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ABSTRACT

How Efficient are Firms in Transition Countries? Firm-Level Evidence from Bulgaria and Romania*

Stochastic frontier production functions are estimated for Bulgarian (1993–5) and Romanian (1994–5) manufacturing industries using firm-level panel data. The technical efficiency of firms is found to vary significantly both within and across industrial sectors in each country. We find strong evidence of a positive relationship between firm technical efficiency levels and their profitability, which suggests the reforms have succeeded in creating hard budget constraints. The relationship between firm efficiency and size is also found to be positive, suggesting big industrial firms in the former planned economies are not necessarily inefficient.

JEL Classification: C23, C52, D24, L0
Keywords: efficiency, stochastic production frontier, firm size

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NON-TECHNICAL SUMMARY

The economic reforms in Central and Eastern Europe were aimed at creating a competitive market economy, which should lead to increased enterprise efficiency through firm restructuring and institutional change. Little is known, however, about firm technical efficiency and its determinants in transition countries. A base line estimate of efficiency would be useful in assessing whether economic reforms can indeed achieve higher efficiency. In this paper, we estimate the technical efficiency of Bulgarian and Romanian firms for 15 separate sectors. We use a unique firm-level panel data set of 681 Bulgarian and 4521 Romanian firms for the years 1993–5. We use dollar values of firms' value-added and capital stock, to ensure comparability of our estimates between the two countries. The panel nature of the data allows us to infer the evolution of technical efficiency of firms as transition progresses. We also test whether a number of firm-specific characteristics are systematically correlated with its efficiency. To do that, we employ a stochastic production possibility frontier approach as introduced by Aigner, Lovell and Schmidt (1979) and further developed for panel data by Battese and Coelli (1995).

A short comparative analysis of the two countries' macroeconomic situtations allows us to conclude that the two countries are fairly similar both in terms of their income categories and the degree of advancement of their economic reforms. According to the European Bank of Research and Development reports, both countries were most successful in liberalizing their trade and price system, but not that advanced in terms of large-scale privatization and competition policy.

We find that average efficiency varies substantially between sectors for both countries. Interestingly, there is no clear correlation between the average efficiency of sectors in Bulgaria and those in Romania. The extraction sector, however, is characterized by the highest average efficiency level in both countries. One can argue that the high average efficiency level in this branch is the result of its being a priority sector under the plan. This meant that, on the one hand, the best managers were dispatched to the firms in this sector, while on the other hand, the control over production process was the highest in these enterprises.

Weighing firms' efficiencies by their share of value-added in the sector total and computing the weighted average efficiencies reveals that the latter always exceed the former. This suggests that most value-added in both countries is produced by the more efficient producers. This finding is rather surprising,

because the mainstream hypotheses concerning the transition economies suggests that big enterprises are also the most inefficient. Our findings conform, however, to the Ickes-Ryterman (1997) hypotheses, which states that the big enterprises in the post-socialist countries are also the most efficient. The model of Ickes and Ryterman suggests that the central planner would maximize the size of the more efficient enterprises and minimize the size of the less efficient ones, hence the positive relationship between firm size and efficiency.

In order to better understand the way firms' technical efficiency relates to other firm characteristics, we employ the model by Battese and Coelli (1995) and estimate the relationship between firms' size and profitability and their efficiency. In both countries, and for all years, we find a positive relationship between firm size and efficiency. We thus find a further confirmation of the Ickes-Ryterman hypotheses and conclude that bigger firms do indeed tend to be more efficient in Bulgaria and Romania. We also found that profitability is systematically positively correlated with firms' efficiency. We would thus conclude that reforms in Bulgaria and Romania were successful in hardening the budget constraints which, in turn, translated into the profit-based incentives for the firms to be more efficient.

Finally, we run a pooled estimation, assuming the two countries have access to the same technology. Again, we find a positive and statistically significant relationship between size, profitability and efficiency in all 15 sectors in the two countries. The production frontier lies, in most cases, at a higher level in Romania than in Bulgaria, suggesting that Romania is more technologically advanced. In the efficiency model, Romanian firms reach a higher efficiency level than those in Bulgaria.

We conclude by arguing against the dismantling of big industrial enterprises at the beginning of economic reform since that would entail dismantling the most efficient firms. We also conclude that the introduction of progressive taxation at the beginning of transition taxes the most efficient producers and thus serves as a disincentive for firms to be more efficient.

1. Introduction

The economic reforms in Central and Eastern Europe of the last six years were aimed at creating a competitive market economy which should lead to increased enterprise efficiency and better economic performance. Price liberalization, privatising state property and restructuring of enterprises were some of the key measures that accompanied the movement from communism to a capitalist society. An interesting theoretical and empirical literature emerged. The former focused on modelling the sequencing of reforms and optimal restructuring of enterprises (Aghion and Blanchard (1993); Boycko, Shleifer and Visny (1996); Dewatripont and Roland (1996), among others), while the latter focused on documenting firm restructuring and analysing the effects of ownership on firm restructuring (Earle, Estrin and Leschenko (1996); Richter and Schaffer (1996); Konings (1997), among others).

Firm restructuring and institutional change that took place should have a considerable impact on the technical efficiency of firms given that under Central Planning substantial overuse was made of labour and other input factors. Little is known, however, about the technical efficiency of firms and its determinants in transition countries. A number of authors have investigated the issue for the pre-transition years and the results vary between highly efficient firms and firms that can achieve considerable efficiency gains, this often depends on the sector and the period under consideration (Brada and King (1994); Kemme and Neufeld (1991); Danilin et al. (1985), Liu et al. (1995)). All in all, little is known about the technical efficiency of firms in the transition towards a market economy. Yet, a base line estimate of efficiency would be a useful starting point to be able to judge whether economic reforms can indeed achieve higher efficiency. Moreover, with market reforms being implemented it is expected that the efficiency of firms should increase. Brada et al. (1997) estimate for the Czechoslovak and Hungarian industry in the early 90's that the average efficiency varied between 40 and 80% and hence economic reforms could improve technical efficiency considerably. In addition, they test whether a number of firm specific factors affect technical efficiency and report evidence that firm size and profitability is positively related to efficiency, but ownership has no effect[2].

In this paper we estimate the technical efficiency of Bulgarian and Romanian firms for 15 separate sectors. To this end we use a unique firm level panel data set of 869 Bulgarian firms over the period 1993-95 and 2912 Romanian enterprises for the years 1994-95. Moreover, the panel nature of the data allows us to infer the evolution of the technical efficiency of firms as transition progresses. Furthermore, we test whether a number of firm specific characteristics are systematically correlated with its efficiency. To this end we use a stochastic production possibility frontier approach as introduced by Aigner, Lovell and Schmidt (1979), Meeusen and van den Broeck (1977) and further developed for panel data by Battese and Coelli (1995).

The paper is structured as follows. In section II we provide a macroeconomic and institutional background of Bulgaria and Romania. Section III discusses the model, estimation methodology and the data that we use, while section IV shows and discusses the results. Section V is a concluding one.

[2] Hofler and Payne (1993) find for Yugoslavia that the private sector agricultural firms display higher efficiency levels than the social sector.

2. Macroeconomic developments in Bulgaria and Romania, 1989-1994

Both Bulgaria and Romania started their economic reforms in 1989. Both belong to the low middle-income countries with GDP per capita equal to $1330 and $1130 respectively in 1992. Table 1 and Table 2 provide an overview of the macroeconomic developments in the two countries. Both countries experienced approximately the same GDP decline in 1994 with respect to 1989 with Romanian GDP resuming its growth one year earlier than Bulgaria. Table 2shows various transition indicators compiled by the EBRD[3].

According to the EBRD transition indicators most indicators have the same values in both countries and both are most successful in their trade and foreign exchange system reform. Romania is, however, more advanced in terms of its bank reform and interest rate liberalization than Bulgaria is. The lowest index value pertains to the competition policy with Romania being less advanced in this area than Bulgaria. As Table 1 and Table 2 demonstrate, these two countries lag behind Hungary and the Czech Republic in terms of the EBRD transition indices.

Table 1: Percentage change in GDP

	1990	1991	1992	1993	1994	89-94 Cumulative
Bulgaria	-9.1%	-11.7%	-7.3%	-2.4%	1.4%	-26.3%
Romania	-5.6%	-12.9%	-10.0%	1.3%	3.4%	-22.3%
Hungary	-5.6%	-12.9%	-8.8%	1.3%	3.9%	-20.9%
Czech Republic	-0.4%	-14.2%	-6.4%	-0.9%	2.6%	-17.8

Source: EBRD Transition Report, 1995

[3] This index various between 1 and 5, where 5 marks the highest development similar as a developed industrial economy.

Table 2: Indicators of transition, 1995

	GDP share in private sector, mid-95	Large-scale privatization	Small-scale privatization	Enterprise restructuring	Price liberalization	Trade and foreign exchange system	Competition policy	Bank reform and interest rate liberalization
Bulgaria	45%	2	3	2	3	4	2	2
Romania	40%	2	3	2	3	4*	1	3
Hungary	70%	4	4*	3	3	4*	3	3
Czech Republic	75%	4	4*	3	3	4*	3	3

Source: EBRD Transition Report, 1995

In Bulgaria, the economic situation has been deteriorating since 1989 up to 1994. Before the reform process started, the country's trade volume (measured by exports plus imports) constituted about 80% of the GDP which is unusually large. Thus, the CMEA collapse had a potentially destructive effect on the industry. Combined with increasing nominal wages, credit expansion and price controls, this led to pronounced shortages of goods and the monetary overhang. Investment spending dropped by 25% in 1990 while inflation reached 64% by the end of the year. In 1991, a more radical economic reform program was adopted which encompassed restrictive monetary and fiscal policy, including higher interest rates. One of the most important measures that year was price liberalization. As a result, prices tripled in the first two months in 1991 and GDP declined 11.7% accompanied by 10% unemployment rate and about 40% decline in real wages. This led to political uncertainty which forced the government to relax its macroeconomic policies in 1992. In April 1992, the Privatization Law was enacted, but only a handful of large privatizations had actually been realized with most enterprises remaining in state property. By the end of 1993, the country's economic conditions were roughly the same as they were in 1990. It's only in 1994 that the government committed itself to an extremely tight budget, introduced the VAT law (at 18%), and also a new privatization program has been formulated involving 70 large enterprises.

Thus, our results for Bulgaria in 1994 refer to the case of a transition country which succeeded in liberalizing its prices but was not consistent in its stabilization policy and where the privatization program was delayed and did not result in the change of ownership from the state to the private sector.

Romania is characterized by similar developments, however, it was more efficient in privatization and had a higher level of commitment to the stabilization than Bulgaria. As a result of the Romanian reform program a new Constitution has been adopted which established the property rights and provided a legal framework for a market economy. One of the more radical measures the transition government has applied was the price reform, consumer subsidy reduction and the introduction of VAT. As Bulgaria, Romania was also affected by the CMEA collapse. Until 1992, the macroeconomic stabilization policies were characterized by inconistency resulting from frequent changes in the government. By late 1992, the legal and administrative basis for privatization was laid down. About 30% of share ownership was distributed to the population, while 70% ended up in the state property

fund (to be divested in 7 years, by law). In 1993, the government tightened its macroeconomic policies by partially removing subsidies and establishing more tight control over expenditures. As a result, a balanced budget was achieved in that year. However, both inflation and unemployment rates remained high (256% and 10.2% resp.) In 1994, the government proceeded with its reform program. The most important measures were the liberalization of the price setting with removal of consumer subsidies, giving up control of the profit margins and elimination of almost all export restraints. In the first half of 1994, the inflation rate has subsided and industrial output showed a positive growth rate for the first time since 1989.

3. Methodology and Data

3.1. Econometric Method

To obtain a measure for technical efficiency we use a method which has been applied in a variety of economic problems and estimate a stochastic production frontier as introduced by Aigner, Lovell and Schmidt (1979) and Meeusen and van den Broeck (1977). The method assumes the presence of technical inefficiencies in producing a particular output. While estimating the average efficiency relative to some "best practice" for a number of sectors is a valuable and interesting exercise, in recent years more effort has been made to explain firm level differences in efficiency as a function of a number of explanatory variables[4]. A two-step procedure was mostly applied, which existed in first estimating for each firm its technical inefficiency, under the assumption that these inefficiency effects are identically distributed. In a second stage, the predicted inefficiency effects are estimated as a funcion of a number of explanatory variables, which contradicts the assumption of identically distributed inefficiency effects in the stochastic frontier. In order to circumvent this problem, in this paper we use a method in which the parameters of the stochastic production frontier and the inefficiency model are estimated simultaneously, given appropriate distributional assumptions associated with the cross-sectional data on the sample of firms (Battese and Coelli (1995)).

[4] Early contributions include Pitt and Lee (1981); Kalijaran (1981); and in the context of public economics, De Borger, Kerstens, Moesen, Vanneste (1994); and in the transition context e.g. Brada et al. (1997).

To focus ideas, assume the following stochastic frontier production function,

$$Y_{it} = F(X_{it}\beta) \cdot e^{v_{it} - u_{it}} \quad (1)$$

where Y denotes production for observation i at time t, X is an input vector associated with the ith firm and β is a vector of unknown parameters to be estimated, F is a production function. It is assumed that the v_{it}'s are random variables that are iid $N(0,\sigma^2_v)$ and independent of the u_{it}'s. The u_{it}'s are non-negative random variables, associated with technical inefficiency in production, independently distributed, such that u_{it} is obtained by truncation (at zero) of the normal distribution with mean $z_{it}\delta$ and variance σ^2_u . Finally, z is a vector of explanatory variables that are associated with technical inefficiency and δ is a vector of unknown parameters (for more details see also Battese and Coelli, 1995). The inefficiency model can also be expressed more explicitly as follows,

$$u_{it} = z_{it}\delta + w_{it} \quad (2)$$

where w_{it} is defined by the truncation of the normal distribution with zero mean and variance σ^2 such that the point of truncation is $z_{it}\delta$.

The above model is estimated by maximum likelihood and the technical efficiency of production for firm i is defined by (3a) in case of the technical efficiency effects model and by (3b) the estimation of stochastic production frontier alone (Battese and Coelli (1993)).

$$TE_{it} = e^{-u_{it}} = e^{-z_{it}\delta - w_{it}} \quad (3a)$$

$$TE_{it} = e^{-u_{it}} \quad (3b)$$

3.2. Empirical Specification

We specify a log-quadratic production function as introduced by Chu, Aigner and Frankel (1970) to estimate the stochastic production frontier and the inefficiency model. In particular,

$$\ln Y_{it} = \alpha_0 + \alpha_1 \ln K_{it} + \alpha_2 \ln L_{it} + \alpha_3 (\ln K_{it})^2 + \alpha_4 (\ln L_{it})^2 + v_{it} - u_{it} \quad (4)$$

and in the technical efficiency effects model,

$$u_{it} = \beta_0 + \beta_1 MS_{it} + \beta_2 PROF_{it} + w_{it}$$

where Y is value added, K is the capital stock, proxied by net tangible assets, L is the number of employees, MS is the market share of firm i and Profit stands for the profitability of firm i. Both value added and the capital stock are measured in terms of millions of current US dollars. We will explain the economic intuition of the variables associated with technical efficiency later in section 4.3.

The log-quadratic specification encompasses the Cobb-Douglas specification and is a less restrictive one. In addition, the empirical implementation, which includes an iterative estimation procedure, obtained convergence with this specification, rather than the Cobb-Douglas or the Translog specification.

3.3. Data

The data at our disposal is a unique firm level company accounts database compiled by "bureau Van Dyck", Amadeus. The data include 869 Bulgarian firms for the years 1993-95 and 2912 Romanian for the years 1994-95. To be included in Amadeus, two of the following criteria must be satisfied: a

turnover of at least 12mln. USD, number of employees greater than 150 and total assets greater than 12mln USD. Thus, it is only the largest firms which are represented in the sample. Recalling that the well-known problem of the socialist economies is excessively large size of their industrial enterprises, one can assert that the Amadeus sample is representative of a significant share of these countries' industries.

Table 3 shows some summary statistics for 1994. The average firm is larger in Romania than in Bulgaria.

Table 3: Data Summary Statistics

Bulgaria: 681 firms

	Mean	Min	Max	Coefficient of Variation
Y	2.14	-38.06	277.67	4.80
K	2.16	-77.69	314.39	6.11
L	670	115	62120	3.11

Romania: 4520 firms

	Mean	Min	Max	Coefficient of Variation
Y	2.66	-7.51	230.41	2.78
K	1.99	-46.13	303.10	4.87
L	979	150	37319	1.72

Note: Y and K x 1000 000 USD

4. Results

We estimated separate frontier production functions for 15 (NACE 2 digit) sectors in both countries. To account for time effects, we included the year dummies into the specification of the production functions. In tables 4 and 5 it can be seen that the average efficiency varies substantially between sectors for both countries. In Bulgaria, the lowest value for average efficiency is found in the Chemicals sector (22.84% average efficiency) while the maximum efficiency of 100% for Utilities. The latter should be viewed with some caution as there were only 7 firms in this sector, so the estimates are based on a very small sample. The next most efficient sector in Bulgaria is 'Extraction' (99.73% in 1993 but falling down to 66.73% in 1995). In Romania, the variation of average efficiency levels is also quite high: the lowest level is 33.94% for Utilities in 1995 while the highest level is 80.48% (Extraction 1994). Interestingly, there is no clear correlation between the average efficiency of sectors in Bulgaria and the one in Romania.

Table 4

Bulgaria Industry Frontier Production Function Estimates, Years 1993-1995

# firms	NACE	Const.	LnK	LnL	LnK2	LnL2	LnK*LnL	Year 93	Year 94	Av. Eff. 93	Av. Eff. 94	Av. Eff. 95	W.Av.Eff.93	W.Av.Eff.94	W.Av.Eff.95
78	Food and Beverage	-0.433 -0.319	0.476 10.474	-0.011 -0.025	0.017 1.022	0.032 0.907	0.017 0.160	-0.046 -0.495	63.59%	65.95%	68.24%	73.67%	74.27%	76.37%	
95	Textile and Apparel	-3.375 -1.156	0.384 6.898	0.630 0.660	0.009 0.490	-0.001 -0.011	0.129 1.380	0.048 0.814	54.54%	60.10%	65.32%	63.27%	68.36%	72.76%	
31	Leather and Products	-30.975 -6.949	0.625 3.996	9.830 7.001	0.109 3.120	-0.747 -6.857	0.207 1.012	0.094 0.748	41.66%	44.36%	47.06%	50.97%	54.82%	57.71%	
28	Wood and Products	1.204 0.163	0.424 2.966	-0.808 -0.314	0.014 0.459	0.117 0.529	-0.146 -1.071	-0.257 -2.157	70.07%	65.07%	59.72%	74.41%	72.01%	67.75%	
26	Printing and Publishing	-3.521 -2.035	0.622 5.530	1.465 2.692	-0.030 -0.694	-0.094 -1.898	-0.057 -0.338	-0.042 -0.320	30.97%	30.84%	30.71%	39.41%	43.45%	40.98%	
34	Chemicals, prod. and fibres	-0.343 -0.333	0.387 4.644	0.299 0.865	0.026 1.044	0.015 0.461	-0.182 -1.156	-0.291 -2.644	24.93%	23.88%	22.84%	31.04%	31.24%	28.80%	
24	Rubber and Plastic	-2.852 -0.684	0.579 4.879	1.018 0.815	0.016 0.302	-0.059 -0.647	-0.320 -1.550	-0.111 -0.761	54.19%	51.51%	48.81%	64.94%	66.45%	66.08%	
36	Mineral mat. and Prod.	-2.260 -0.868	0.434 2.776	0.480 0.578	0.013 0.346	0.012 0.166	0.074 0.381	-0.055 -0.436	43.52%	50.49%	57.17%	49.02%	53.37%	59.58%	
73	Basic met. and prod.	-3.189 -0.987	0.410 6.078	0.581 0.565	0.016 0.620	0.009 0.108	-0.189 -1.652	-0.150 -1.816	59.47%	59.95%	60.43%	63.13%	63.38%	63.85%	
86	Machinery excl. Electr.	-2.486 -1.902	0.313 4.534	0.328 0.819	0.010 0.354	0.022 0.654	0.129 0.878	-0.086 -0.832	58.26%	63.06%	67.60%	69.99%	70.84%	75.00%	
77	Electr. and Opt. Eq.	0.117 0.021	0.694 9.205	-0.021 -0.011	0.049 1.265	0.015 0.103	-0.040 -0.279	-0.055 -0.554	53.07%	56.66%	60.16%	66.18%	65.80%	69.88%	
13	Transport Eq.	-1.429 -0.565	0.302 2.495	-0.107 -0.172	-0.033 -1.194	0.057 1.660	0.202 1.179	-0.065 -0.554	78.51%	81.85%	84.78%	84.55%	87.13%	89.48%	
7	Utilities	-1.310 -0.748	0.826 6.966	0.256 0.578	-0.064 -2.839	0.014 0.532	-0.028 -0.192	-0.402 -2.802	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	
31	Extraction	1.208 0.767	0.503 7.102	-0.575 -1.256	-0.008 -0.497	0.087 2.653	-0 457 -3.980	-0.507 -3.463	99.73%	96.41%	66.73%	99.57%	94.02%	67.11%	
42	Furniture	-11.063 -7.492	0.267 1.573	3.188 6.627	0.009 0.239	-0.195 -3.781	-0.323 -1.894	-0.405 -3.044	46.29%	40.69%	35.12%	51.66%	48.33%	43.84%	

Note: the second line shows t-statistics

Table 5

Romania Industry Forntier Production Function Estimates, Years 1994-1995

# firms	NACE	Const.	Ln K	Ln L	Ln K^2	Ln L^2	Year 94	Av. Eff. 94	Av. Eff. 95	W.Av. Eff. 94	W.Av. Eff. 95
791	Food and Beverage	-4.946	0.404	1.374	0.048	-0.061	-0.198	51.63%	42.00%	57.25%	49.42%
		-5.858	30.234	5.442	9.290	-3.118	-5.237				
366	Textile and Apparel	-2.006	0.330	0.300	0.023	0.027	-0.025	48.39%	46.48%	53.41%	52.44%
		-1.972	12.155	0.991	3.035	1.151	-0.663				
96	Leather and Products	-3.266	0.405	0.676	0.019	-0.012	0.105	74.38%	79.68%	79.88%	84.30%
		-3.391	9.388	2.259	1.344	-0.531	1.418				
349	Wood and Products	-4.344	0.291	0.983	0.025	-0.022	-0.052	53.37%	50.25%	55.78%	53.19%
		-5.529	12.108	4.279	3.266	-1.220	-1.379				
155	Printing and Publishing	-4.822	0.371	1.250	0.040	-0.049	-0.012	52.04%	52.63%	58.48%	59.27%
		-4.501	15.400	4.045	3.810	-2.171	-0.208				
175	Chemicals, prod. and fibres	-5.536	0.422	1.648	0.057	-0.086	-0.109	44.45%	40.08%	50.77%	46.69%
		-5.743	20.018	5.718	8.499	-4.089	-1.851				
181	Rubber and Plastic	-5.538	0.536	1.570	0.063	-0.082	-0.095	55.72%	49.47%	60.18%	55.29%
		-4.172	20.732	3.977	8.003	-2.794	-1.803				
347	Mineral mat. and Prod.	-4.168	0.323	0.943	0.029	-0.020	0.124	53.68%	58.09%	59.73%	63.35%
		-5.271	18.813	3.899	5.601	-1.116	4.008				
697	Basic met. and prod.	-4.723	0.358	1.226	0.038	-0.047	0.045	46.39%	48.47%	50.35%	53.13%
		-7.453	26.887	6.466	8.465	-3.349	1.836				
417	Machinery excl. Electr.	-5.691	0.328	1.436	0.040	-0.059	-0.082	54.82%	50.19%	59.58%	55.41%
		-8.291	19.799	7.145	5.872	-4.050	-2.773				
202	Electr. and Opt. Eq.	-1.642	0.418	0.520	0.031	-0.008	0.012	42.79%	43.05%	50.15%	50.40%
		-1.667	15.683	1.795	3.401	-0.392	0.242				
225	Transport Eq.	-7.305	0.367	2.018	0.051	-0.106	0.008	46.20%	46.20%	54.78%	54.96%
		-10.167	13.043	9.231	5.832	-6.549	0.180				
91	Utilities	-6.778	0.237	1.899	0.015	-0.087	-0.179	37.27%	33.94%	46.25%	44.22%
		-5.697	7.623	5.316	1.357	-3.159	-3.004				
136	Extraction	-7.434	0.411	1.895	0.088	-0.093	-0.137	80.48%	70.40%	80.55%	70.17%
		-5.469	19.015	4.739	11.044	-3.164	-2.588				
292	Furniture	-5.275	0.445	1.432	0.057	-0.067	-0.059	50.77%	48.78%	55.51%	54.69%
		-5.382	19.827	4.884	7.823	-3.041	-1.289				

Both our estimates and those of the other authors (see for example Brada et al. (1995) and Brock (1997)) point to a greater variance in sectoral average efficiencies than that found in the work of Danilin et al. (1985) which studied the Soviet textile enterprises. The average efficiency levels in the latter paper were found to be narrowly grouped around 92%. In contrast, we only find average efficiency levels exceeding 90% in two sectors in Bulgaria (Utilities and Extraction). There are two points to be made here. First, as conceded by Danilin and coauthors, high efficiency levels do not necessarily mean that the enterprises are efficient in an absolute sense. Rather, it may be the case that all firms in the sector are very similar, so each one is producing close to the best practice frontier. Our findings suggest that in the course of transition, the firms' behaviour has become more diverse which resulted in increased variation of firms' efficiency levels within industrial branches. Second, consistent with Brada et al. (1997) we find also high efficiency levels for 'Extraction': More than 96% in Bulgaria in 1993 and 1994 but dropping off to 66% in 1995. The hypotheses put forward by Ickes and Ryterman (1997) is that in a Soviet-type economy dominated by the large heavy industry enterprises, their efficiency levels would be high both because of increased control on the "priority" enterprises and because of dispatching of the better managers to those firms. As tables 4 and 5 show, the average efficiency levels in the extraction branch are high in both countries but with the course of time they decrease significantly. This could reflect a decreasing relative importance of heavy industry enterprises in the former planned economies. However, one must keep in mind that high efficiency levels estimates are not necessarily testifying about high technical efficiency in the "absolute" sense. Also, low relative efficiency levels may be the reflection of a situation whereby a few very efficient producers push the production frontier upwards so that most firms look inefficient relative to them.

Along with the branch average efficiency levels, tables 4 and 5 also provide weighted branch average efficiencies where firms' shares of value added for that sector were used as weights. We find weighted average efficiencies dominate the unweighted ones for all sectors and years in both countries. This strongly suggests that most value added in both countries is produced by more efficient producers. The average amount by which weighted average efficiency estimates exceed the normal ones is similar in both countries and constitutes 12% and 15% in Romania and Bulgaria, respectively, which suggests there exists a positive relationship between firms' efficiency levels and the relative amount of output they produce. This relationship is rather surprising because the mainstream hypotheses concerning the

operation of planned economies is that big industrial enterprises were responsible for the inefficiency of economy as a whole. Our findings, however, conform to the Ickes-Ryterman hypotheses (1997) and to the empirical findings of Brada et al. (1997) and suggest that the large output enterprises are also the more efficient ones. We test this proposition more rigorously by incorporating explanatory variables for efficiency levels into the maximum likelihood estimation of stochastic production frontier below find a significant positive relationship between firms' technical efficiency levels and their size.

One of the challenges of the transition reforms was to increase firms' technical efficiency. It was expected that the introduction of market forces into the transition economies would make the way firms use their inputs more efficient. Tables 4 and 5 show the evolution of the average efficiency per sector over time. The highest growing sector in terms of efficiency levels in both countries is "Mineral materials and products" (31% growth from 93 to 95 in Bulgaria and 8% in Romania from 94 to 95). This growth, however, is occurring around 50% efficiency level. The fastest declining efficiency levels are found in Bulgaria (23% decline from 93 to 95 in the Extraction sector and 19% decline in Romania in the Food and Beverage sector from 1994 to 1995). In both countries, we find that only about half of the estimated sectors are displaying increasing efficiency levels while their number is only one third in Romania. Thus our estimates do not reveal reasonably high average efficiency levels (>75%) for most of the sectors and years nor do they point to any evidence of steadily increasing efficiency levels for the years 1993-95. While some sectors became more efficient, others did not. This could be related to the initial conditions some sectors were facing, or to the way in which reforms were implemented in different sectors. In any case, the different evolution of efficiency suggests that reforms filter through in a very heterogeneous way.

We next want to identify what explains efficiency in both countries. In particular, we will analyse whether size and profitability are systematically correlated with the technical efficiency of the enterprises. For this purpose, we are employing joint maximum likelihood function incorporating efficiency explanatory variables (Battese and Coelli (1995)). We measure firms' size as its market share. To avoid the specification problem, however, we are using lagged firm size in our estimation. Profitability is measured as the firm's profit margin, defined as the ratio of firms' Profit(Loss) before tax to their Turnover.

We focus on these explanatory variables for two reasons. Transition countries are characterised by very large firms and it is believed that the large firm sizes could lead to an inefficient way of production. Ickes and Ryterman (1997) defelop a model where they show that the size distribution of firms in centrally planned economies implies a bimodal distribution under transition in which the most efficient firms are the larger ones. The source for this difference is the willingness of the planner to maximize the size of efficient producers while reducing that of the inefficient ones. While in the market economy, the latter would eventually exit, this would be considered politically undesirable under the plan or in the early stages of transition, so that the inefficient firms would not immediately exit. Given the slow pace of reforms both in Bulgaria and Romania, we would expect this result to hold.

Turning to profitability, the reasoning is based on the competitive mechanisms in a market economy. Competitive pressure creates incentives for firms to become more technically efficient. This would reduce costs and allow them to survive. The least efficient firms will make losses and have to exit. Such a mechanism was expected to start functioning as a result of the introduction of economic reforms. Under the plan, the relationship between profitability and efficiency could be negative for a number of reasons. Kornai (1986), for example, pointed out a process he termed "profit levelling" which essentially consists of reallocation of resources by the central planners from the more successful firms to the less successful ones. The ratchet effect was also responsible for the lack of incentives to be efficient. The planners set targets for the enterprises, and once the target has been met, a new, usually higher target was fixed for the next period. As a result, neither managers nor the workers had an incentive to increase efficiency of the production process. Instead, missing the target often paid off.

The results of explaining efficiency are provided in tables 6 and 7. In both countries and for all years (now reduced by one because we are using lagged firm size) we found a positive relationship between firm size and efficiency. This relationship is significant at a 1% level in 7 branches out of 15 in Bulgaria and in 2 sectors in Romania. In the latter country, the relationship is significant at a 10% level in 5 sectors. Also for profitability, we found it's systematically positively correlated with efficiency. In Bulgaria, it is significant at the 1% level in all branches but the "Furniture". In Romania, it is only insignificant in the "Printing and Publishing" branch. In the work of Brada et al. (1997), the same positive relationship is found for most branches in Hungary, although it is positive only for one half of the branches in Czechoslovakia. The authors are arguing that in Czechoslovakia, the practice of profit-

leveling still existed in that country in 1990, the year they do their estimates in. We would similarly conclude that reforms in Bulgaria and Romania were successful in the sense that they hardened the budget constraints which translated into the profit-based incentives to be more efficient. Thus our two hypotheses are confirmed for a number of sectors.

Finally, in table 8 we pooled the two countries and assumed that as both countries have access to the same technology they could face the same production possibility frontier. This allows us to test whether there is an intercept shift of the frontier for the country under consideration and whether any of the countries is more efficient than the other. So, we included a country dummy (1 for Romania, 0 for Bulgaria) both into the stochastic production frontier and into the set of efficiency explanatory variables. Again our main result comes through, there is a positive and statistically significant relationship between size, profitablity and efficiency in all 15 sectors. The production frontier lies in most cases at a higher level in Romania than in Bulgaria, suggesting that Romania is more technologically advanced. In addition, in the efficiency model, Romanian firms reach a higher efficiency level than Bulgarian ones.

Table 6

Bulgaria: Explaining Efficiency Levels, 1994-1995

Firms	NACE	Const	LnK	LnL	LnK^2	LnL^2	Year 94	Profitability	Size	AV Eff 94	AV Eff 95
115	Food and Beverage	-3.000 -2.131	0.525 17.115	0.930 2.104	0.022 1.845	-0.046 -1.324	-0.198 -2.926	0.018 7.717	17.739 1.797	62.22%	59.91%
143	Textile and Apparel	-3.404 -2.098	0.371 6.747	0.615 1.143	-0.018 -1.005	-0.002 -0.054	-0.070 -1.308	0.004 5.458	89.696 3.519	74.84%	76.08%
40	Leather and Products	-10.677 -3.366	0.347 4.309	3.028 2.919	0.018 0.703	-0.197 -2.346	-0.038 -0.400	0.037 5.226	46.559 2.024	66.60%	66.68%
42	Wood and Productzs	-3.193 -1.273	0.387 3.455	0.718 0.798	0.007 0.345	-0.017 -0.213	-0.030 -0.319	0.029 3.312	45.443 3.399	60.82%	63.59%
45	Printing and Publishing	-0.871 -0.126	0.753 7.680	-0.071 -0.031	0.039 1.331	0.049 0.258	-0.016 -0.113	0.018 5.400	2.514 1.488	92.35%	92.72%
41	Chemicals, prod. and libres	-5.362 -1.854	0.438 5.721	1.305 1.624	-0.007 -0.118	-0.058 -0.991	-0.131 -1.079	0.016 6.387	3.936 0.563	88.20%	91.79%
38	Rubber and Plastic	3.701 2.430	0.593 6.291	-1.144 -2.379	-0.068 -2.339	0.109 2.896	-0.001 -0.006	0.022 3.442	23.375 2.043	63.35%	65.77%
45	Mineral mat. and Prod.	-3.510 -1.068	0.497 4.248	0.805 0.740	0.058 1.654	-0.013 -0.149	-0.185 -2.239	0.040 4.372	50.235 2.728	64.41%	66.03%
98	Basic met. and prod.	-5.164 -3.882	0.465 7.993	1.326 3.299	0.045 2.005	-0.059 -1.877	-0.141 -1.773	0.007 6.333	26.331 4.797	57.09%	58.84%
122	Machinery excl. Electr.	-9.978 -4.847	0.347 7.763	2.832 4.299	0.055 2.755	-0.180 -3.459	-0.125 -1.736	0.011 8.317	92.370 15.571	56.44%	59.40%
101	Electr. and Opt. Eq.	-12.138 -4.489	0.687 13.526	3.938 4.442	0.111 4.794	-0.302 -4.180	-0.057 -0.760	0.009 7.886	75.047 3.179	56.50%	60.71%
18	Transport Eq.	1.793 4.144	0.531 1.672	-0.679 -2.221	-0.043 -0.684	0.081 2.353	-0.426 -0.954	0.003 3.517	0.116 0.095	64.95%	58.10%
7	Utilities	-1.769 -1.841	0.799 9.150	0.502 2.157	-0.056 -5.013	-0.007 -0.502	-0.483 -1.250	0.017 3.322	0.726 1.032	89.60%	84.50%
36	Extraction	-0.257 -0.098	0.403 5.362	-0.202 -0.266	0.036 0.775	0.066 1.183	-0.125 -1.218	0.038 4.770	22.493 1.124	56.69%	57.33%
66	Furniture	-9.273 -1.887	0.506 2.457	2.900 1.640	0.005 0.113	-0.213 -1.359	-0.104 -1.137	14.916 0.656	0.102 0.776	70.57%	70.79%

Table 7

Romania: Explaining Efficiency Levles, 1995

# firms	NACE	Const	LnK	Ln L	Ln K²	Ln L²	Profitability	Size	AV. Eff (95)
825	Food and Beverage	-7.091 -7.912	0.346 27.561	1.810 6.527	0.032 5.723	-0.090 -4.260	0.026 17.510	108.833 12.691	74.80%
377	Textile and Apparel	-2.786 -2.340	0.283 10.058	0.379 1.025	0.015 1.518	0.021 0.721	0.033 11.484	137.608 4.149	76.55%
102	Leather and Products	-1.052 -0.595	0.377 7.634	0.042 0.077	-0.010 -0.514	0.033 0.794	0.022 4.693	39.710 1.897	79.11%
360	Wood and Productzs	-4.717 -5.158	0.313 11.067	1.009 3.573	0.016 1.601	-0.027 -1.219	0.030 9.659	12.772 0.709	76.69%
157	Printing and Publishing	-5.240 -5.441	0.309 2.893	1.097 2.688	0.033 1.967	-0.031 -0.770	0.029 0.891	0.111 0.014	92.94%
183	Chemicals, prod. and fibres	-5.061 -3.629	0.393 12.150	1.238 3.044	0.042 3.265	-0.051 -1.709	0.003 3.707	15.539 1.874	76.74%
187	Rubber and Plastic	-6.066 -3.694	0.464 12.295	1.499 3.075	0.064 5.060	-0.071 -1.967	0.027 7.924	0.266 0.995	80.14%
361	Mineral mat. and Prod.	-5.294 -6.594	0.326 17.707	1.192 4.850	0.024 4.096	-0.040 -2.117	0.034 11.459	42.844 1.820	81.37%
716	Basic met. and prod.	-6.062 -9.230	0.373 20.749	1.482 7.580	0.034 5.961	-0.067 -4.541	0.003 5.115	28.627 1.496	77.63%
426	Machinery excl. Electr.	-6.589 -7.828	0.302 15.066	1.514 6.111	0.047 5.484	-0.063 -3.418	0.022 12.724	13.102 1.056	83.69%
205	Electr. and Opt. Eq.	-4.619 -3.572	0.361 9.758	1.023 2.588	0.041 3.487	-0.035 -1.153	0.021 5.427	11.820 0.782	90.90%
236	Transport Eq.	-6.025 -6.110	0.210 6.695	1.220 4.161	0.022 2.633	-0.033 -1.498	0.021 7.287	5.892 0.801	93.59%
97	Utilities	-8.273 -4.152	0.252 6.409	2.076 3.556	0.044 3.004	-0.103 -2.411	0.061 6.193	31.899 1.947	77.07%
148	Extraction	-8.361 -7.781	0.408 13.394	2.184 6.517	0.076 6.528	-0.118 -4.579	0.025 9.199	0.158 0.158	81.48%
298	Furniture	-7.090 -9.362	0.370 11.640	1.707 7.386	0.042 4.151	-0.082 -4.622	0.028 11.092	8.691 1.074	89.57%

Table 8

Pooling: explaining efficiency levels using Country dummy

# firms	NACE	Const	LnK	Ln L	Ln K1	Ln L1	Country	Year 94	Profitability	Size	Country	AV Eff
1055	Food and Beverage	-6.356	0.374	1.974	0.024	-0.109	4.436	-0.221	0.018	13.047	-4.542	7.92%
		-9.194	26.262	8.213	4.838	-5.781	5.596	-3.639	24.130	12.723	-5.682	
663	Textile and Apparel	-4.364	0.227	1.243	-0.023	-0.063	2.811	0.033	0.004	106.445	-2.231	17.82%
		-4.527	8.916	4.051	-2.716	-2.616	25.272	0.760	8.692	26.125	-21.177	
182	Leather and Products	-7.578	0.204	2.222	0.003	-0.137	0.994	-0.017	0.011	31.880	-0.365	29.54%
		-7.752	6.337	7.023	0.343	-5.382	12.625	-0.353	6.033	24.053	-3.487	
186	Wood and Productzs	-3.957	0.450	0.973	0.022	-0.038	-0.086	-0.089	0.072	32.222	4.100	73.50%
		-3.979	9.256	3.096	1.542	-1.538	-1.003	-1.000	5.255	1.842	2.574	
247	Printing and Publishing	-3.410	0.318	1.035	-0.002	-0.038	-0.032	-0.040	0.015	18.235	0.578	34.02%
		-1.990	7.119	2.425	-0.150	-1.248	-0.126	-0.224	6.995	4.115	1.958	
265	Chemicals, prod. and fibres	-0.683	0.417	1.215	0.041	-0.048	-4.610	-0.293	0.007	0.995	8.020	64.59%
		-0.327	13.429	3.169	3.103	-1.689	-3.109	-1.929	5.338	0.587	3.303	
263	Rubber and Plastic	-4.284	0.555	1.109	0.036	-0.051	0.033	-0.095	0.025	0.523	0.032	70.05%
		-4.164	14.797	3.506	2.735	-2.081	0.217	-0.780	5.433	1.219	0.047	
451	Mineral mat. and Prod.	-4.043	0.298	1.060	0.016	-0.031	-0.412	-0.108	0.018	22.748	0.542	53.70%
		-5.505	14.527	4.678	2.438	-1.806	-3.764	-1.384	9.645	5.434	5.101	
912	Basic met. and prod.	-4.846	0.382	1.266	0.035	-0.051	-0.583	-0.128	0.005	23.026	2.400	75.47%
		-8.833	21.669	7.107	5.706	-3.765	-5.609	-1.785	8.491	2.718	9.121	
670	Machinery excl. Electr.	-6.236	0.337	1.496	0.047	-0.064	-0.168	-0.165	0.014	28.250	2.708	73.61%
		-6.767	17.394	5.367	5.095	-3.054	-2.379	-2.584	9.165	2.027	4.153	
407	Electr. and Opt. Eq.	-1.443	0.373	0.258	0.006	0.018	-0.372	-0.007	0.006	49.352	2.698	66.92%
		-1.161	11.564	0.679	0.576	0.597	-4.171	-0.084	6.404	5.529	8.823	
272	Transport Eq.	-4.734	0.222	0.914	0.007	-0.012	0.023	-0.349	0.004	2.641	0.147	73.79%
		-4.812	6.252	3.120	0.709	-0.563	0.123	-2.532	4.412	0.899	0.647	
111	Utilities	-6.536	0.249	1.651	0.043	-0.068	-0.070	-0.490	0.039	2.299	-0.635	56.17%
		-6.786	6.791	5.978	4.402	-3.475	-0.294	-2.205	6.958	1.950	1.942	
220	Extraction	-5.291	0.216	1.318	0.022	-0.039	-0.418	-0.119	0.023	11.095	0.212	48.63%
		-4.834	7.886	3.918	2.272	-1.537	-2.506	-1.168	15.534	2.162	1.399	
430	Furniture	-2.653	0.375	1.215	0.007	-0.049	-0.130	-0.182	0.016	12.459	0.305	7.04%
		-1.828	10.265	3.280	0.450	-1.725	-1.294	-2.495	12.945	1.961	2.420	

5. Conclusions and policy implications

Using the concept of stochastic production frontier, we estimated firms' technical efficiencies for 15 industrial sectors in Bulgaria in the period of 1993-1995 and Romania in 1994-1995. The results of this exercise can be summarized as follows:

1. Efficiency levels are widely dispersed with the Extraction branch displaying high efficiency levels in both countries. This sector's priority status under the former system may account for this observation.
2. In both countries, the bulk of value added is produced by relatively more efficient producers.
3. The biggest firms are found to be systematically more efficient. Combined with the previous observation, this indicates that big enterprises in the two countries are both efficient and account for a significant fraction of the countries' value added. The Ickes-Ryterman hypotheses which states that the bigger industrial enterprises are also more efficient because of their priority status under the plan, is thus supported by our statistical evidence.
4. Higher efficiency levels are associated with more profitability in both countries. This relationship is found to be robust to model specifications and is always statistically significant.

Perhaps one of the most important challenges of any research on transition issues is to gain insights into the desirable economic policies which could be applied by the reformers. We focus on two issues of the economic policy pursued in the transition countries: dismantling of large enterprises into a number of smaller production units (1) and progressive taxation (2).

1. *Breaking up larger enterprises*. Not uncommon is the opinion that big enterprises in the Soviet type economies were largely inefficient because their existence was motivated by political rather than economic reasons. However, in accordance with the Ickes-Ryterman model, the negative relationship between firms' size (measured as market share of the enterprises) and efficiency was found to be positive in all sectors. Depending on specification of the model, this positive relationship is significantly positive in a number of branches in our sample ranging from half to the whole. Our estimates thus indicate that reorganizing large enterprises in the two countries into the

smaller production units does not necessarily pay off, at least in terms of technical efficiency levels of the firms.

2. *Progressive taxation.* One of the reasons why the relationship between firms' profitability and efficiency can be negative might be the profit levelling put into practice through the use of progressive taxation mechanism. It might be regarded as a market reforms version of the ratchet effect which plagued the Soviet type economies. Under progressive taxation system, the higher profits of more efficient enterprises are taken away from the more efficient enterprises and can later be used by the state authorities to bail out the less efficient firms which is essentially the ratchet effect. Our evidence of a positive relationship between firms' profitability and efficiency suggests that under progressive taxation mechanism, namely the most efficient firms are carrying the tax burden. For that reason, levying lump sum taxes in the early stages of transition rather than the progressive ones may speed up the transition process by providing more incentives for the firms to be efficient.

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