GRAPE Working Paper # 32

Structural change and misallocation. Firm-level evidence from Poland

Jan Hagemejer, Joanna Tyrowicz

FAME | GRAPE, 2018

Foundation of Admirers and Mavens of Economics
Group for Research in Applied Economics

Structural change and misallocation. Firm-level evidence from Poland

Jan Hagemejer
University of Warsaw
NBP, and FAME | GRAPE

Joanna Tyrowicz
FAME | GRAPE, IAAEU
University of Warsaw, and IZA

Abstract

Early transition literature linked large number of firm failures with the inability to overcome the pre-transition misallocation of resources, i.e. the inadequate capital-labor ratio. We look at the link between misallocation and firm survival using a rich firm-level dataset of over 1600 manufacturing plants established in a centrally planned economy after 1945. Our duration models include the standard Olley-Pakes misallocation measures as well as firm-level counterfactual level of capital that takes into account the present day market allocation and productivity. We show that i) misallocation was rather a firm-level than sector-level phenomenon and more importantly ii) it did not have a sizeable effect on the actual firm survival. Moreover, privatization tends to be negatively related to firm survival. This may imply both inappropriate self-selection into privatization programs and possibly inadequate implementation of the privatization.

Keywords:

misallocation, privatization, transition

JEL Classification

P31, D24, O47

Corresponding author

Jan Hagemejer, j.hagemejer@uw.edu.pl

Acknowledgements

The authors gratefully acknowledge financial support from the Polish National Science Center (Narodowe Centrum Nauki), grant number: 2014/13/B/HS4/03260. Views expressed in this article are solely those of the authors and should not be attributed to National Science Center, nor the National Bank of Poland. Giang Tran and Peter Szewczyk provided excellent research assistance. Earlier versions of this study received very valuable comments from Daniel Dăianu, Saul Estrin, Jan Firdmuc, Tomasz Mickiewicz, Jan Švejnar. The remaining errors are ours.

Published by: FAME | GRAPE
ISSN: 2544-2473
© with the authors, 2018

Foundation of Admirers and Mavens of Economics
ull. Mazowiecka 11/14
00-052 Warszaw
Poland

W | grape.org.pl
E | grape@grape.org.pl
TT | GRAPE_ORG
FB | GRAPE.ORG
PH | +48 799 012 202

1. Introduction

It was long argued that state-owned enterprises under central planning were over-manned (Blanchard et al., 1991; Aghion et al., 1994), whereas economy as a whole invested capital inefficiently (e.g. Kornai, 1980; Brada, 1989), over-capitalizing some industries relative to others (Terrell 1992; 1993). This consensus view of the situation on the onset of transition laid the foundations for most of the policy advice offered to transition economies (e.g. Montiel and Borenstein, 1991). Implicitly, this approach assumes labor needs to be shed, whereas capital needs to be released from inefficient to more efficient use. Hence, the capital-labor ratio will adjust in the process of transition, increasing capital intensity, possibly to a heterogeneous extent. Allocation is thus improved if a company changes relative inputs, thus allowing productivity to catch up. There is substantial body of empirical studies in this strand of literature. Starting from descriptive (Pinto et al., 1993) towards numerous econometric approaches (e.g. Prasnikar et al., 1992; Carlin et al., 1995; Estrin et al., 1995; Svejnar, 1996; Jones et al., 1998)

Somehow misallocation literature evolved independently of the transition literature (Fisher, 1988), gradually building up an analytical framework to analyze misallocation of resources in the economies (e.g. Hsieh and Klenow, 2009; Bartelsman et al., 2013; Restuccia and Rogerson, 2013). This literature conceptualizes misallocation as a barrier for more efficient firms to acquire more inputs. Allocation is thus improved if a company with higher productivity increases its share in inputs (Hyytinen et al., 2015), without altering the relative input shares.

While studies from pre-transition had access to long panels, this has not been the case for the analyses devoted to transition. Most of the studies of early transition rely on a relatively short horizon of data: few years at annual frequency. Hence, analyses of both dynamic inefficiency (inadequate K/L ratio) and misallocation (productivity decompositions) were relatively scarce. It is our objective in this study to partially fill this gap. We develop a unique database with data on sales revenues, capital stock and employment for all SOE plants established in Poland after 1945. This data is coupled with transition histories of these plants as well as other data. With this unique data, we develop measures of both dynamic inefficiency and misallocation. The former attempts to capture whether or not input shares were optimal, whereas the latter attempts to verify if more productive firms grow faster.

Our findings suggest that misallocation is not relevant for firm survival in the periods of large structural change. We provide a variety of specifications and measures. The estimated link between firm survival and the extent of initial misallocation is typically insignificant, and even if significant, it is of minor economic importance. We provide several potential explanations for this finding.

This paper is structured as follows. In the next section we review insights concerning both types of misallocation already available in the literature. While our paper utilizes data for Poland, the review is not narrowed to just this country, as the empirical insights from all transition economies are likely to be similar. In the subsequent sections we move to describing the unique data used in this study as well as the utilized methodology. Presentation of results is followed by the discussion of the policy implications from our study.

2. Literature review

In the traditional view, the production process in a centrally planned economy suffers from multiple inefficiencies: target input and output are determined as a result of negotiation between planner and managers, with little consideration given to firms' relative capacity and productivity (Bergson, 1964; Ellman, 1989). As a mean to mitigate the risk of under-delivering expected output, firms' managers may find it optimal to stockpile hidden reserves of inputs and underuse capacity. Moreover, central planners under socialism may tend to prioritize the development of the capital goods sector over the consumption goods, relative to social preferences as well as scope for technology-driven productivity growth (Weitzman, 1970). Hence, capital goods sectors may have a capital-labor ratio that is too high, with the opposite being true for the consumer goods sector. The implied misallocations could accumulate over time (Brada, 1989; Estrin et al., 2001). Still, Izyumov and Vahaly (2006) employ the perpetual inventory method to argue that despite these tendencies, capital accumulation in central planning was lagging behind Western European countries in both levels and growth rates (see also Campos et al., 2002).

However, even with functional factor markets, measurement of adequate allocation and factor productivity is subject to several imperfections. First, total factor productivity is typically a residual measure, conditional on the assumption of perfect factor market – not just functional ones (Jorgenson and Griliches, 1967). Measurement error plays an important role (Denison, 1972). Consequently, the literature has analyzed both the role of misallocation in market economies and the methodological aspect of its measurement. In the former strand, there is compelling evidence that if resource misallocation were eliminated, the cross-country TFP gap would be narrowed (Herrendorf et al. 2012). Moreover, constraints on access to credit imply capital distortions, whereas constraints on firm growth imply output distortions in many market economies (Hsieh et al., 2010; Jones, 2011; Jones 2013). In the latter strand of the literature, measurement of factor use appears to be less prone to measurement error if done via prices rather than quantities (Jorgenson et al., 1967; Hsieh, 2002), but data availability often limits such approach.

In response to the paramount policy relevance and the methodological constraints implied by data availability and quality, alternative approaches have been developed. Hsieh et al (2009) propose a counter-factual decomposition based on a functional form (see also Busso et al., 2012; Santana et al., 2015). Bartelsman et al (2013) offer an approach using the covariance between firm size and productivity, based on a decomposition of productivity originally proposed by Olley and Pakes (1996). Building on these insights we provide both counter-factual decompositions and dynamic efficiency decompositions.

3. Data

Data for this study comes from a combination of sources. First, we utilize a list of SOEs established after 1945 from the registry collected by Karpinski et al. (2013). This is a complete registry of all 50+ plants operational in 1988 that were established as state-owned enterprises after the World War II. It comprises data on sales revenues, employment and capital for 1759 plants. To the best of our knowledge, this is the largest database available for a individual country. For example, Frydman et al (1999) in their QJE paper analyze only 506 firms from three countries with 128 instances of privatization in total and such low numbers are no

exception for the literature in the field. Pinto et al (1993a,b) utilize data on 61 enterprises for Poland. Terrell (1993a,b) works with sector-level aggregates.

The database is comprehensive in the information it provides, but has no data on the post-transition fate of these plants. In some cases it suggests that a given plant was shut down, but does not give the transition history, nor the year of this event. To complete this information, we collected the transition histories ourselves, the detailed procedure for data collection is described in Appendix A. The complete database identifies the year of privatization and method of privatization (if there was any), bankruptcy (if there as any) as well as other important ownership changes (e.g. consolidation post-privatization, acquisition by a foreign firm, etc.).[1]

We also utilize firm-level data from 1995 onwards, provided by the Central Statistical Office (CSO), which is a census of all 49+ enterprises registered in Poland over 1995-2010 and a representative sample of all 9-49 enterprises registered in Poland over this period. The census data comprises information about capital stock, employment, sales revenues as well as form of ownership and sector. On average, in each year this database comprises complete information on roughly 20 000-40 000 firms which employ roughly 70% of salaried workers and generate roughly 70% of the economy output, which is substantial when compared to alternative data sources such as Business Environment Enterprise Performance Survey of the European Bank for Reconstruction and Development (about 1200 firms from Poland in total) or Amadeus (less than 5000 firms in total prior to 2002). Unfortunately, this data is not distributed at firm-level, hence we could only utilize aggregates to obtain estimates of the production function for the available years.

Table 1. Descriptive statistics

	Cross-section (Karpiński et al., 2013)		Panel (Amadeus)	
Variable	K(2013)	Identified in K(2013)	Matched from K (2013)	All firms
Capital	7861.48	10169.89	13072.28	13712.1
	[25218.34]	[21930.79]	[26198.28]	[131489.10]
Labor	1215.328	1621.68	1873.53	455.89
	[2004.57]	[2305.57]	[2497.81]	[3403.46]
K/L ratio	6.69	6.75	7.01	59.14
	[13.67]	[13.66]	[14.25]	[1042.98]
# of obs.	1638	763	482	61960

Source: own computation using data from Karpinski et al (2013) and Amadeus. Capital deflated with CPI. Consistent PPI deflators are not available for the early years of transition.

Finally, since each record in the Karpinski et al (2013) database comes with the name and location, we subsequently match this data to the earliest available editions of the Amadeus database, which covers data from 1995 onwards[2]. The records were matched manually, controlling for the exact address of the firm, the sector in which it operates and – if possible –

[1] This newly collected database is also available at the website http://grape.org.pl/privatization.

[2] We approached Bureau van Dijk, the provider of the Amadeus database to provide us with earlier editions of this database. However, at this point, neither the company HQ in Brussels nor regional offices dispose of any usable version of this data. Some recovered floppy disks are no longer usable. We also contacted numerous authors who published in early 1990s using the Amadeus data, but they no longer kept the copies of the data. If any researcher still had the early editions of Amadeus, authors of this study would be extremely grateful for sharing.

also data from the official registries relating former SOEs to already incorporated establishments. We discuss the detailed procedure of matching the two sources in Appendix B. Matching the Karpinski et al (2013) data with Amadeus allows for decomposition of aggregate and sectoral productivity into two components: average firm-level productivity and the allocative efficiency.

The descriptive statistics of the data are reported in Table 1. Clearly, our identification procedure finds firms that are larger both in terms of employment and in terms of capital. However, in terms of relative capital intensity the difference is not large. The firms from Karpinski et al (2013) identified subsequently in Amadeus data are in these later years on average larger and have higher capital intensity. However, neither of these differences is statistically significant, nor economically large.

4. Methodology

There was a substantial heterogeneity in K/L ratios as well as sales efficiency across firms already prior to the transition, see Table 2. This heterogeneity is stronger between firms than between sectors, which reveals that possibly over-capitalization (or dynamic inefficiency) was not only a sectoral phenomenon, as suggested by Terrell (1993a,b), but actually a firm level one. This initial allocation of capital and workers was subsequently subjected to multiple processes. First, some of the firms went bankrupt, while others survived. Second, those which survived, could have consolidated domestically or been acquired by a foreign firm. Third, each surviving firm made continuous staffing and investment decisions, adjusting capital and labor over time.

Table 2. Pre-transition capital and labor allocation across firms – variance decomposition

Variation decomposition	Capital	Labor	K/L ratio	Labor productivity
Due to between sector	35.3%	38.1%	34.6%	32.3%
Due to between plants	64.7%	61.9%	65.4%	67.7%
No of plants	1,526	1,523	1,519	1518
No of sectors	27	27	27	27

Source: own computation using data from Karpinski et al (2013), labor productivity computed as sales revenues over employment.

To address these phenomena, we adopt the following empirical strategy. First we analyze to what extent the capital to labor ratios were "adequate" before the transition started. To this end we utilize data from subsequent years and estimate sector-specific production functions, in order to compute the implied level of capital (and labor). In practice, for each plant available in the 1989 data, we compute the respective counter-factual capital level, which would be adequate for the given sales and the given labor employed, had the firm had the same production function, as prevailed in the data from 1995 onwards. The coefficients for the sector-specific production functions were estimated using the census data from the CSO. This approach is intended to obtain an approximation of the dynamic inefficiency.

Specifically, we estimate the equation

$$\ln(\text{sale revenue})_{\text{i}} = \text{TFP} + \beta_1 \ln(\text{K})_{\text{i}} + \beta_2 \ln(\text{L})_{\text{i}} + \epsilon_i \quad , \qquad (1)$$

for every available year in the CSO census data to obtain the estimates of TFP ,β_1 and β_2. While value added would have been a preferred measure of output, it was not available for the pre-transition data as at this time material production system rather than national accounts were utilized. Hence, we resort to sales revenue, which is available in both Karpinski et al (2013) database and in the subsequent years in the CSO census. With these estimates on hand, we compute the counter-factual amount of capital necessary to obtain the same output, had the 1988 firm used the technology and capital/labor ratio as observed in later data.

$$\ln(\mathrm{K}_{\mathrm{counterfactual}}) = \frac{\ln(\text{output sale})_{\mathrm{i}} - \mathrm{TFP}^{\wedge} - \bar{\beta}_2 \ln(\mathrm{L})_{\mathrm{i}}}{\bar{\beta}_1}\ , \qquad (2)$$

taking as $\ln(\text{sale revenue})_{\mathrm{i}}$ $\ln(\mathrm{L})_{\mathrm{i}}$and values observed in 1988. This procedure may be repeated alternatively for labor, keeping the capital fixed at 1988 level, to obtain counter-factual level of employment. Note that in this model TFP is understood as Hicks neutral technological change, in which improvement in firm productivity does not favor one factor over another, thus elasticities of substitution stay unchanged. Note also that the counterfactual estimations may be obtained for any subpopulation of firms available in the CSO census. For example, following Sabirianova et al. (2005), we could utilize only foreign owned firms, as they could have presumably global production practices (as opposed to domestic firms which only attempt to catch up with the frontier). However, for many sectors we could not obtain the estimates due to insufficient number of foreign owned firms to identify the model. Moreover, average sector production function in 2010 is likely to reflect an allocation of capital and labor already in alignment with international production frontier, it is the TFP that is likely to differ between the global frontier and the domestic firms. Hence, we utilize the benchmark of all the firms in 2010 to provide estimates of the production functions parameters and thus counter-factual levels of capital and labor. Comparing the estimated counter-factual capital to the actual one, we obtain a measure of the capital gap, or – dynamic inefficiency.

Applying the counterfactual decompositions reveals several important observations. First, with the exception of chemicals, the data from late 2010s (denoted in Figure 1 as ‘sectoral data’) yield a higher estimated TFP than the data from 1989 (denoted in Figure 1 as ‘K(2013) data’). The fact that the estimated level TFP is so much higher for all the sectors reveals the depth and scope of changes these sectors had to undergo in addition to adjusting allocation of capital and labor.

However, it appears also that the misallocation could be an important part of the story behind the catching up of the Polish economy. Figure 2 reports the actual vs. counter-factual firm-level values of capital and labor, following the thought experiment described in equation (2). It reveals rather remarkable dispersion of the counter-factual levels of capital and labor for the SOEs observed in 1989. A non-negligible fraction of firms records negative capital and/or labor gaps, which is equivalent to stating that with the observed level of capital (labor), they should require virtually zero labor (capital) to deliver the same sales using future production function and thus allocation. Note, that we preserve the TFP estimated for the 1989 data, so the changes in TFP, as reported in Figure 1, cannot stand behind the gaps between the actual and counter-factual use of inputs, as reported in Figure 2.

Figure 1. Sectoral TFPs estimated from a Cobb-Douglas production function

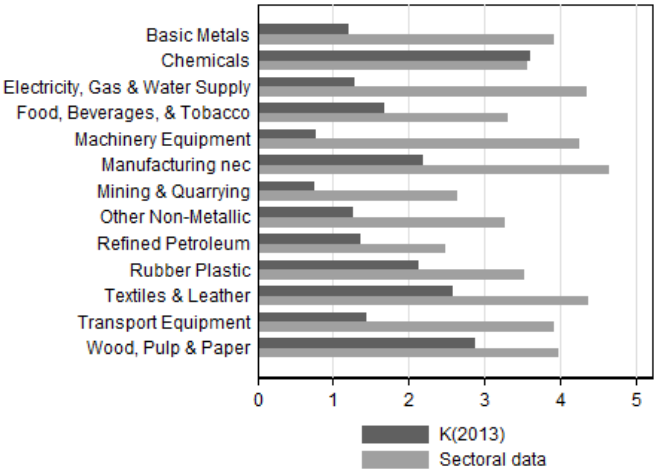
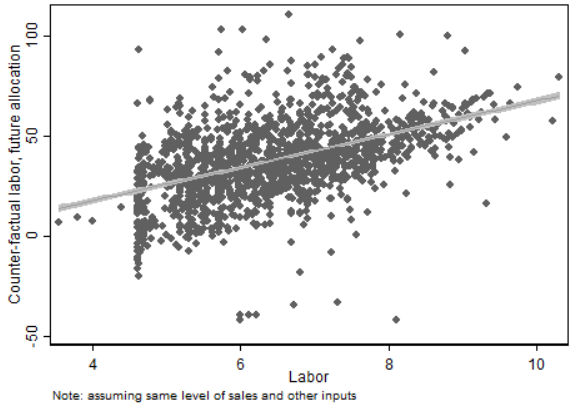
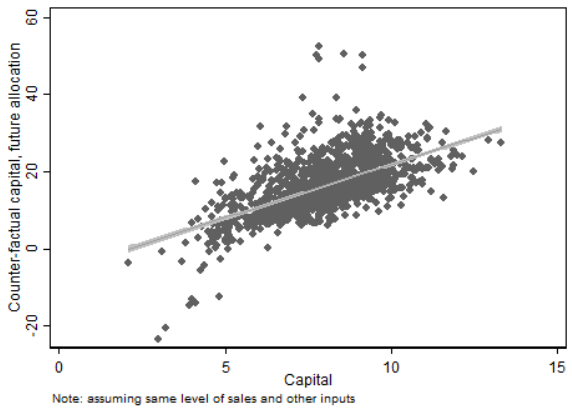


Figure 2. Actual vs counter-factual allocation estimated from a Cobb-Douglas production function





Notes: all values in logs, counterfactuals estimated according to equation (2) for capital and analogously for labor.

The inadequate K/L ratio at the firm level need not signify the misallocation in the productivity decompositions. Olley and Pakes (1996) suggested a measure of TFP using within-sector

covariance between plant size and productivity. This measure is utilized henceforth to compare the level of misallocation across firms between countries or time periods. Let ω_i be a measure of productivity of plant i and θ_i a measure of relative size of plant i. We can define an index Ω of aggregate productivity as follows:

$$\Omega = \sum_i^N \omega_i \theta_i \quad (3)$$

Accordingly, TFP is determined as within-sector covariance between firm-specific factor shares and factor productivity or between firm-specific production shares and TFP which was previously utilized by Hsieh and Klenow (2009) in the case of China. It is based on the assumption that under an efficient allocation of resources, more productive firms are likely to produce more, thus requiring more capital and workers (Olley and Pakes, 1996). Consequently, the higher the covariance is computed, the more efficient firms are supposed to be at utilizing factors of production. Bartelsman et al. (2013) emphasized that this covariance is perhaps the most robust measure of misallocation.

Having obtained the measures of dynamic inefficiency and misallocation, we analyze the survival probabilities for plants from Karpinski et al. (2013) database, which concludes our empirical analysis. Note that while dynamic inefficiency may be obtained at firm level (even if estimates are from sector level), the measures of misallocation are by construction sector-level. Also, due to data limitation, we cannot identify the effects of exits and entry on the efficiency, in the spirit of Polanec and Melitz (2015). In fact, since the earliest available edition of Amadeus comes from 2002, then by construction no firm present in Amadeus exits until then. Sector level data that we use from the Central Statistical Office do not account for entries and exits either.

5. Results

We employ two estimation strategies: a logistic regression for survival (a dummy outcome) and a survival regression (a continuous, yet censored outcome). In both estimation strategies we employ the same control variables. All estimations are performed with sector fixed effects. Additionally, we have own effects of a firm, which is measured by a difference between own number of years survived after 1989 and the average for the sector. This variable is needed in the survival estimations, because otherwise proportional hazard assumption is violated. All the estimations were performed on a total sample and sample from which energy and mining sector are excluded (admittedly, the K/L ratio in these two sectors departs from an economy average).

In addition to controls, we introduce two variables. First, there is a dummy variable for whether or not a firm was privatized. Second, we introduce a battery of misallocation measures, ranging from simple deviation from sector average K/L ratio, through difference between actual and counter-factual K/L ratios, to Olley-Pakes measures. Note that the measure based on deviations of K/L ratio from the sector has no natural benchmark. The measure based on the gap between actual and counter-factual capital has an internal benchmark in a sense that these values have no clear economic interpretation. The Olley-Pakes measure is by construction benchmarked. First, we compute it within the SOEs from Karpinski et al (2013). However, once transition started, this group of firms by and large was no longer the “whole” economy. Hence, we utilize the universe of the firms in the Amadeus data to compute the

capital shares of the SOEs from Karpiński et al (2013) relative to the enterprise sector in general.

The results from logistic regression and survival model in Table 3 are consistent: misallocation plays a minor role in explaining the variation of survival, whereas the lack of privatization itself as well as its delayed implementation tend to be correlated with higher probability of survival and longer survival duration. The results suggest some minor positive nonlinear effect for misallocation measured as a gap in K/L ratio and strong negative effects for the Olley-Pakes covariance term but only in the survival models. There is no evidence that non-standard allocation of capital and labor had a differentiated impact for privatized and non-privatized firms. Olley-Pakes covariance computed for the universe of firms has no explanatory power, which suggests that the competition for the resources between SOEs (privatized or not) and private newcomer firms had minor effect on firms' ability to survive.

Table 3: Survival analysis using probit and survival models

	(1) Firm K/L ratio				(2) Gap in K/L ratio				(3) Olley-Pakes covariance (only K 2013)				(4) Olley-Pakes covariance (full Amadeus)			
	Logit models															
Time to privatization	0.041***	0.041***	0.043***	0.044***	0.041***	0.041***	0.043***	0.043***	0.041***	0.041***	0.043***	0.043***	0.037***	0.035***	0.039***	0.040***
	(0.004)	(0.005)	(0.005)	(0.005)	(0.004)	(0.005)	(0.005)	(0.005)	(0.004)	(0.005)	(0.005)	(0.005)	(0.004)	(0.005)	(0.005)	(0.005)
Privatization	-0.233***	-0.221***	-0.276***	-0.268***	-0.253***	-0.259***	-0.348***	-0.342***	-0.223***	-0.215***	-0.260***	-0.258***	-0.261***	-0.247***	-0.304***	-0.311***
	(0.071)	(0.076)	(0.078)	(0.084)	(0.080)	(0.086)	(0.094)	(0.099)	(0.071)	(0.076)	(0.077)	(0.083)	(0.048)	(0.054)	(0.056)	(0.064)
Misallocation	0.030	0.036	0.030	0.029	-0.041	-0.044	-0.093	-0.048	-0.625	-0.811	-0.533	-0.592	-0.130	-0.082	-0.145	-0.106
	(0.039)	(0.040)	(0.041)	(0.043)	(0.058)	(0.071)	(0.077)	(0.090)	(0.874)	(0.929)	(0.915)	(0.979)	(0.119)	(0.126)	(0.132)	(0.144)
Misallocation ^2	-0.029*	-0.030*	-0.040**	-0.041**	0.004*	0.005	0.013***	0.010***	1.308	0.931	1.250	1.004	-0.003	0.003	-0.003	0.001
	(0.019)	(0.020)	(0.021)	(0.022)	(0.003)	(0.004)	(0.005)	(0.005)	(1.547)	(2.629)	(1.626)	(2.803)	(0.006)	(0.021)	(0.007)	(0.023)
Misallocation # privatization	0.006	0.004	-0.002	0.002	-0.035	-0.053	-0.125	-0.132	1.573*	1.555	1.373	1.357	0.050	0.051	0.053	0.061
	(0.052)	(0.054)	(0.057)	(0.059)	(0.069)	(0.075)	(0.104)	(0.103)	(1.063)	(1.154)	(1.113)	(1.226)	(0.156)	(0.155)	(0.173)	(0.178)
No of observations	712	694	625	607	697	681	622	606	711	693	624	606	458	437	395	374
Sector fixed effects	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Energy and mining	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
	Survival models															
Time to privatization	0.134***	0.132***	0.130***	0.131***	0.133***	0.130***	0.126***	0.126***	0.134***	0.131***	0.130***	0.130***	0.092***	0.089***	0.088***	0.086***
	(0.013)	(0.013)	(0.013)	(0.014)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.014)	(0.011)	(0.012)	(0.011)	(0.012)
Privatization	-1.324***	-1.321***	-1.314***	-1.322***	-1.405***	-1.439***	-1.550***	-1.555***	-1.329***	-1.345***	-1.318***	-1.347***	-1.059***	-1.007***	-1.036***	-1.007***
	(0.167)	(0.176)	(0.171)	(0.181)	(0.194)	(0.204)	(0.202)	(0.214)	(0.163)	(0.172)	(0.165)	(0.176)	(0.150)	(0.168)	(0.150)	(0.169)
Misallocation	0.081	0.094	0.073	0.083	-0.198*	-0.145	-0.214*	-0.126	-3.798*	-3.931**	-3.563*	-3.635**	-0.110	-0.003	-0.052	0.039
	(0.085)	(0.085)	(0.084)	(0.085)	(0.127)	(0.155)	(0.130)	(0.162)	(2.350)	(2.143)	(2.295)	(2.138)	(0.191)	(0.248)	(0.254)	(0.259)
Misallocation ^2	-0.010	-0.002	-0.022	-0.014	0.142***	0.068	0.077**	0.057	1.137	-1.940	1.174	-1.959	-0.002	0.011	0.003	0.015
	(0.050)	(0.051)	(0.050)	(0.050)	(0.058)	(0.066)	(0.044)	(0.043)	(3.931)	(6.209)	(4.109)	(6.240)	(0.019)	(0.030)	(0.031)	(0.031)
Misallocation # privatization	0.101	0.110	0.087	0.111	-0.093	-0.163	-0.374**	-0.378**	4.508*	3.576	4.116	3.231	-0.012	0.019	-0.034	-0.008
	(0.122)	(0.122)	(0.125)	(0.125)	(0.181)	(0.197)	(0.204)	(0.215)	(2.922)	(2.834)	(2.865)	(2.823)	(0.244)	(0.295)	(0.310)	(0.310)
Constant	3.633***	4.267***	3.616***	3.445***	3.374***	4.093***	3.381***	3.517***	3.588***	4.250***	3.563***	3.448***	3.552***	3.915***	3.545***	3.569***
	(0.074)	(0.617)	(0.076)	(0.239)	(0.109)	(0.630)	(0.108)	(0.250)	(0.066)	(0.616)	(0.067)	(0.238)	(0.069)	(0.415)	(0.071)	(0.248)
Log (p)	0.487***	0.498***	0.490***	0.499***	0.491***	0.497***	0.503***	0.505***	0.485***	0.498***	0.488***	0.499***	0.903***	0.910***	0.915***	0.922***
	(0.067)	(0.066)	(0.068)	(0.068)	(0.066)	(0.066)	(0.068)	(0.068)	(0.067)	(0.066)	(0.068)	(0.068)	(0.091)	(0.091)	(0.093)	(0.093)
No of observations	706	704	626	624	693	693	623	623	705	703	625	623	455	450	396	391
Sector fixed effects	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Energy and mining	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No

Notes: Marginal effects after probit estimation, sector fixed effects not reported (available upon request). *, ** and *** denote significance at 5%, 10% and 15%, respectively. Unless otherwise stated, all available observations. Energy and mining are dropped in subsequent specifications due to special character. In columns denoted by (1) firm's misallocation measured by firm's TFP as sector difference in K/L ratio. In columns denoted by (2) misallocation measured by the difference between counterfactual & actual KL ratio. In columns denoted by (3) misallocation measured by firm's TFP as Olley-Pakes covariance between capital productivity and capital share. In columns denoted by (4) misallocation measured by Olley-Pakes covariance between capital productivity and capital share, where share is computed out of the entire population in the Amadeus data.

These results are encouraging in a sense that one would hope managerial ability,functional capital and labor markets would be able to overcome any scope of misallocation. It appears that even firms particularly not fit for the market-based system were able to relatively swiftly adjust the capital and / or labor. Alternative explanation of these results is that the shock of

introducing a market-based system dominated whatever scope of adjustment was feasible, resulting in a relatively large probability of discontinuing activity. In fact that does not seem to be the case. On average, privatized firms were approximately 25% less likely to survive than non-privatized firms. This may signify both inappropriate self-selection into privatization programs and possibly inadequate implementation of the privatization, regardless of the initial scope of misallocation.

These mixed conclusions are corroborated by the analysis of variance, reported in Table 4. Indeed, privatization is a single most important covariate of survival duration. However, it only captures roughly 8.5-10% of the variation in survival duration. Misallocation measures (turned into categorical variables) explain each at best a few percent of the variation. Notably, when considered together, they appear to have slightly more explanatory power, which hints that none of the standard misallocation measures alone can capture the survival potential of the firm in the period of a large structural change.

Table 4. Covariates of survival (*anova*)

Controls	All firms	No energy and mining
Sector	4.22%	3.20%
Region	4.33%	5.38%
Year of birth	7.58%	8.87%
-- together	15.86%	17.30%
Privatization	10.04%	8.51%
Firm K/L ratio	1.94%	2.40%
Gap in K/L ratio	3.76%	4.49%
Olley-Pakes covariance (only K 2013)	3.03%	2.86%
Olley-Pakes covariance (full Amadeus)	1.45%	1.66%
-- together	11.18%	13.23%
All	33.32%	35.58%

The estimates in Table 4 reveal as well that there appears to be little or no interaction between the scope of misallocation, the sector, regional and birth cohort composition and the privatization. When considered together in the analysis of variance, they have somewhat more explanatory power than individually, which hints to some interaction terms. However, this effect is quantitatively relatively small and if subjected to formal testing (e.g. via bootstrap) it does not appear to be statistically significant.

6. Conclusions

A large body of literature on economic transition has been centered around the inappropriate allocation of resources prior to the introduction of the market based system. As a consequence, and in parallel to the literature from advanced economies, the literature has hypothesized that firms with larger scope of misallocation of resources are less likely to survive. Moreover, large scope of misallocation within an economy could slow its growth rate, especially if factor markets were imperfect enough to prevent swift adjustment in capital and / or labor inputs. Our study contributes to the literature by empirically testing these predictions.

We benefit from a unique source of data: we analyze a complete universe of all medium and large state-owned plants established between 1945 and 1989. We dispose of the information about employment and capital stock in these establishments as well as sales revenues. We complement the data in Karpiński et al (2013) with the transition trajectories of these plants. Additionally, we match these plants to firms database known as Amadeus, which provides financial records for firms active as of 1995. This unique data set allows to provide estimates of the correlates of survival. We estimate probit and survival models. We also perform analysis of variance for the illustrative purposes. All the models are estimated for a variety of misallocation measures.

We find no or negligible effect of misallocation on firm survival. There is some weak evidence of non-linear relationship between the initial and the "effective" gap in K/L ratio and survival, but economic importance of this factor is minor. We show that factors beyond plants' control – such as region, sector as well as birth cohort – had a comparable bearing on plants' ability to survive as factors within its control, namely input composition.

Our findings are mixed in a sense that they may be interpreted in two ways. The first interpretation emphasizes the size of the structural change. In fact, virtually all plants in our sample were substantially misaligned in terms of labor and capital use, relative to Polish firms in 2010. Hence, the scope of adjustment needed was large relative to initial inputs. Under such circumstances, initial inputs may be less relevant, provided that factor markets function properly. The second interpretation is centered around the role of the adjustment processes. In our data, remaining state-owned firms were conducive to survival, as opposed to privatization. If privatization process was inappropriately implemented, than the weak role of the initial inputs misalignment could be overweighed by this factor. Providing reliable identification to these two potential explanations is a fruitful avenue for future research.

Bibliography

Aghion, P., Blanchard, O., & Burgess, R. (1994). The behaviour of state firms in eastern Europe, pre-privatisation. European Economic Review, 38(6), 1327-1349.

Blanchard, O., & R. Dornbusch, & P. Krugman, & R. Layard, & L. Summers. (1991) "Reform in Eastern Europe.".

Brada, Josef C. (1989) "Technological progress and factor utilization in Eastern European economic growth." Economica: 433-448.

Bartelsman, E., Haltiwanger, J., & Scarpetta, S. (2013). Cross-country differences in productivity: The role of allocation and selection. The American Economic Review, 103(1), 305-334.

Carlin, W., Reenen, J. V., & Wolfe, T. (1995). Enterprise restructuring in early transition: the case study evidence from Central and Eastern Europe1. Economics of Transition, 3(4), 427-458.

Estrin, S., Gelb, A., & Singh, I. (1995). Shocks and adjustment by firms in transition: A comparative study. Journal of Comparative Economics, 21(2), 131-153.

Fischer, S. (1988). Symposium on the slowdown in productivity growth. The Journal of Economic Perspectives, 2(4), 3-7.

Frydman, R., Gray, C., Hessel, M. and Rapaczynski, A.: 1999, When does privatization work? The impact of private ownership on corporate performance in the transition economies, The Quarterly Journal of Economics 114(4), 1153{1191.

Hsieh, C. T., & Klenow, P. J. (2009). Misallocation and Manufacturing TFP in China and India. The Quarterly Journal of Economics, 124(4), 1403-1448.

Hyytinen, A., Ilmakunnas, P., & Maliranta, M. (2015). Olley–Pakes productivity decomposition: computation and inference. Journal of the Royal Statistical Society: Series A (Statistics in Society).

Izyumov, A & Vahaly, J (2006). New capital accumulation in transition economies: implications for capital-labor and capital-output ratios." Economic Change and Restructuring 39.1-2, 63-83.

Jones, D., Klinedinst, M., & Rock, C. (1998). Productive efficiency during transition: evidence from Bulgarian panel data. Journal of Comparative Economics, 26(3), 446-464.

Karpiński, A, S. Paradysz, P. Soroka & W. Żółtkowski (2013) Jak powstawały i jak upadały zakłady przemysłowe w Polsce, Warszawa: Muza

Kornai, J. (1980). Economics of Shortage. New York: Elsevier North-Holland

Montiel, P., & E. Borensztein . (1991). Savings, Investment, and Growth in Eastern Europe (No. 91/61). International Monetary Fund.

Murrell, P., & Olson, M. (1991). The devolution of centrally planned economies. Journal of Comparative Economics, 15(2), 239-265.

Olley, G. S & Pakes, A. (1996) The Dynamics of Productivity in the Telecommunications Equipment Industry. Econometrica, Vol. 64, No. 6, pp. pp. 1263–1297

Pinto, Brian & Belka, Marek & Krajewski, Stefan, (1993a), "Transforming state enterprises in Poland : macroeconomic evidence on adjustment," Policy Research Working Paper Series 1101, The World Bank.

Pinto, B., Belka, M., Krajewski, S., & Shleifer, A. (1993b). Transforming state enterprises in Poland: Evidence on adjustment by manufacturing firms. Brookings papers on economic activity, 1993(1), 213-270.

Prasnikar, J., Svejnar, J., & Klinedinst, M. (1992). Structural adjustment policies and productive efficiency of socialist enterprises. European Economic Review, 36(1), 179-199.

Restuccia, D., & Rogerson, R. (2013). Misallocation and productivity. Review of Economic Dynamics, 16(1), 1-10.

Sabirianova, K., Svejnar, J., & Terrell, K. (2005). Distance to the efficiency frontier and foreign direct investment spillovers. Journal of the European Economic Association, 3(2-3), 576-586.

Svejnar, J. (1996). Enterprises and workers in the transition: econometric evidence. The American Economic Review, 86(2), 123-127.

Terrell, K. (1992). Productivity of western and domestic capital in Polish industry. Journal of Comparative Economics, 16(3), 494-514.

Terrell, K. (1993). Technical Change and Factor Bias in Polish Industry (1962-1983). The Review of Economics and Statistics, 741-747.

Appendix A – Data collection procedure

There is no single comprehensive source of data about the firms (or plants) existing in Poland prior to the transition. Karpinski et al. (2013) provide a comprehensive list with data on sales, employment and capital stock, but this source does not match the privatization registries of the Ministry of Treasury, neither does it match fully the registries of SOEs held in early transition by the Ministry of Finance. In fact, Karpinski et al. (2013) is substantially longer than the alternative sources. To inquire the transition history of these plants we exploited two sources of data: Internet and Court Archives.

Internet Search - Plant-level data from the Internet was collected in a threefold manner. First, we searched for information using accessible public records. Second, we searched for any relevant articles available in Polish newspapers as well as for information on a given company's official website. Last, we used relevant keywords in Google searches to find any additional information.

[1] In the beginning of our search, we found the appropriate identification numbers for a given firm, namely the REGON, NIP, and KRS. Using anyone of these three IDs, we were able to search for basic information about the firm (e.g. whether it is still active, and if not, when it stopped functioning) by inputting them into the engine on the Central Statistical Office's website (Wyszukiwarka GUS) and, additionally, into third-party sites offering digital recordkeeping services (KRS-Online.com.pl and IMSiG). Information provided by these websites included the date of formation, date of liquidation, and the date of removal from the registry. Typically, a state-owned enterprise retained its ID when it was restructured and privatized. However, in some instances when the newly formed private company was not a direct continuation of the former SOE, it was registered as a completely new entity. This would, for example, happen when the new investor of the firm changed the business and production profile of the company. At the same time, a privatized SOE could be recognized as a completely new firm if other parts of its capital were sold off or liquidated. Since our data is plant level, we considered a newly established firm to be a continuation of an SOE when the plant specific to our database remained functioning following the restructuring.

[2] If not all of the desired data could be attained through information linked to the aforementioned identification numbers, we searched for websites linked with the specific plant, firm or industry. Most existing firms with a websites feature some sort of "about us" section with relevant historical information. The detail with which the history of an existing plant was explained on a company website varied considerably, and therefore could not be taken as the sole means of identification for surviving plants. Further sources, mostly national and local newspapers, had to be used to gain deeper insight into the current status of some of the plants. Newspaper and media sources additionally contributed to information on liquidation and changes in ownership. For plants that were liquidated, restructured or privatized in the 1990's and early 2000's, we searched the digital archive of the daily newspapers and weeklies (both national and regional).

[3] When the two above methods failed to yield the information we desired, we did a basic Google search on the given plant/firm. The specific search terms were:

- plant name* + “prywatyzacja” OR “podział” OR “inwestor” OR “FDI” OR “zagraniczny inwestor” OR “spółka akcyjna” OR “spółka skarbu państwa” OR “akcje” OR “sprzedaż”[3]; and
- plant name* + “upadłość” OR “likwidacja” OR “podział” OR “nierentowność” OR “sprzedaż mienia” OR “sprzedaż gruntu” OR “zamknięcie”[4]

To ensure reliability of the information provided in the search results, we sought to find multiple sources that verified given facts about a plant. Only when a certain date or event was reported by two or more sources was it included in our dataset. These sources had to be independent of each other. In that, two websites that cited the same source could not be taken as two independent sources. Thus, only primary sources were considered factual.

Please note that the name is typically not sufficient. For example, there are 12 “Zakłady Ceramiki Budowlanej” (Construction Ceramics Plant) in our sample, each in a different location, possibly also different specialization. To identify the fate of the plant one needs to identify a specific plant, with location matching.

Court Archives. We collected data from the Regional Commercial Court in Warsaw (pol. “Sąd Okręgowy w Warszawie – Sąd Gospodarczy”). The registry of public firms (RPP- pl. Rejestr Przedsiębiorstw Państwowych) found in the court was used for information about the potential privatization or liquidation of state-owned enterprises. The records available in several regional courts were queried, but the procedure was not carried out for all regional courts because of its inefficiency. First, most of the information from the RPP is also available online in alternative sources (RPP holds the source documents, but the status has been recorded in a number of digital registries). Second, a large number of privatizations involved at initial stage a transformation from a state enterprise to a treasury-owned company. Given that our interest encompasses the complete privatization process, RPP records conclude too early for many plants. Third, RPP contains information from a firm level, whereas our data are available at plant level.

Checking the reliability of information: business Intelligence. We addressed two business intelligence firms – a domestic and international one – with the request to provide transition histories of the plants from Karpiński et al (2013). A randomly selected subsample of both identified and unindentified plants was provided with the request. Both of the business intelligence firms were unable to enrich our database.

On the whole, among 1,641 Polish plants in the Karpinski et al (2013) database, 47% are definitely identified. Noticeably, the identification varied significantly based on sector: sectors with high capital concentration had more transparent histories, whereas plants such as food processing or clothing have more frequently disappeared without an identifiable legal trace.

[3] Translated search terms: “privatization”, “division”, “investor”, “foreign investor”, “joint-stock company”, “treasury-owned enterprise”, “stock” and “sale”

[4] Translated search terms: “bankruptcy”, “liquidation”, “split”, “unprofitable”, “asset sale”, “property sale” and “closing”.

Appendix B – Matching the SOE data to Amadeus records

In order to track the post 1989 financial records of the state-owned plants we our collection to the earliest available edition of the Amadeus database, i.e. from 2000. For former state-owned plant we identified registration number, VAT number, history of ownership structure, possible location change and name changes. We match it case by case to Amadeus database, with the following procedure (in priority order).

1. Registration number and VAT number match.
2. Plant name match.
   The names are read in English in Amadeus database and in Polish in our database. This implies that for some plants diacritic Polish signs prevent perfect matching. We replace the Polish diacritic signs with Latin letters (such as *a* fro *ą* and *c* for *ć*).
3. Plant address match and plant history.
   Surviving plants may either remain SOEs or be privatized with domestic or foreign investor, followed by changes to year of incorporation, business sector and name of the plant. We distinguish between a plant surviving on its own and a plant acquired by an investor (in which case the plant shares the same identification number in Amadeus database with parent firm). There are numerous cases when plants, particularly privatized ones and FDI recipients, changed their names or many plants sharing the same name. Thus, firm level address records from Amadeus would not match the plant-level address. We utilize data on plant ownership changes and mother-firm records to accommodate for that fact.

The table below describes in detail when the plant may be identified in Amadeus database.

Plant post 1989 history	Active?	Functions independently		Has own ID in Amadeus data?
		YES	NO	
Survived, privatized or SOE	YES	YES	NO	YES
Active consolidated with another firm	YES	NO	YES	YES if enters Amadeus before acquisition, otherwise shares ID with parent
Privatized then liquidated	NO	YES	YES	YES, unless liquidation prior to entering Amadeus
SOE then liquidated	NO	NO	NO	YES, unless liquidation prior to entering Amadeus
Liquidated	NO	N/A	N/A	NO

Inevitably, not each plant could be matched with Amadeus data. First, of the state owned 1,641 plants in 1989, it was possible to identify the fate of 47%. Of this number, not all survived until 1995, i.e. the first year of data availability in Amadeus. Also, the Amadeus data is not comprehensive in a sense that it provides data on 7,099 firms, whereas approximately 14,000 firms existed in 1995 in the enterprise sector. On the whole we matched 477 firms, of which 419 plants have its own ID number.

Plant post 1989 history	Cases in Karpiński (2013)		Cases matched in Amadeus	
	Frequency	Percent	Frequency	Percent
Survived itself, privatized	212	27.71	145	30.40
Survived itself, SOE	10	1.31	4	0.84
Active, consolidated with privatized	243	31.76	189	39.62
Active, consolidated with SOE	12	1.57	10	2.10
Privatized then liquidated	121	15.82	76	15.93
SOE then liquidated	21	2.75	13	2.73
Liquidated	144	18.82	38	7.97
Active	2	0.26	2	0.42
Total	765		477	