strategies: Theory and Evidence from Russian Enterprise Panel Data*

A critical, but largely unexamined assumption in the debate over reform policy design, concerns the complementarity or substitutability of market competition and private ownership in increasing firm efficiency. We analyse a simple Cournot model that distinguishes two aspects of privatization interacting with market opening: privatization of a firm and privatization of its competitors. Under plausible conditions, the model implies that privatizing a firm is a substitute for exposing it to competitive markets, but privatizing its competitors is complementary. Our empirical analysis uses augmented 3-factor translog production functions estimated on 1992–9 panel data for 13,288 Russian manufacturing enterprises. We find that non-state ownership of a firm reduces the marginal efficiency impact from product market dispersion, but the share of its competitors that are non-state increases this marginal impact. Disaggregating non-state ownership, we find that the shares of competitors in all three non-state types are complementary with dispersed market structure, where the strongest complementarity involves foreign ownership. The evidence suggests that an important indirect impact of private ownership may be the intensification of market competition, and thus that competition only among state-owned enterprises may be ineffectual in stimulating them to increase efficiency.

JEL Classification: L10, L32, L33, P23
Keywords: competition, market structure, privatization, structure conduct performance, transition, Russia

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NON-TECHNICAL SUMMARY

The interaction of the effects of private ownership and market competition on enterprise behaviour has been a crucial unknown for policy design in transition economies. While most economists have been ready to believe that the efficiency of state-owned enterprises might be increased both through privatization to improve corporate governance and through price and entry liberalization to open up competition, the implementation of privatization has faced many practical and political problems in the transition economies. As a result, privatization has proven slow and difficult, and a central debate among policy-makers and analysts of transition has arisen concerning the urgency of privatization. It is our contention that an important, but largely implicit, assumption in this debate concerns how the forces of competition and privatization interact.

On one side of the debate are advocates of 'big bang' transition strategies who see competition as ineffective in the absence of private ownership and effective corporate governance, which is generally supposed to be achieved through concentrated ownership by outside blockholders. During the early transition period several economists emphasized the desirability of rapid privatization, seeing liberalization as necessary but not sufficient to induce restructuring. At the same time, they did not favour privatization without market liberalization. According to this view, competition and privatization are complementary in their effects on enterprise performance: privatization may be enhanced by more competitive markets, and the latter cannot substitute for the former.

On the other side are critics of privatization who believe that competition can work to improve performance in the absence of private ownership. Given the difficulties of designing and carrying out effective privatization policies, a more cautious, 'gradualist' approach is implied. According to this view, privatization and competition are substitutes, or at least independent, in their effects on firm behaviour, in the sense that the marginal gain from market liberalization is not increasing in the extent of privatization. Market liberalization need not be followed up by immediate privatization, as state-owned enterprises are disciplined by the market even as they await privatization.

Other advocates of the delayed privatization approach stress the need to demonopolize industry in advance of privatization, suggesting that privatized monopolists would simply raise prices instead of restructuring.

The substitutability or complementarity of the forces of market competition and private ownership is therefore a critical determinant of the choice of transition policy strategy. While stabilization and liberalization policies were generally introduced rapidly and with relatively little controversy (at least among most Western economists), the proper pace of privatization has become the most

contested policy design issue in the transition economies. A closely related controversy has concerned the choice of privatization method, with scepticism frequently voiced about the quality of corporate governance likely to result from employee buy-outs and voucher programmes, but the justification for these methods is usually couched in terms of their speed, with attention paid to design details that mitigate the governance problems. Given the difficulty of carrying out trade sales to large investors, the debate is whether such methods of privatization, even if second-best, should nevertheless be a priority for policy.

In this Paper, we argue that the debate suffers from two problems: first, it has been conducted on the basis of very little empirical evidence, particularly firm-level information on the privatization–competition interaction; and, second, it has overlooked an important interaction at the level of the firm's product market. Taking the second point first, our argument is that the degree of competition in a market is a function not only of market structure or concentration, nor just the extent of price and entry liberalization, but also who the participants in the market are. We hypothesize that private firms may be more aggressive competitors than state firms, and thus that a firm operating in a given market may face tougher competition if most competitors are private. Thus, even if the effect of privatizing a firm is independent or substitutable with exposing it to competitive markets, privatization of competitors may be complementary, raising the effective competition associated with a particular market structure. The effects of privatization may show up indirectly, working through market competition, as much as or more than they do directly, through the corporate governance of a particular firm.

First we analyse a simple Cournot competition model that distinguishes two aspects of the competition–privatization interaction: privatization of a firm and privatization of the firm's competitors. Under plausible conditions, the model implies that privatizing a firm is a substitute for exposing it to competitive markets, but privatizing its competitors is complementary.

Then we test the model empirically. In contrast with earlier studies of competition and firm performance in transition economies, our empirical work has several distinct advantages in terms of the size and coverage of the data set, the time span of observations on each firm, and the availability of a variety of measures of market structure and competition. The panel data set we use for estimation purposes is quite comprehensive, including 13,288 Russian manufacturing enterprises covering 83.3% of total employment in Russian industry in 1992, the year of the liberalization shock, and spanning eight years from 1992 to 1999. Since we have nearly the entire population of medium- and large-size industrial enterprises, including information on their exact locations and disaggregated five-digit industries, we can use much more precise measures of market structure than those available to other researchers in Russia or in many other countries.

We find that on average privatization improves efficiency, while reduced market concentration does not. The privatization of a firm reduces the marginal impact on firm efficiency from reduced market concentration, but the privatization of its competitors increases this marginal effect. The marginal effect becomes positive when most of the firm's competitors are privatized. It is largest when the firm's competitors are foreign-owned, though the marginal effect is still strong when the firm's competitors are domestic firms with either private or mixed private and state ownership. The results imply that an important indirect impact of private ownership is the intensification of market competition, and thus that competition only among state-owned enterprises may be ineffectual in stimulating them to increase efficiency. Privatization improves firm efficiency whether or not the firm faces competition, while reducing market concentration will only improve firm efficiency if the other firms in the market are private. The evidence suggests that liberalizing the economy without also privatizing it would be ineffective. It would be better not to wait to privatize until after demonopolizing industry.

1. Introduction

The interaction of the effects of private ownership and market competition on enterprise behavior has been a crucial unknown for policy design in transition and other reforming economies. While most economists have been ready to believe that the efficiency of state-owned enterprises might be increased both through liberalization to open up competition and through privatization to improve corporate governance, the implementation of privatization has faced many practical and political problems. As a result, privatization has proven slow and difficult, and a central debate among policymakers and analysts of transition has arisen concerning the urgency of privatization. It is our contention that an important, but largely implicit, assumption in this debate concerns how the forces of competition and privatization interact.

On one side of the debate are advocates of "big-bang" transition strategies who see competition as ineffective in the absence of private ownership and effective corporate governance. Early transition writings by Lipton and Sachs (1990), Balcerowicz (1995), Blanchard and Layard (1992), Frydman and Rapaczynski (1991), and Boycko, Shleifer and Vishny (1993), for instance, emphasized the desirability of rapid privatization, as they saw liberalization as necessary but not sufficient to induce restructuring. At the same time, they did not favor privatization without market liberalization. According to this view, competition and privatization are complements in their effects on enterprise performance: the effects of privatization may be enhanced by more competitive markets, and the latter cannot substitute for the former.

On the other side are critics of rapid privatization who believe that competition can work to improve performance even in the absence of private ownership. Given the

difficulties of designing and carrying out effective privatization policies, a more cautious, gradual approach is implied. Some observers of British privatization policies in the 1980's had concluded that competition was sufficient to induce efficient behavior (e.g., Kay and Thompson, 1986), but the "gradualist" position crystallized in the debate over privatization in the transition economies.[1] According to Stiglitz (1994, p. 136), for instance, "[M]ore important in many cases than changing the 'ownership' is changing the market structure - subjecting these enterprises to competition." More recently, Black *et al* (2000) advocate a "staged" approach, where firms are privatized cautiously, through a process of learning and experimentation, and Spicer *et al* (2000) favor a gradualist, "negotiated" approach.[2] According to these views, privatization and competition are substitutes or at least independent factors affecting firm behavior, in the sense that the marginal gain from market liberalization is not increasing in the extent of privatization. Privatization can be implemented slowly, as state-owned enterprises are disciplined by the market even while awaiting ownership change.

The substitutability or complementarity of the forces of market competition and private ownership is therefore a critical determinant of the choice of policy strategy in transition and other situations of large-scale reform. While stabilization and liberalization policies were generally introduced rapidly and with relatively little controversy (at least among most Western economists), the proper pace of privatization has become the most contested policy design issue in the transition economies. A closely related controversy has concerned the choice of privatization method, with skepticism frequently voiced about the

[1] A more radical gradualist view is that the state sector should be neither privatized nor exposed to full competition, but gradually reduced in size as the new private sector grows (Murrell, 1991). In practice, central control disintegrated and liberalization occurred quickly in most countries, so that the issue became the appropriate pace and choice of method of privatization, rather than whether or not to liberalize the state sector.

[2] Others questioning the benefits of rapid privatization include Fox and Heller (2000), Kornai (1990 and 2000), Nellis (1999), and Roland (2000).

quality of corporate governance likely to result from employee buyouts and voucher programs, but the justification for these methods is usually couched in terms of their speed, with attention paid to design details that mitigate the governance problems.[3] Given the difficulty of carrying out trade sales to large investors, the main debate has been whether such methods of privatization, even if second-best, should nevertheless be a priority for policy.

In this paper, we argue that the debate suffers from two problems. First, it has overlooked an important interaction at the level of the firm's product market: the degree of competition in a market may be a function not only of market structure or concentration and the extent of price and entry liberalization, but also the characteristics of market participants. We hypothesize, specifically, that private firms may be more aggressive competitors than state firms, suggesting that a firm operating in a given market may face tougher competition if most competitors are private. Thus, even if the effect of privatizing a particular firm is independent or substitutable with exposing it to competitive markets, privatization of competitors may be complementary, raising the effective competition associated with a particular market structure. The effects of privatization on efficiency may show up indirectly, working through enhanced market competition, as much as or more than they do directly through the corporate governance of a particular firm.

The second problem is that the debate has been conducted on the basis of very little empirical evidence, particularly firm-level analyses of the interaction between competition and privatization in affecting efficiency. Indeed, there have been rather few studies of competition and firm performance more generally. A recent exception is Nickell (1996), but this paper examines the efficiency effects only of market structure. A small number of studies have examined the impact of both competition and privatization in Russia and other

[3] E.g., Frydman and Rapaczynski (1994) on mass privatization, or Earle and Estrin (1996) on employee buyouts.

transitional economies, including Anderson *et al* (1999) on Mongolia; Earle and Estrin (1995) on Russia; Jones *et al* (1998) on Bulgaria; Konings (1997) on Bulgaria, Hungary, and Romania; and Li (1997) on China. But none of these studies investigates the interaction of market structure and private ownership.

Some evidence related to the interaction effect comes from Nickell *et al* (1997), who test the joint effect of rents (a proxy for market power) and the presence of a dominant outside shareholder on productivity growth of a sample of firms in the UK, finding weak evidence that the two effects are substitutable. In the transition context, where the theoretical possibility of interaction effects has been discussed by Gates, Milgrom, and Roberts (1996) and Friedman and Johnson (1996, 1997) with respect to a variety of policy reforms, only Earle and Estrin (1998) appear to have conducted an empirical analysis. They find little evidence of either substitutability or complementarity in market competition and private ownership at the firm level, although data limitations in their study preclude strong conclusions.[4] Neither they, nor any other researchers of whom we are aware, have investigated the possible complementarity between market competition and privatization of a firm's competitors.[5]

This paper investigates these interactions using a data set that has distinct advantages over prior research in terms of size and coverage, the time span of observations on each firm, and the availability of measures of market structure. The panel data set we use for estimation purposes is quite comprehensive, including 80.5 percent of total employment in Russian manufacturing industry in 1992, the year of the liberalization shock, and containing annual

[4] Earle and Estrin (1998) relied on survey data from about 200 firms collected in July 1994, which was not long after the competitive shock. Their measures of product market concentration were highly aggregated, and their data did not permit them to estimate total factor productivity.

[5] Pinto *et al*'s (1993) report that state-owned enterprises were engaged in restructuring in Poland during 1990-92 has been taken as evidence for the view that competitive forces can work even in the absence of privatization (thus, that the two factors are independent or substitutable), but the interaction is not estimated and the sample size is very small.

information from 1992 to 1999.[6] Since we have nearly the entire population of medium- and large-size industrial enterprises, including information on their exact locations and disaggregated five-digit industries, we can use much more precise measures of market structure than those available to other researchers in Russia or in many other countries. Motivated by the large size and poor infrastructure of Russia, we exploit this feature of the data to measure product market structure so as to take into account the geographic dispersion of the market.

The effects of market competition and private ownership on firm efficiency are, of course, of much broader interest than the debate in transition economies. To start with, attempts to liberalize particular sectors in market economies typically face sequencing choices in divesting ownership, contracting out services, permitting entry, deregulation, etc. Yet, as we have noted, empirical evidence on the topic has almost always estimated average effects of either market or ownership structure, rather than considering how these effects may vary with each other and with other conditions.[7] Such interactions are important to our understanding of the competitive process and firm behavior more generally. Research on capital structure going back to Jensen (1986), for instance, has examined the possible role of leverage as a disciplinary device, and recent analyses have examined the impact of changes in leverage of a firm on competition, measured as entry of rivals (Chevalier, 1995); by contrast we focus on the efficiency effects, and we investigate the interactions for a given set of incumbent firms. Also relevant are recent theories of mixed oligopoly behavior, which

[6] Some enterprises are excluded from the regression analysis due to missing values or to avoid a potential bias, as discussed below. The percentage of total industrial employment that is used for calculating the market structure measures is 91 percent. These figures are calculated by dividing the sum of employment for the firms in our sample by the total industrial employment reported in Goskomstat (1996).

[7] For example, Kokko (1996) and others have sought to determine whether increased competition is an important channel through which foreign affiliates' presence in developing economies provides productivity spillovers for domestic firms. They examine only average effects of market structure and foreign share of the industry's production, however, so it is impossible to distinguish between spillovers due to increased competition from other types of spillovers (e.g., from knowledge) in their studies.

examine the implications for allocative efficiency when firms with non-profit maximizing objectives participate in a market, but our work differs in focusing on the interaction effect on productive efficiency.[8]

Moreover, our analysis of the situation in Russia is useful for shedding light on the broader questions of factors affecting the intensity of competition, including the effects of ownership. In the developed market economies, the analyst has little opportunity to observe large changes in market competition and in ownership, nor to study the behavior of firms operating far from the production frontier. The potential endogeneity of market structure in this setting has hindered strong conclusions on the behavioral effects of competition.[9] In Russia, by contrast, the market structure was inherited from the central planning period, which suggests that it can be treated as exogenous with respect to market forces, and the potential for competition inherent in this structure was only realized with economic liberalization in 1992. Many firms were privatized; thus we also observe considerable heterogeneity and changes in ownership. Finally, many of the firms that were inherited from the Soviet regime were quite inefficient, so they had plenty of scope to improve their performance. For these reasons, the situation can be characterized as a "quasi-experiment" from which we can learn much about the nature of market competition, private ownership, and their interactions.[10]

In the following Section 2, we develop a model for analyzing the private ownership – market competition interaction. Section 3 describes our data, Section 4 our econometric

[8] The mixed oligopoly literature, which originated in Merrill and Schneider (1966), is mostly theoretical, with two recent exceptions. Barros and Modesto (1999) analyze market behavior in the Portuguese banking sector, where one state-owned bank competes with several private banks. Using the same Russian data set as in this paper, Brown and Brown (2001) find that the relationship between industry profitability and market structure is much stronger in industries that have undergone more complete privatization.

[9] See, for instance, the theory of efficient market structure (Demsetz, 1973; Peltzman, 1977).

[10] Meyer (1995) discusses natural and quasi-experiments in economics.

framework, and Section 5 our principal results. Section 6 offers some checks of robustness and extensions, while Section 7 concludes.

2. A Model of Competition-Privatization Interactions

In this section we lay out a simple model of the impact of competition and ownership on firm behavior. The main purpose is to illustrate how such factors may interact in affecting managerial effort to increase productivity, and thus to motivate our empirical work. Ownership is modelled as affecting managerial incentives and managerial quality.[11]

Consider the decision of the manager of some firm *i* concerning the division of her total time *E* between leisure, L_i, and effort, e_i. Effort reduces per unit production costs, $c_i = a_i - b_i e_i$, where $1 > a_i > 0 \; \forall i$ is the per unit production cost when no effort is supplied and $b_i \geq 0$ is a parameter for managerial skill in translating effort into cost reduction. b_i may reflect ownership of the firm, and we assume that $b_i^N \geq b_i^S$ for all firms *i*, where the superscripts *N* and *S* indicate nonstate and state ownership, respectively. Essentially, this assumption states that nonstate owners are able to hire better matched managers, better in the sense of more skilled at reducing costs at their firm. As Barberis *et al* (1996) expressed it in a study of the privatization of Russian shops, privatization may "work" because it improves human capital – primarily through managerial replacement.

Having determined effort, the firm then engages in Cournot competition with the *n-1* other firms. Following Cournot competition, firm *i* realizes profit $\prod_i$. We assume that only firms making non-negative profit operate in the market.[12]

Let the manager of any firm *i* have the utility function

[11] The model is similar to those developed to analyze research and development expenditures and subsequent competition (e.g., Spencer and Brander, 1983).

[12] All that is necessary, however, is for managers' rents to be positive, which could be the case even if the firm's reported accounting profit is negative.

$$\max_{e_i} \Omega_i = \Pi_i^{\alpha_i} L_i^{\beta_i},$$

where $\alpha_i > 0$ and $\beta_i > 0$ are the weights the manager places on profit and leisure, respectively. Ownership of the firm may affect these weights, and we assume that managerial incentives to increase profit vary with the ownership of the firm such that $\alpha_i^N \geq \alpha_i^S$, where the superscripts *N* and *S* again indicate nonstate and state ownership, respectively. This assumption is consistent with standard analyses of the privatization of cash flow rights, as in Shleifer and Vishny (1994) and Blanchard (1997). Ownership may affect managerial incentives directly, if managers own a stake in the company, which was a common outcome of Russian privatization (Earle *et al*, 1996). They may also affect incentives indirectly, if managers received better incentive contracts or are more closely monitored by nonstate owners.

Inserting $E - e_i$ for L_i and taking logs, we obtain the transformed problem

$$\max_{e_i} \log \Omega_i = \alpha_i \log \Pi_i(e_i) + \beta_i \log(E - e_i).$$

Taking the first-order condition with respect to effort, e_i, yields

$$\frac{\partial \log \Omega_i}{\partial e_i} = \frac{\alpha_i \dfrac{\partial \Pi_i}{\partial e_i}}{\Pi_i(e_i)} - \frac{\beta_i}{E - e_i} = 0.$$

To determine $\dfrac{\partial \Pi_i}{\partial e_i}$ and $\Pi_i(e_i)$, we need to work out the results of the subsequent Cournot competition. Assume that there are *n* firms with marginal costs $c_1, c_2, ..., c_n$ producing quantities $q_1, q_2, ..., q_n$ and that the inverse demand function is $P = 1 - Q$, where

$$Q = \sum_{i=1}^{n} q_i \,. \qquad (1)$$

Each firm *i* chooses q_i to maximize profit $\Pi_i = (1 - q_i - \sum_{j \neq i} q_j) q_i - c_i q_i$ for given q_j.

The first-order condition is $\frac{\partial \Pi_i}{\partial q_i} = 1 - \sum_{j \neq i} q_j - 2q_i - c_i = 0$ or $q_i = 1 - \sum_{j \neq i} q_j - q_i - c_i$.

Substituting (1), we obtain

$$q_i = 1 - Q - c_i, \tag{2}$$

and after adding up (2) for *i*=1,…, *n*,

$$Q = n(1 - Q) - \sum_{i=1}^{n} c_i . \tag{3}$$

Hence $Q = \frac{n - \sum_{i=1}^{n} c_i}{n+1}$, and, again using (2), $q_i^* = \frac{1 + (n-1)\bar{c}_{j \neq i} - nc_i}{n+1}$.

$\bar{c}_{j \neq i} = \frac{1}{n-1} \sum_{j \neq i} c_j = \bar{a}_{j \neq i} - \bar{b}_{j \neq i} \bar{e}_{j \neq i}$ is the marginal cost of the representative competitor, where

$\bar{a}_{j \neq i} = \frac{1}{n-1} \sum_{j \neq i} a_j$, $\bar{b}_{j \neq i} = \frac{1}{n-1} \sum_{j \neq i} b_j$, and $\bar{e}_{j \neq i} = \frac{1}{n-1} \sum_{j \neq i} e_j$ are the average values among the competitors. Equilibrium profit is therefore $\Pi_i^* = \left(\frac{1 + (n-1)\bar{c}_{j \neq i} - nc_i}{n+1} \right)^2 = q_i^{*2}$.

Returning to the manager of firm *i*'s effort decision, and taking the derivative of profit with respect to effort: $\frac{\partial \Pi_i^*}{\partial e_i} = \frac{2nb_i q_i^*}{n+1}$. Finally, inserting this into the first-order condition for the maximization of utility and solving for e_i^* and c_i^* yields the following equilibrium expressions:

$$e_i^* = \frac{2nb_i \alpha_i E - \beta_i - \beta_i \bar{c}_{j \neq i}(n-1) + \beta_i a_i n}{nb_i (2\alpha_i + \beta_i)}, \text{ and thus}$$

$$c_i^* = a_i - \frac{2nb_i \alpha_i E - \beta_i - \beta_i \bar{c}_{j \neq i}(n-1) + \beta_i a_i n}{n(2\alpha_i + \beta_i)} .$$

Comparative static analysis of these equilibrium results yields the following propositions that we examine in our empirical work.

Proposition 1 *Firm costs are decreasing in the number of competitors*.

Proof. This follows directly from the derivative of firm *i*'s costs with respect to the number of firms, which is

$$\frac{\partial c_i^*}{\partial n} = -\frac{\beta_i \left(n(1-a_i)+(1-\bar{c}_{j\neq i})\right)}{n^2(2\alpha_i+\beta_i)} < 0 .^{13}$$

Proposition 2 *Firm costs are decreasing in managerial skill in cost reduction*.

Proof. This follows directly from the derivative of firm *i*'s costs with respect to b_i, which is

$$\frac{\partial c_i^*}{\partial b_i} = -\frac{2\alpha_i E}{2\alpha_i+\beta_i} < 0 .$$

Proposition 3 *Firm costs are non-increasing in the weight on profit in its manager's utility function.*

Proof. This follows directly from the derivative of firm *i*'s costs with respect to α_i, which is

$$\frac{\partial c_i^*}{\partial \alpha_i} = -\frac{2\beta_i \left(nb_i E+1+\bar{c}_{j\neq i}(n-1)-a_i n\right)}{n(2\alpha_i+\beta_i)^2} .$$

[13] The theoretical results in general are sensitive to the assumptions made. For example, the relationship between managerial effort and the number of competitors depends on the form of the managerial utility function. If it is additively separable, then managerial effort is a decreasing function of the number of competitors.

This expression is non-positive if $a_i \leq \frac{nb_i E + 1 + \bar{c}_{j\neq i}(n-1)}{n}$. One can see from the equilibrium profit function that firm *i*'s profit will be non-negative only when this condition is satisfied. Thus, the proposition holds for all operating firms. Firm costs are decreasing in the weight on profit in its manager's utility function when the firm is profitable.

From Propositions 2 and 3, plus our assumption on the relative value of α_i and b_i under state and nonstate ownership, we derive the following, testable result:

Corollary 1 *Firm costs are lower under nonstate than state ownership.*

Proof. This follows directly from Propositions 2 and 3 together with our assumptions on the relative values of α_i and b_i under state and nonstate ownership ($\alpha_i^N \geq \alpha_i^S$ and $b_i^N \geq b_i^S$).

Next, we consider the impact of changes in a firm's competitors.

Proposition 4 *Firm costs are decreasing in the skill of competitors' managers in cost reduction.*

Proof. This follows directly from the derivative of firm *i*'s costs with respect to a representative competitor's managerial effort efficiency parameter, $\bar{b}_{j\neq i}$, which is

$$\frac{\partial c_i^*}{\partial \bar{b}_{j\neq i}} = -\frac{2\bar{\alpha}_{j\neq i} E\beta_i (n-1)}{n(2\alpha_i + \beta_i)(2\bar{\alpha}_{j\neq i} + \bar{\beta}_{j\neq i})} < 0 .$$

Proposition 5 *Firm costs are non-increasing in the weight placed by managers of competitors on profit.*

Proof. This follows directly from the derivative of firm *i*'s costs with respect to a representative competitor manager's weight on profit, $\bar{\alpha}_{j\neq i}$, which is

$$\frac{\partial c_i^*}{\partial \bar{\alpha}_{j\neq i}} = -\frac{2\beta_i \bar{\beta}_{j\neq i}(n-1)\left(n\bar{b}_{j\neq i} E + 1 + \bar{c}_{j\neq i}(n-2) + c_i - \bar{a}_{j\neq i}(n-1) - a_i\right)}{n\left(2\bar{\alpha}_{j\neq i} + \bar{\beta}_{j\neq i}\right)^2 (2\alpha_i + \beta_i)},$$

which is non-positive for all operating firms, and negative for all profitable firms.

Again, we may derive a corollary, based on the observable share of the market accounted for by nonstate firms:

Corollary 2 *Firm costs are lower when a larger fraction of competitors are nonstate-owned than when more are state-owned.*

Proof. This follows directly from Propositions 4 and 5 together with our assumptions on the values of α_j and b_j for any competitor *j* under state and nonstate ownership ($\alpha_j^N \geq \alpha_j^S$ and $b_j^N \geq b_j^S$).

Next, we turn to interaction effects, beginning with that between the degree of competition and firm-level skills and objectives.

Proposition 6 *The cost reduction effect from an increase in the number of competitors is independent of managerial skill in cost reduction.*

Proof. This follows directly from the second derivative of firm *i*'s costs with respect to the number of firms and its managerial effort efficiency parameter, b_i, which is zero.

Proposition 7 *The cost reduction effect from an increase in the number of competitors is weaker the higher the weight placed on profit in its manager's utility function.*

Proof. This follows directly from the second derivative of firm *i*'s costs with respect to the number of firms and the weight on profit in its manager's utility function, α_i:

$$\frac{\partial^2 c_i^*}{\partial n \partial \alpha_i} = \frac{2\beta_i\left(n(1-a_i)+\left(1-\bar{c}_{j\neq i}\right)\right)}{n^2\left(2\alpha_i+\beta_i\right)^2} > 0.$$

Corollary 3 *The cost reduction effect from an increase in the number of competitors is weaker for a firm in nonstate than one in state ownership.*

Proof. This follows directly from Proposition 7 together with our assumptions that $\alpha_i^N \geq \alpha_i^S$ and $b_i^N \geq b_i^S$.

The strength of the effect of ownership depends on how much α_i and b_i vary across ownership types. If privatization works primarily through raising the skill of managers, b_i, then Proposition 6 tells us that privatization and competition are independent. If privatization work primarily through changing managerial incentives, α_i, then Proposition 7 tells us that privatization and competition are substitutes. Thus, while a more complex model might be able to generate the result that privatization and competition may be complements, our simple model does not. Ultimately, the nature of the interaction is an empirical question, which we address below.

Finally, we address the interaction effect associated with a change in the characteristics of a firm's competitors.

Proposition 8 *The cost reduction effect from an increase in the number of competitors is stronger the greater the skill of competitors' managers in cost reduction.*

Proof. This follows directly from the second derivative of firm *i*'s costs with respect to the number of firms and its competitors' managerial effort efficiency parameter, $b_{j\neq i}$, which is

$$\frac{\partial^2 c_i^*}{\partial n \partial \overline{b}_{j\neq i}} = -\frac{2\overline{\alpha}_{j\neq i} E \beta_i}{n^2 (2\alpha_i + \beta_i)(2\overline{\alpha}_{j\neq i} + \overline{\beta}_{j\neq i})} < 0$$

.

Proposition 9 *The cost reduction effect from an increase in the number of competitors is non-decreasing (in absolute value) with the weight placed by competitors' managers on profit.*

Proof. This follows directly from the second derivative of firm *i*'s costs with respect to the number of firms and to a representative competitor manager's weight on profit, $\alpha_{j\neq i}$:

$$\frac{\partial^2 c_i^*}{\partial n \partial \overline{\alpha}_{j\neq i}} = -\frac{2\beta_i \beta_j \left(n\overline{b}_{j\neq i} E + 1 + \overline{c}_{j\neq i}(n-2) + c_i - \overline{a}_{j\neq i}(n-1) - a_i\right)}{n^3 (2\alpha_i + \beta_i)(2\overline{\alpha}_{j\neq i} + \overline{\beta}_{j\neq i})^2}.$$

This expression is non-positive for all operating firms, and strictly negative for profitable firms.

Corollary 4 *The cost reduction effect from an increase in the number of competitors is stronger if a larger share of the competitors are nonstate-owned than if they are state-owned.*

Proof. This follows directly from Propositions 8 and 9 together with our assumptions on the values of α_j and b_j for any competitor j under state and nonstate ownership ($\alpha_j^N \geq \alpha_j^S$ and $b_j^N \geq b_j^S$).

With respect to both managerial skill b_j and managerial incentives α_j, our model implies a complementary relationship, a positive cross-effect with respect to firm efficiency. Proposition 8 states that increased managerial skill in a firm's competitors intensifies the competitive effect associated with a particular market structure, while Proposition 9 asserts that increased profit-orientation of competitors' managers does the same. Our simple model therefore predicts that privatization of the product market competitors increases the intensity of competition associated with a given market structure. Thus, the effects of privatization may work indirectly through enhanced market competition, even if privatization of a particular firm and competition have effects that are independent or substitutable.

We examine the four corollaries in our empirical work below, with a particular focus on the interaction effects described by Corollaries 3 and 4.

3. Estimation Framework

This section discusses measurement and econometric issues that arise in adapting the model for estimation. We describe the concepts we employ for the dependent variable – firm efficiency – and for the variables of interest – market competition and private ownership. We

also discuss issues of specification, including our methods for controlling for endogeneity and selection bias in estimation.

Concerning the indicator of firm efficiency, we follow the approach of Nickell (1996) and others of estimating the production function, the dual to the cost function. Our firm efficiency measure is thus total factor productivity (TFP) rather than cost efficiency. The reasons for this are purely data-driven: our data, described further in Section 4 below, provide precise measures for output, two types of employment, and the stock of plant and equipment. But they contain no price information for output and capital, and only the wage bill for employment.

With respect to the measure of market structure, the model variable is the number of competitors that a firm faces, *n*. The empirical work on which we report in this paper, however, uses not only *n* but also a variety of alternative measures of market dispersion. The results are quite robust across the alternatives, but our preferred measure of dispersion is 1 minus the Herfindahl-Hirschman index of the product market, adjusted for the geographical size of the market. Our adjustment for geographic market size, an important consideration in a very large country such as Russia, is described further in the next section.

An important issue that arises in any research on the effects of market structure is the possibility of endogeneity. According to the "efficient market structure" view of Demsetz (1973) and Peltzman (1977), for instance, market concentration rises as a result of the growth of more efficient firms, implying that concentration measures may be endogenous when included as regressors in profitability or productivity equations. Our approach to this problem follows the recent literature on natural and quasi-experiments in economics (see, e.g., Meyer, 1995). We argue that the socialist policies prior to transition in Russia created a different data-generating process for variables representing competititive pressure at the time

of liberalization than found in a market economy. Under the Soviet regime, central planners determined the size and resources of firms according to the whims of the Communist Party leadership and political criteria such as regional integration, employment, and military considerations (Kornai, 1992). Planners had an incentive also to take efficiency into account (simply to increase their rents), but they faced extraordinary difficulties in measuring firm productivity in an economy of fixed, distorted relative prices and considerable black market activity. Managerial incentives were tied primarily to fulfillment of the output plan targets, and only secondarily to costs (which again were measured using artificial prices).

For these reasons, we believe that the process of reverse causality – running from efficiency to market structure – is much attenuated when we study firms and industries emerging from the socialist system than in the standard setting of stable market economies. The quasi-experiment created by the suddenness of liberalization in 1992 suggests that we can treat the 1992 market structure as exogenous with respect to productivity, and this is our practice in the empirical work reported in Sections 5 and 6.[14] We do control for other confounding influences and various sources of heterogeneity, however, as discussed below.

Concerning our other variable of interest, ownership, the nature of our data again limits the analysis in that we have only discrete measures: state versus nonstate categories, and a disaggregation of the nonstate category into mixed state-private, 100 percent private (domestic), and foreign ownership. Our measure of nonstate ownership of competitors is therefore the proportion of output accounted for by competitors in the nonstate ownership category, and our measure of the disaggregated nonstate ownership types is similarly their respective proportions. As with the dispersion indicator, our measure of the share of

[14] As pointed out by Nickell (1996), the potential bias induced by the endogeneity of market structure would tend to raise the estimated effect of concentration on productivity. The direction of the bias on the interactions with privatization are unclear, however, so we prefer to limit the bias by relying on the 1992 structure.

competitors of a certain ownership type takes into account the geographic scope of the market.

Another important issue is the possibility of endogeneity in firm ownership. Better firms may have been more likely to be privatized, for instance, or to be privatized fully or to receive foreign investment. If firm quality is unobservable, then selection bias in the privatization process may induce spurious inferences concerning the efficiency-ownership relationship. Thus, we employ a selection bias correction in the results reported below.

We estimate augmented production functions with three inputs:

$$Y = F(A, K, L_1, L_2),$$

where Y=value-added, K=capital stock, L_1=labor services of type 1 (number of production workers), and L_2=labor services of type 2 (number of nonproduction workers). A indexes total factor productivity (disembodied) and $A = A(Disp, Nonstate, NonstateShare, Disp*Nonstate, Disp*NonstateShare\ Disp, u)$, where *Disp* is a measure of product market dispersion, *Nonstate* is a dummy indicating whether the firm is not state-owned, *NonstateShare* is the proportion of product market competitors in nonstate ownership, and u is a disturbance reflecting residual factors affecting productivity. Assuming a translog form for $F(.)$ with coefficients varying across 2-digit sectors, an exponential for A, and only disembodied total factor productivity effects,

$$\begin{aligned} logY_{it} &= \Sigma_j \gamma_{Kj} logK_{it} + \Sigma_j \gamma_{1j} logL_{1it} + \Sigma_j \gamma_{2j} logL_{2it} \\ &+ \Sigma_j \gamma_{KKj} (logK_{it})^2 + \Sigma_j \gamma_{11j} (logL_{1it})^2 + \Sigma_j \gamma_{22j} (logL_{2it})^2 \\ &+ \Sigma_j \gamma_{K1j} logK_{it} logL_{1it} + \Sigma_j \gamma_{K2j} logK_{it} logL_{2it} + \Sigma_j \gamma_{12j} logL_{1it} logL_{2it} \\ &+ \beta_0 Disp_{it} + \beta_1 Nonstate_{it} + \beta_2 NonstateShare_{it} \\ &+ \beta_{01} Disp_{it}*Nonstate_{it} + \beta_{02} Disp_{it}*NonstateShare_{it} + u_{it}, \end{aligned}$$

where *log* refers to the natural logarithm, *i* indexes firms, *j* indexes the firm's 2-digit manufacturing sector (of which there are 10), *t* indexes years (for annual data from 1993-99) and the β and γ are parameters to be estimated. β_{01} measures the substitutability of market dispersion and nonstate ownership of a firm, while β_{02} does likewise for the proportion of the output of competitors in nonstate ownership.

Several econometric problems arise in the estimation of this function. First is the possibility that $E(Disp_{it}u_{it}) \neq 0$ due to the endogeneity problems discussed above. As we discussed above, we use the quasi-experiment of the sudden shock of liberalization in 1992, when we argue that market structure was relatively exogenous. We fix $Disp_{it} = Disp_{i92}$ for all *t*, and estimate

$$\begin{aligned} logY_{it} &= \Sigma_j \gamma_{Kj} logK_{it} + \Sigma_j \gamma_{1j} logL_{1it} + \Sigma_j \gamma_{2j} logL_{2it} \\ &+ \Sigma_j \gamma_{KKj} (logK_{it})^2 + \Sigma_j \gamma_{11j} (logL_{1it})^2 + \Sigma_j \gamma_{22j} (logL_{2it})^2 \\ &+ \Sigma_j \gamma_{K1j} logK_{it} logL_{1it} + \Sigma_j \gamma_{K2j} logK_{it} logL_{2it} + \Sigma_j \gamma_{12j} logL_{1it} logL_{2it} \\ &+ \beta_0 Disp_{i92} + \beta_1 Nonstate_{it} + \beta_2 NonstateShare_{it} \\ &+ \beta_{01} Disp_{i92} * Nonstate_{it} + \beta_{02} Disp_{i92} * NonstateShare_{it} + u_{it}. \end{aligned}$$

Under our assumption that $Disp_{i92}$ is exogenously determined, $E(Disp_{i92}u_{it}) = 0$, and estimation yields consistent estimates of β_0, β_{01}, and β_{02}.

We handle the potential problem of endogeneity of *Nonstate* using standard control function methods, first estimating a selection probit for *Nonstate*, and then adding the resulting inverse Mill's ratio to the production function estimation. The exclusion restrictions include the corresponding former Soviet branch ministry and regional shares (not including firm *i*) of each of these variables. The factors of production may also be endogenous, and we instrument them using their 1992 values.

As a further check on the robustness of our results, we add random effects to some specifications, permitting heterogeneity in the intercept according to a normal distribution. Because our specification includes variables of interest that are specific for individual firms (*Nonstate*), and some that vary across region-industry cells (*Disp* and *NonstateShare*), we estimate alternative specifications with random effects defined at the firm level and for region-industry groups.[15]

Another problem in estimating any of these equations is that the sample may be nonrandom due to systematic patterns of exit and survival: again if these are correlated with both output and the independent variables of interest, then this may produce bias in the estimates. As discussed above, such selection effects may be especially powerful when the competitive shock is very large. If the failure rate of firms is correlated with performance and the size of the shock, which seems to be a probable situation, then this may imply $E(u_{it}) \neq 0$ and induce a bias in the estimate of β_t. To address this issue, we estimate a survival probability function

$$\Pr(S_{it+1} = 1) = 1 - \Phi(\delta_1 Disp_{i92} + \delta_2 Nonstate_{it} + \delta_3 NonstateShare_{it} + \delta_4' Z_{it} + \delta_5 Subsidiary93_i + \delta_6 Plants93_i),$$

where Φ is the normal distribution function, Z_{it} refers to observable characteristics of firms influencing competition and productivity (discussed further below), and the δ are parameters to be estimated. $Subsidiary93_i$ indicates whether the firm is in a subsidiary relationship in 1993, and $Plants93_i$ indicates the number of plants in 1993, additional variables that are included in the survival equation but not the performance equation.

[15] We do not employ fixed effects, both because of the low intertemporal variation in our variables of interest and because of the many unobservable changes in firm boundaries associated with spin-offs, split-ups, and mergers during the transition process.

Other factors affecting TFP include initial conditions and the magnitude of the demand shock faced by the firm, as the state cut its orders drastically and customer and supply chains broke down (Blanchard and Kremer, 1997). A firm with better initial conditions may have been more cushioned from the impact of competition, while a greater shock suggests that firms may have greater difficulty adjusting and maintaining TFP. Our controls for initial conditions include affiliation in the Military-Industrial Complex (*Military*), its profitability in 1992 (*Profit92*), and a dummy variable for whether it was an exporter in 1993 (*Export93*) – the first year for which this information was available.

We also include the change in real industry output (*IndustryGrowth*), regional output (*RegionalGrowth*) and in industry producer price indices (*PriceChange*) under the assumption that these represent exogenous factors that may be correlated with unobserved shocks to a firm's productivity and possibly with competition and ownership as well. We hypothesize that firms facing a greater demand shock will have more difficulty maintaining productive efficiency, due to the costs of laying off workers, unbundling equipment and other capital, etc. A greater price change, though, may cushion firms from external pressure, allowing them to delay restructuring. The effects of these variables may also reflect market conditions in a firm's environment: particularly for declining firms, maintaining TFP may be easier when the industry and region is growing, facilitating the release of workers and capital to other firms. We also include industry group dummies (10 groups), which may help to take into account problems in the measurement of the capital stock, for instance due to some firms inheriting relatively modern equipment, since such variation is likely to be correlated with initial conditions and industry affiliation. Finally, there may be aggregate fluctuations over time; certainly such time effects would appear to be important in Russia.

To summarize, our estimating equation is the following:

$$logY_{it} = \Sigma_j \gamma_{Kj} logK_{it} + \Sigma_j \gamma_{1j} logL_{1it} + \Sigma_j \gamma_{2j} logL_{2it} + \Sigma_j \gamma_{KKj} (logK_{it})^2 + \Sigma_j \gamma_{11j} (logL_{1it})^2 +$$

$$\Sigma_j \gamma_{22j} (logL_{2it})^2 + \Sigma_j \gamma_{K1j} logK_{it} logL_{1it} + \Sigma_j \gamma_{K2j} logK_{it} logL_{2it} + \Sigma_j \gamma_{12j} logL_{1it} logL_{2it}$$

$$+ \beta_0 Disp_{i92} + \beta_1 Nonstate_{it} + \beta_2 NonstateShare_{it}$$

$$+ \beta_{01} Disp_{i92} * Nonstate_{it} + \beta_{02} Disp_{i92} * NonstateShare_{it}$$

$$+ \alpha_i + \alpha_t + \eta' Z_{it} + \mu_1 NonstateMills_{it} + \mu_2 StateMills_{it} + \mu_3 SurvivalMills_{it} + \nu_{it},$$

where K_{it}, L_{1it}, and L_{2it} are instrumented (using 1992 values, as described above), α_i is a random firm effect (in some specifications, group by industry-region), α_t are fixed time (year) effects, Z_{it} refers to observable characteristics of firms influencing productivity (proxies for initial conditions and the magnitude of the demand shock – *Military*, *Profit92*, *Export93*, *IndustryGrowth*, *RegionalGrowth*, *PriceChange* – as discussed above) and η is the associated vector of parameters, $SurvivalMills_{it}$ is the component of the error associated with sample selection bias due to nonrandom exit and survival, $NonstateMills_{it}$ *and* $StateMills_{it}$ control for selection bias associated with the process generating ownership, the μ are their associated coefficients, and ν_{it} is a mean-zero error with $E(X_{it}\nu_{it})=0$.

The results below first present specifications where we assume $\beta_{01} = \beta_{02} = 0$, in other words dropping the interaction terms ($Disp_{i92}*Nonstate_{it}$ and $Disp_{i92}*NonstateShare_{it}$), in order to test the average effects of dispersion and nonstate ownership implied by Corollaries 1 and 2, respectively. Corollary 1 implies $\beta_0 > 0$, and Corollary 2 implies $\beta_1 > 0$.

With the interaction terms included, Corollary 3 concerning substitution between market competition and private ownership at the firm level involves β_{01}; a negative result for the coefficient on the interaction between market dispersion and private ownership would support Corollary 3. Corollary 4 involves β_{02}: a positive finding for this coefficient would suggest complementarity of product market dispersion and privatization of competitors. We

also estimate functions without the Mill's ratios, to examine the robustness with respect to this aspect of the specification.

4. Data

The firm panel data in this study are constructed from three sets of sources. The most important set consists of the Goskomstat (State Committee for Statistics) industrial registries: annual industrial censuses on all Russian industrial enterprises with 100 or more employees and those with fewer than 100 employees that are at least 25 percent owned by other legal entities (including the state). The data do not cover industrial enterprises with fewer than 100 employees and more than 75 percent owned by individuals or industrial divisions of non-industrial enterprises (representing 9.5 percent of industrial employment in 1992). Similarly to industrial surveys and censuses in the US, only a small number of variables are collected, but they are sufficient to permit us to measure market structure quite precisely along a number of dimensions (as described below) and to estimate three-factor production functions. We have obtained files for these registries for each of the years from 1993 to 1999, but as each file contains previous year information for most of the variables, we are able to make use of the year 1992 data as well, although we do not observe enterprises that exited between 1992 and 1993.

We supplement the Goskomstat Industrial Registry database with information from two other sources. First, a Foreign Direct Investment (FDI) database, an annual registry with all foreign-owned firms and joint ventures in Russia permits us to add a large number of firms with foreign ownership in all years except 1996, when the Industrial Registry contains nearly all of the foreign-owned firms. Second, we added some additional enterprises and filled in missing values for enterprises already in the database from a panel database

constructed by Economics, Analysis, and Marketing, Inc. (EKAM) of Moscow using a second version of the Goskomstat annual industrial censuses.

We constructed a panel by matching enterprise identification codes (IDs) across the supplemented registry files. Each registry contains 3,000-4,000 IDs not in previous registries, and a similar number of IDs drop out of each subsequent registry. Some of this is due to genuine firm entry and exit, some due to non-reporting enterprises, and some to enterprises that re-registered, receiving different IDs. For all the IDs not having data in every registry, we searched in all the other registries for matching enterprises by using names, addresses, industries, employment, and output values. By so doing, we were able to link 1,094 enterprises in 1993 whose IDs appear to have changed in a later year, 708 in 1994, 606 in 1995, 203 in 1996, 78 in 1997, and 60 in 1998. Since the registries contain previous year as well as current year values, we were able to fill in entire years of data for several thousand enterprises that existed in a particular year, but for some reason did not report.

The definition of the unit of observation is an important issue in our treatment of the data. To start with, we should emphasize that our data pertain to firms, as is most appropriate for measuring market structure, rather than establishments. The definition of the firm deserves further comment, however. In the process of linking enterprises across years, we identified several hundred cases where both consolidated data and data for subsidiaries appeared. In such cases, the name of the parent enterprise and the word "subsidiary" usually appeared somewhere in the field for the name of the subsidiary, and employment of the subsidiaries usually added exactly to the employment of the consolidated record. We avoid double-counting by excluding either consolidated entities or subsidiaries, but choose between these based on the purpose at hand: we define the unit of observation to be the consolidated entity when we measure product market dispersion at the national level, but use the

information on subsidiaries instead in measuring product market dispersion within regions, and when estimating our productivity equations.

The top half of Table 1 shows the numbers of observations and construction of the sample. The first three rows contain the number of observations obtained from the three sources, and the fourth shows the total number. As discussed above, we include subsidiaries wherever possible and exclude redundant consolidated firms (that is, firms for which we are able to include subsidiaries); the total is shown in the first row of this part. From this total in each year, we excluded firms classified as public organizations (non-profit firms and those belonging to the ministry of culture, the environment, health, or the interior – the database contains a number of prison-based firms).

We have also excluded enterprises that have fewer than 100 employees in 1993, because the database includes only firms in this category with at least 25 percent ownership by a legal entity, which skews the sample. Finally, missing data are a significant problem in the database, creating a final restriction on firms included in our sample for regression analysis. The most important restriction stems from the fact that our research question concerns the impact of the competitive shock of 1992, which thus requires information for that year and indeed pertains only to firms that existed at that time. New start-up firms, likely to be intrinsically different in many respects from the enterprises inherited from the socialist system, are therefore excluded from our sample, which is in any case necessary since such firms entered only after 1992 or were very small in 1992, so would not be in the 1993 registry.

The regression sample thus restricted contains 1993 to 1999 data for an unbalanced panel of 13,288 manufacturing enterprises. This sample covers 80.5 percent of total manufacturing industry employment in 1992, as reported by Goskomstat.

Next, we turn to a discussion of our measures of market dispersion. Our data permit us to calculate conventional measures, including one minus the Herfindahl-Hirschman Index (HHI) or any dispersion ratio or dispersion index, since the database contains the population of large firms. We calculate these measures at the most disaggregated level available: the Russian 5-digit industry classification (OKONKh), of which there are 264 separate categories in the data set we use in the regressions. As discussed in Joskow, Schmalensee, and Tsukanova (1994) and Brown and Brown (1999), the 5-digit OKONKh is roughly comparable to 4-digit categories in the U.S. Standard Industrial Classification, although some sectors are less and others somewhat more disaggregated.

As an enormous country with uneven infrastructure, Russia may have product markets that are constrained geographically. Therefore, we have constructed mixed measures of market dispersion that reflect the likely geographic scope of the market. We use data at three geographic levels: national, regional, and municipal. The regional level is the subject of the Russian Federation (*oblast*), of which there are 77 in the database).[16] The municipal level includes 5,061 communities. Our argument is that the geographic scope of the market in an industry is reflected in the degree to which producers in the industry are located in all the regions and municipalities of the country. For instance, an industry with member firms in all municipalities is likely to be characterized by mostly local markets. An industry with only few firms in the country has mostly a national market. And some industries may be in between, with many firms spread across the country, but many fewer than one per municipality, in which case the market is likely to be regional.

[16] There are 89 subjects of the Russian Federation. The database does not include data from Chechnya or Ingushetia, and the ten autonomous districts (*okrugi*) are aggregated together with the regions that surround them.

To implement a mixed dispersion measure, we calculated the HHI for each OKONKh at each geographic level ($MunDisp_{ij}$ for the municipal HHI of firm i in 5-digit industry j, $RegDisp_{ij}$ for the corresponding regional HHI, and $NatDisp_{ij}$ for the national HHI) and combined them into a single index as follows:

$$Disp_{ij} = MunProp_j * MunDisp_{ij}$$

$$+ (1 - MunProp_j)(RegProp_j * RegDisp_{ij} + (1 - RegProp_j) * NatDisp_{ij}),$$

where $MunProp_j$ refers to the proportion of municipalities with at least one firm in industry j, and $RegProp_j$ refers to the proportion of regions with at least one firm in industry j. We also tried an alternative weighting scheme, as follows:

$$Disp_{ij}' = (1 - RegProp_j) * NatDisp_{ij}$$

$$+ RegProp_j * ((1 - MunProp_j) RegDisp_{ij} + MunProp_j * MunDisp_{ij}),$$

but the correlation of $Disp_{ij}$ and $Disp_{ij}'$ is .997, and the results nearly identical. Thus, we report only results for the first variable, *Disp*.

Descriptive statistics for *Disp* and all the variables used in the regressions (except for industry dummies) are shown in Table 2.

5. Estimation Results

We begin with the results from estimating specifications of the production function excluding the interaction terms between dispersion and ownership. These baseline specifications form the point of comparison for the equations including interactions, and they permit us to test Proposition 1 and Corollaries 1 and 2 of the Model in Section 2, above. To examine robustness, we report results excluding and including the Mill's ratios (*NonstateMills* and *StateMills*), and with three alternative specifications of random effects: none (indicated *OLS)*, firm-level grouping (*RE(FIRM)*), and region-industry grouping

(*RE(REG-IND)*). We consider alternative groupings of the random effects because the variables of interest vary over different groups of observations.[17]

Table 3 contains the results. Our market dispersion measure *Disp* displays little systematic effect in these data. Only in the specification including both the Mill's ratios and firm random effects is its coefficient statistically significant. The impact of the *Nonstate* dummy is much more robust, with a positive, statistically significant coefficient in five of the six specifications. The exception is the OLS equation including Mills ratios but no random effects, where the coefficient is statistically insigificant (and the point estimate is negative). The magnitude of the estimated effect varies between approximately zero and 18 log points higher productivity for nonstate than state firms. *NonstateShare*, the proportion of competitors with nonstate ownership, is also estimated to raise productivity in five of six cases, with a negative effect only when Mills ratios and random effects at the firm level are included; random effects for region-industry cells produce a positive result. The magnitude of the effect of a change from a *NonstateShare* of zero to a value of one ranges up to 22 log points. The slight instability in both the *Nonstate* and the *NonstateShare* estimates, in particular the sign reversal in one specification for each of them, is somewhat disturbing as it suggests the possibility that the equations are misspecified. We return to this issue when we examine the interaction effects, below.[18]

Table 3 also contains the results for all the control variables (the Z_i of Section 3). Consistent with our justification for including the proxies for the initial conditions of the firm, *Military* has a strong negative effect and *Profit92* has a strongly positive effect in all

[17] We do not report separate equations with city-industry random effects, because these are very close to the results from firm random effects.

[18] We performed the Breusch-Pagan Lagrange multiplier test, which rejected the hypothesis that firm- or industry-specific effects not captured by our controls exist, suggesting that random effects are appropriate. The Hausman test rejected the hypothesis of no correlation between the error term and the independent variables, however, suggesting that the random effects specifications are inconsistent. As we mentioned above, however, the normal solution of using fixed effects is not appropriate here.

specifications, although *Export93* is usually insignificant. With respect to the demand shock indicators, *IndustryGrowth*, *RegionalGrowth* and *PriceChange*, the results are similar to those expected, strong and robust across specifications. The year effects show *ceteris paribus* decreasing TFP through the period until 1998. While these are important controls that we maintain in all specifications reported below, the results are quite consistent across all equations. Therefore we omit them in subsequent tables.

Next we turn to the central set of results of the paper: our findings concerning competition-privatization interactions. Table 4 shows the results from estimating the same six specifications as in Table 3 but with the addition of *Conc*Nonstate* and *Conc*NonstateShare*, to capture the firm-level and product market-level substitutability or complementarity. For all six specifications, we find large positive estimated coefficients on the firm-level interaction and large negative ones on the product market-level interaction. In all cases except one (the *Conc*Nonstate* result with random effects for firms) the results are statistically significant, and particularly for *Conc*NonstateShare*, the estimated coefficient lies in a rather narrow range. The main effect of *NonstateShare* is estimated to be positive in all specifications. Thus, the instability of the estimated coefficients in Table 3 appears to be less of a problem in Table 4. We conclude that the data show strong evidence of substitution between privatization and competition at the firm level, and strong evidence of complementarity at the level of the product market.

6. Robustness and Extensions

In this section, we investigate the robustness of the findings reported in the previous section as well as an extension based on a disaggregation of *NonstateShare* ownership into three categories: foreign joint ventures, 100 percent private, and mixed state-private. To

begin with, Table 5 reports the results from re-estimating the equations reported in Table 4 with alternative measures of market structure. The first set permits the measure *Disp* to vary by year, taking on its true values, while the second instruments $Disp_t$ with its 1992 values. The third specification substitutes national dispersion in 1992 (*NatDisp92*) and the fourth regional dispersion (*RegDisp92*) in place of *Disp*. The fifth and sixth specification both employ the number of firms in the sector in 1992 (*NoFirms92*), in the former cases on its own and in the latter in conjunction with the Gini coefficient for the regional dispersion of firms in the sector. Though not displayed here, we have run the regressions using 1991 *Disp*. We have also estimated least-absolute deviations regressions to avoid biases associated with large outliers. In all cases, the results are consistent with the basic message from Table 4: substitutability between market dispersion and private ownership at the firm level, and complementarity between market dispersion and private ownership of competitors.

We also investigated a number of alternative estimation methods, including estimation by least absolute deviations and robust regression in order to check whether the findings depended on the influence of large outliers; they were not. We also used fixed firm effects, which is not our preferred specification as we prefer to fix *Disp* at its 1992 values. Again, the essential results – the substitutability of market dispersion and private ownership at the firm level and the complementarity of market dispersion and private ownership of market competitors – were highly robust. In all cases, the results were very similar to those reported in Table 4.

Finally, motivated by the possibility that different types of private owners may have different advantages in selecting managers and in providing them with incentives to increase profits, we consider a disaggregation of nonstate ownership into three categories permitted by the data. If $\alpha_i^F \geq \alpha_i^P \geq \alpha_i^M \geq \alpha_i^S$, where the nonstate category is disaggregated into foreign

joint ventures, 100 percent private, and mixed state-private subcategories, indicated by superscripts *F*, *P*, and *M*, respectively, then managers of foreign firms place a higher weight on profit, followed by 100 percent private firms, followed by firms of mixed state-private ownership. If $b_i^F \geq b_i^P \geq b_i^M \geq b_i^S$, then foreign owners are best at selecting suitable managers, followed by 100 private owners, followed by mixed, while the state is the worst at managerial selection.

With these additional assumptions, our model predicts that the substitutability between market dispersion and ownership of a firm should follow a similar hierarchy: strongest for foreign-owned firms, followed by 100 percent private, mixed, and state (by analogy with Corollary 3). The complementarity between market dispersion and ownership of a firm's competitors should follow the same ordering as well (by analogy with Corollary 4).

With this motivation, Table 6 reports the results from estimating the following equation:

$$\begin{aligned} logY_{it} = {} & \Sigma_j \gamma_{Kj} logK_{it} + \Sigma_j \gamma_{1j} logL_{1it} + \Sigma_j \gamma_{2j} logL_{2it} + \Sigma_j \gamma_{KKj} (logK_{it})^2 + \Sigma_j \gamma_{11j} (logL_{1it})^2 + \\ & \Sigma_j \gamma_{22j} (logL_{2it})^2 + \Sigma_j \gamma_{K1j} logK_{it} logL_{1it} + \Sigma_j \gamma_{K2j} logK_i logL_{2it} + \Sigma_j \gamma_{12j} logL_{1it} logL_{2it} \\ & + \beta_0 Conc_{i92} + \beta_3 Mixed_{it} + \beta_4 Private_{it} + \beta_5 Foreign_{it} \\ & + \beta_6 MixedShare_{it} + \beta_7 PrivateShare_{it} + \beta_8 ForeignShare_{it} \\ & + \beta_{03} Conc_{i92} * Mixed_{it} + \beta_{04} Conc_{i92} * Private_{it} + \beta_{05} Conc_{i92} * Foreign_{it} \\ & + \beta_{06} Conc_{i92} * MixedShare_{it} + \beta_{07} Conc_{i92} * PrivateShare_{it} + \beta_{08} Conc_{i92} * ForeignShare_{it} \\ & + \alpha_i + \alpha_t + \eta' Z_{it} + \mu_4 StateMills_{it} + \mu_5 MixedMills_{it} + \mu_6 PrivateMills_{it} + \\ & \mu_7 ForeignMills_{it} + \mu_3 SurvivalMills_{it} + \nu_{it}. \end{aligned}$$

The analysis above implies $\beta_{05} < \beta_{04} < \beta_{03} < 0$, and $\beta_{08} > \beta_{07} > \beta_{06} > 0$.

The results in Table 6 provide evidence suggest that *Mixed* and *Private* are substitutes with market competition, but *Foreign* ownership is independent. Possibly foreign owners' efforts to increase productivity depend more on international standards and markets, and less on discipline associated with domestic market competition. Concerning the product market-level interaction, the results strongly imply complementarity between market competition and all three types of private ownership of competitors. The relative magnitudes vary somewhat across specifications, but the strongest complementarity appears to be with *Conc*ForeignShare*, the coefficient of which has the largest magnitude in the specifications including random effects for region-industry cells, although the differences between coefficients across the three ownership categories are not statistically significant.

7. Conclusion

This paper has examined an important implicit assumption in the debate over transition policy strategies. According to what is frequently labelled the "gradualist" school of thought, rapid privatization should not be a policy priority. Some analysts (e.g., Kornai, 1990; Murrell, 1991) argue that the state sector should continue to be governed by central planning and tight bureaucratic controls and be reduced only slowly, at a pace consistent with an "optimal capital replacement policy" (Murrell, 1991, p. 43). Other analysts favor market liberalization, but slow "staged privatization" (Black *et al*, 2000) and "negotiated" rather than "market-driven" restructuring (Spicer *et al*, 2000). As Stiglitz (2000, p. 1) puts it, "The promise of quick economic transformation based on voucher privatization with investment funds has proven illusory. I argue for an alternative present strategy of decentralization to push economic decision-making down to the level where the stakeholders can protect their own interests...."

In any case, it has not been the objective of this paper to investigate all aspects of the gradualism – shock therapy debate. Nor has it been the purpose, despite the fact that our results do provide some evidence of beneficial effects of privatization, to resolve the many questions about the effects of privatization on company management and performance, which are issues requiring further data collection. Rather, our focus has been narrower: on the interaction of privatization with market liberalization. In particular, we have provided a model that suggests that privatization of the firms in a product market may be a necessary condition to stimulate competition that can improve incentives for firm efficiency. Our econometric analysis provides substantial empirical support for this implication of the model.

Although this paper is the first to provide a theoretical and empirical analysis of this complementarity, our line of thought is consistent with some analyses of mixed systems such as market socialism, in which state ownership is combined with market coordination. According to Kornai (1992, p. 509), for instance, "[t]he semideregulated public sector shows few signs of being influenced by respect for industry and thrift associated with private ownership..." Rather, "[a] market based on private ownership...imposes a discipline. The rivalry is merciless..." He goes on to assert the "affinity" of market coordination and private ownership, a proposition which this paper has sought to formalize and test.

While these issues are relevant not only to the study of post-socialist transition and comparative economic systems, but more broadly to our understanding of the competitive process among firms, they are of great practical import in transition economies. In most countries of Eastern Europe and the former Soviet Union, liberalization of prices and entry came rapidly but privatization proceeded more slowly and controversially. All the countries still have large state sectors, and minority (and majority) state holdings exist in many nominally privatized companies. Given a menu of privatization policies, which vary in their

speed and their prospective economic and political outcomes, a major policy issue has been and continues in many countries to be the best choice of policy. In this paper, we have suggested that an important, but frequently overlooked benefit of privatization may arise from the intensifying effects of private ownership of competitors on the disciplining influence of competition.

Appendix: Definitions of Variables

Disp92 is *MunicipalShare*MunDisp92 + (1-MunicipalShare) *(RegionalShare*RegDisp92 + (1-RegionalShare)*NatDisp92*).

Disp$_t$ is calculated similarly to *Disp92*, with the exception that it uses the municipal share, regional share, municipal dispersion, regional dispersion, and national dispersion in year *t* instead of in 1992.

Employment92 is the log of the enterprise's 1992 industrial employment.

Export93 is a dummy equal to 1 if the enterprise exported at least part of its production in 1993.

Foreign$_t$ is a dummy equal to 1 if the firm is partly or wholly owned by foreign entities in year *t*.

ForeignShare$_t$ is $MunicipalShare*MunicipalForeignShare_t + (1-MunicipalShare)*(RegionalShare* RegionalForeignShare_t + (1-RegionalShare)* NationalForeignShare_t$). These calculations exclude the output of firm *i*.

IndustryGrowth$_t$ is the log of the ratio of year *t* output of the firm's five-digit industry (using our database, not including firm *i*) in December 1992 prices to the previous year output of the industry in December 1992 prices.

K_t is the log of the book value in 1992 prices of the enterprise's fixed assets used in industrial production. Revaluations are controlled for using beginning- and end-year book values.

L_{1t} is the log of the enterprise's number of production workers.

L_{2t} is the log of the enterprise's number of non-production employees.

Military is a dummy equal to 1 if the enterprise formerly belonged to an MIC branch ministry.

Mixed$_t$ is a dummy equal to 1 if the firm is owned by domestic private owners and the state in year *t*.

MixedShare$_t$ is $MunicipalShare*MunicipalMixedShare_t + (1-MunicipalShare)*(RegionalShare* RegionalMixedShare_t + (1-RegionalShare)* NationalMixedShare_t$). These calculations exclude the output of firm *i*.

MunDisp92 is 1 minus the Herfindahl-Hirschman Index (sum of squared output shares of each firm in the industry, divided by 10,000) for the five-digit industry at the municipal level in 1992.

MunicipalShare is the proportion of municipalities that contained at least one enterprise in the 5-digit OKONKh in 1992.

MunicipalForeignShare$_t$ is the share of output in the 5-digit industry in the municipality in year *t* produced by firms at least partly owned by foreign entities.

MunicipalMixedShare$_t$ is the share of output in the 5-digit industry in the municipality in year *t* produced by firms of mixed private and state ownership.

MunicipalNonstateShare$_t$ is the share of output in the 5-digit industry in the municipality in year *t* produced by firms of nonstate ownership.

MunicipalPrivateShare$_t$ is the share of output in the 5-digit industry in the municipality in year *t* produced by 100 percent private firms.

NatDisp92 is 1 minus the Herfindahl-Hirschman Index (sum of squared output shares of each firm in the industry, divided by 10,000) for the five-digit industry at the national level in 1992.

NationalForeignShare$_t$ is the share of output in the national 5-digit industry in year *t* produced by firms at least partly owned by foreign entities.

NationalMixedShare$_t$ is the share of output in the national 5-digit industry in year *t* produced by firms of mixed private and state ownership.

NationalNonstateShare$_t$ is the share of output in the national 5-digit industry in year *t* produced by firms of nonstate ownership.

NationalPrivateShare$_t$ is the share of output in the national 5-digit industry in year *t* produced by 100 percent private firms.

Nonstate$_t$ is a dummy equal to 1 if the firm is at least partly privately owned in year *t*.

NonstateMills$_t$ is the inverse Mills' ratio for nonstate enterprises, calculated from the first-stage probit for whether the enterprise was nonstate or not in year *t*.

NonstateShare$_t$ is *MunicipalShare*MunicipalNonstateShare$_t$ + (1-MunicipalShare)*(RegionalShare* RegionalNonstateShare$_t$ + (1-RegionalShare)* NationalNonstateShare$_t$*). These calculations exclude the output of firm *i*.

Plants93 is the log of the number of plants the firm has in 1993.

PriceChange$_t$ is the log of the year *t* average producer price deflator relative to December 1992 for each four-digit industry.

Private$_t$ is a dummy equal to 1 if the firm is domestically privately owned in year *t*.

PrivateShare$_t$ is *MunicipalShare*MunicipalPrivateShare$_t$ + (1-MunicipalShare)*(RegionalShare* RegionalPrivateShare$_t$ + (1-RegionalShare)* NationalPrivateShare$_t$*). These calculations exclude the output of firm *i*.

Profit92 is the enterprise's profit (loss) divided by output in 1992.

RegDisp92 is 1 minus the Herfindahl-Hirschman Index (sum of squared output shares of each firm in the industry, divided by 10,000) for the five-digit industry at the regional level in 1992.

$RegionalGrowth_t$ is the log of the ratio of year *t* industrial output of the region (using our database, not including firm *i*) in December 1992 prices to the previous year output of the region in December 1992 prices.

$RegionalForeignShare_t$ is the share of output in the 5-digit industry in the region in year *t* produced by firms with foreign ownership.

$RegionalMixedShare_t$ is the share of output in the 5-digit industry in the region in year *t* produced by firms with mixed ownership.

$RegionalNonstateShare_t$ is the share of output in the 5-digit industry in the region in year *t* produced by firms with nonstate ownership.

$RegionalPrivateShare_t$ is the share of output in the 5-digit industry in the region in year *t* produced by firms with private ownership.

RegionalShare is the proportion of regions that contained at least one enterprise in the 5-digit OKONKh in 1992.

$StateMills_t$ is the inverse Mills' ratio for state enterprises, calculated from the first-stage probit for whether the enterprise was nonstate or not in year *t*.

Subsidiary93 is a dummy equal to 1 if the enterprise was either a subsidiary or parent to a subsidiary in 1993.

$SurvivalMills_t$ is the inverse Mills' ratio from the first-stage probit for whether the enterprise exists in the data in year *t* (conditional on existing in 1992).

Y_t is the log of the value of output the enterprise produced in December 1992 prices, using 4-digit producer price deflators.

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Table 1. Construction of the Sample

Number of firms:	1993	1994	1995	1996	1997	1998	1999
In the Industrial Registry	26,484	27,377	28,640	29,698	29,175	26,532	26,751
Added from FDI Database	2,448	3,342	3,638	28	2,328	188	195
Added from EKAM Database	1,144	2,437	37	281	256	0	0
Total	30,076	33,156	32,315	30,007	31,759	26,720	26,946
Minus non-manufacturing firms	23,703	24,400	25,674	24,526	22,927	20,013	20,204
Minus firms classified as "Public Organizations"	23,383	24,044	25,232	24,056	22,393	19,472	19,636
Minus firms not existing in 1992	20,990	19,309	18,491	16,363	15,573	13,534	12,716
Minus firms with fewer than 100 employees in 1993	15,470	14,778	14,262	13,151	12,598	11,043	10,378
Minus firms with missing values (sample for regressions)	13,255	12,691	12,293	11,569	10,965	9,622	8,948

The dispersion statistics are based on 24,018, 24,014, and 23,734 firms at the national, regional, and municipal levels, respectively.

Table 2. Means of Variables

	Variable	Mean	Standard Deviation
Market Structure	*Disp92* (1-mixed HHI 1992)	0.702	0.156
	$Disp_t$ (time-varying 1-mixed HHI)	0.688	0.166
	NationalDisp92 (1-national HHI 1992)	0.958	0.071
	RegionalDisp92 (1-regional HHI 1992)	0.599	0.338
	Gini92 (1-Gini 1992)	0.409	0.104
	NoFirms (log of number of firms 1992)	5.489	1.603
	$Nonstate_t$ (dummy)	0.792	
	$Mixed_t$ (dummy)	0.403	
	$Private_t$ (dummy)	0.379	
	$Foreign_t$ (dummy)	0.009	
	$NonstateShare_t$ (proportion of industrial output)	0.679	0.300
	$MixedShare_t$ (proportion of industrial output)	0.338	0.263
	$PrivateShare_t$ (proportion of industrial output)	0.319	0.285
	$ForeignShare_t$ (proportion of industrial output)	0.033	0.098
	Y_t (mln 1992 rubles)	756	7,071
Factors of Production	K_t (mln 1992 rubles)	670	2,869
	L_{1t} (number)	506	1,225
	L_{2t} (number)	142	360
Firm Initial Conditions	*Military* (dummy)	0.064	
	Export93 (dummy)	0.168	
	Profit92 (per ruble output)	0.207	0.159
	Emp92 (number)	987	2,619
Demand Shocks	$IndustryGrowth_t$ (log ratio to previous year)	-0.199	0.359
	$RegionalGrowth_t$ (log ratio to previous year)	-0.155	0.301
	$PriceChange_t$ (in proportion to previous year)	0.501	0.561
Survival Regression Variables	$Survival_t$ (dummy)	0.925	
	Plants93 (number)	1.260	2.915
	Subsidiary93 (dummy)	0.020	

The means are calculated here without using logs, though some variables are in logs in the regressions.

Table 3. Basic Production Function Regressions

Variable	OLS		RE (FIRM)		RE (REG-IND)		OLS		RE (FIRM)		RE (REG-IND)	
Disp92	0.004	(0.07)	0.073	(1.22)	-0.059	(-1.49)	-0.040	(-0.58)	0.128	(2.13)	-0.064	(-1.56)
$Nonstate_t$	0.103	(4.66)	0.029	(2.21)	0.092	(6.60)	-0.020	(-0.36)	0.182	(5.76)	0.081	(2.35)
$NonstateShare_t$	0.138	(3.57)	0.048	(2.22)	0.075	(3.07)	0.222	(4.19)	-0.059	(-2.00)	0.086	(2.71)
Military	-0.514	(-11.91)	-0.526	(-12.91)	-0.431	(-15.41)	-0.537	(-12.21)	-0.506	(-12.38)	-0.438	(-15.37)
Export93	0.019	(0.60)	0.047	(1.61)	0.076	(5.03)	0.022	(0.69)	0.044	(1.52)	0.077	(5.07)
Profit92	0.868	(12.55)	0.980	(17.40)	0.890	(29.75)	0.878	(12.67)	0.969	(17.22)	0.892	(29.71)
$IndustryGrowth_t$	0.299	(12.71)	0.163	(15.44)	0.272	(18.75)	0.297	(12.60)	0.164	(15.55)	0.271	(18.70)
$RegionalGrowth_t$	0.162	(6.81)	0.120	(8.08)	0.137	(6.56)	0.159	(6.68)	0.123	(8.26)	0.137	(6.54)
$PriceChange_t$	-0.738	(-20.50)	-0.503	(-22.54)	-0.693	(-22.21)	-0.739	(-20.56)	-0.504	(-22.60)	-0.695	(-22.25)
$SurvivalMills_t$	-0.163	(-2.35)	-0.093	(-2.44)	-0.172	(-3.56)	-0.174	(-2.51)	-0.099	(-2.60)	-0.175	(-3.62)
$NonstateMills_t$							0.148	(3.11)	-0.110	(-3.95)	0.053	(1.71)
$StateMills_t$							0.049	(1.42)	-0.099	(-5.31)	-0.014	(-0.70)
1994	-1.148	(-28.38)	-0.997	(-37.40)	-1.096	(-29.87)	-1.123	(-27.64)	-1.015	(-37.43)	-1.088	(-29.31)
1995	-1.836	(-36.21)	-1.567	(-47.48)	-1.744	(-38.77)	-1.809	(-35.69)	-1.588	(-47.50)	-1.737	(-38.23)
1996	-2.295	(-37.96)	-2.005	(-51.74)	-2.184	(-41.60)	-2.265	(-37.65)	-2.028	(-51.79)	-2.178	(-41.10)
1997	-2.530	(-39.88)	-2.227	(-55.09)	-2.411	(-44.32)	-2.498	(-39.50)	-2.252	(-55.08)	-2.404	(-43.73)
1998	-2.575	(-40.65)	-2.292	(-56.89)	-2.460	(-45.37)	-2.540	(-40.13)	-2.320	(-56.80)	-2.452	(-44.71)
1999	-2.251	(-45.05)	-2.087	(-66.03)	-2.156	(-51.87)	-2.204	(-43.12)	-2.121	(-64.70)	-2.142	(-50.04)
R^2	0.568		0.551		0.560		0.568		0.550		0.560	

The number of observations in all regressions is 79,343. The t statistics (z statistics in the random effects specifications) are reported in parentheses. The t statistics in the OLS specifications are based on White-corrected robust standard errors adjusted for clustering on firm id. The factors of production for 10 sectors, sectoral dummies, and a constant term are also included, following the specifications in equations (4) and (5) in the text. 1993 is the omitted year category. The marginal products (weighted average across the 10 sectors) are 0.377, 0.580, and 0.209 for capital, production workers, and non-production workers, respectively in the OLS specification controlling for ownership selection bias.

Table 4. Production Function Regressions with Interactions

Variable	OLS		RE (FIRM)		RE (REG-IND)		OLS		RE (FIRM)		RE (REG-IND)	
Disp92	0.087	(0.72)	-0.017	(-0.21)	-0.097	(-1.27)	0.034	(0.27)	0.052	(0.63)	-0.099	(-1.27)
*Disp92*Nonstate*$_t$	-0.375	(-2.81)	-0.169	(-2.27)	-0.210	(-2.80)	-0.402	(-3.00)	-0.126	(-1.68)	-0.214	(-2.85)
*Disp92*NonstateShare*$_t$	0.359	(2.39)	0.368	(4.33)	0.355	(3.93)	0.409	(2.69)	0.281	(3.24)	0.353	(3.85)
Nonstate$_t$	0.358	(3.72)	0.141	(2.63)	0.235	(4.33)	0.251	(2.39)	0.256	(4.39)	0.223	(3.68)
NonstateShare$_t$	-0.100	(-0.97)	-0.186	(-3.18)	-0.157	(-2.55)	-0.048	(-0.45)	-0.229	(-3.87)	-0.143	(-2.29)
NonstateMills$_t$							0.145	(3.03)	-0.105	(-3.73)	0.052	(1.67)
StateMills$_t$							0.052	(1.50)	-0.093	(-4.87)	-0.010	(-0.51)
R^2	0.568		0.551		0.560		0.568		0.550		0.560	
N	79,343		79,343		79,343		79,343		79,343		79,343	

The t statistics are reported in parentheses. They are based on White-corrected robust standard errors, adjusted for clustering on firm id in the OLS specification. All other variables in the regressions in Table 3 are also included.

Table 5. Production Function Regressions with Various Measures of Market Structure and Interactions

Variable	Random Effects*	
$Disp_t$	0.153	(2.19)
$Disp_t$*$Nonstate_t$	-0.308	(-4.41)
$Disp_t$*$NonstateShare_t$	0.679	(8.18)
$Nonstate_t$	0.340	(6.01)
$NonstateShare_t$	-0.441	(-7.98)
$Disp_t$ (Instrumented)	-0.219	(-2.27)
$Disp_t$*$Nonstate_t$	-0.134	(-1.49)
$Disp_t$*$NonstateShare_t$	0.422	(3.79)
$Nonstate_t$	0.164	(2.37)
$NonstateShare_t$	-0.183	(-2.49)
NatDisp92	-0.295	(-1.08)
*NatDisp92**$Nonstate_t$	-0.366	(-2.36)
*NatDisp92**$NonstateShare_t$	1.929	(9.09)
$Nonstate_t$	0.204	(1.34)
$NonstateShare_t$	-0.971	(-4.82)
RegDisp92	-0.160	(-4.20)
*RegDisp92**$Nonstate_t$	-0.119	(-3.39)
*RegDisp92**$NonstateShare_t$	0.390	(9.35)
$Nonstate_t$	0.192	(5.32)
$NonstateShare_t$	-0.156	(-6.72)
NoFirms92	-0.002	(-0.06)
*NoFirms92**$Nonstate_t$	-0.026	(-3.52)
*NoFirms92**$NonstateShare_t$	0.132	(10.09)
$Nonstate_t$	0.006	(0.12)
$NonstateShare_t$	0.410	(4.58)
NoFirms92	-0.007	(-0.16)
Gini92	-0.103	(-0.26)
*NoFirms92**$Nonstate_t$	-0.024	(-3.16)
*Gini92**$Nonstate_t$	-0.066	(-0.55)
*NoFirms92**$NonstateShare_t$	0.101	(7.45)
*Gini92**$NonstateShare_t$	-0.225	(-1.05)
$Nonstate_t$	0.016	(0.21)
$NonstateShare_t$	0.338	(2.37)

The t statistics are reported in parentheses. They are based on White-corrected robust standard errors, adjusted for clustering on firm id in the OLS specification. All other variables in the regressions in Table 3 are also included.

Table 6. Production Function Regressions with Disaggregated Ownership with Interactions

Variable	OLS		RE (FIRM)		RE (REG-IND)		OLS		RE (FIRM)		RE (REG-IND)	
Disp92	0.024	(0.20)	-0.079	(-0.95)	-0.144	(-1.86)	0.057	(0.46)	-0.035	(-0.42)	-0.073	(-0.93)
*Disp92*Mixed*$_t$	-0.359	(-2.47)	-0.214	(-2.75)	-0.261	(-3.28)	-0.360	(-2.47)	-0.187	(-2.40)	-0.253	(-3.18)
*Disp92*Private*$_t$	-0.363	(-2.43)	-0.193	(-2.21)	-0.130	(-1.57)	-0.399	(-2.66)	-0.178	(-2.03)	-0.168	(-2.03)
*Disp92*Foreign*$_t$	0.201	(0.44)	0.030	(0.11)	0.217	(0.85)	0.087	(0.21)	-0.026	(-0.09)	0.120	(0.47)
*Disp92*MixedShare*$_t$	0.570	(2.86)	0.520	(4.77)	0.340	(2.91)	0.501	(2.50)	0.450	(4.10)	0.252	(2.14)
*Disp92*PrivateShare*$_t$	0.206	(1.09)	0.407	(3.78)	0.307	(2.74)	0.248	(1.31)	0.371	(3.42)	0.313	(2.77)
*Disp92*ForeignShare*$_t$	0.420	(1.09)	0.609	(3.10)	0.691	(2.97)	0.316	(0.82)	0.516	(2.62)	0.571	(2.45)
Mixed$_t$	0.308	(2.95)	0.143	(2.58)	0.243	(4.21)	0.501	(4.46)	0.259	(4.39)	0.493	(7.87)
Private$_t$	0.397	(3.70)	0.185	(2.96)	0.218	(3.64)	0.134	(1.18)	0.160	(2.43)	0.018	(0.29)
Foreign$_t$	0.095	(0.29)	0.151	(0.77)	0.000	(0.00)	1.477	(3.63)	0.807	(3.20)	1.150	(4.33)
MixedShare$_t$	-0.202	(-1.43)	-0.266	(-3.51)	-0.110	(-1.34)	-0.270	(-1.90)	-0.299	(-3.94)	-0.194	(-2.38)
PrivateShare$_t$	0.024	(0.18)	-0.165	(-2.21)	-0.082	(-1.06)	0.128	(0.97)	-0.146	(-1.96)	0.009	(0.12)
ForeignShare$_t$	-0.287	(-1.10)	-0.267	(-1.99)	-0.373	(-2.36)	-0.215	(-0.82)	-0.246	(-1.83)	-0.308	(-1.95)
StateMills$_t$							-0.032	(-1.05)	0.049	(3.01)	0.014	(0.79)
MixedMills$_t$							-0.282	(-7.33)	-0.108	(-5.45)	-0.301	(-13.50)
PrivateMills$_t$							0.281	(7.77)	0.063	(3.33)	0.258	(13.25)
ForeignMills$_t$							-0.591	(-4.97)	-0.261	(-3.96)	-0.475	(-6.01)
R^2		0.569		0.552		0.561		0.571		0.553		0.563

The number of observations in all regressions is 79,343. The t statistics are reported in parentheses. In the OLS specification they are based on White-corrected robust standard errors, adjusted for clustering on firm id. All other variables in the regression in Table 3 are also included.