THE BIG SELL: PRIVATIZING EAST GERMANY'S ECONOMY

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ABSTRACT. Departing from communism, East Germany witnessed history's most extensive privatization program. While the program sparked global interest as a blueprint for economic transformation, its effectiveness remains disputed. Using unique firm-level data, we examine the program's objective to privatize the most competitive firms. We document that firms with higher baseline productivity are more likely to be privatized, yield higher prices, are more often acquired by West Germans, and are more likely to survive 20 years later. Inspecting the inner workings of the privatization agency, we illustrate challenges and lessons for how governments can design and implement industrial policy goals.

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1. Introduction

To boost economic growth and productivity, policymakers around the world make use of industrial policy – active government policies aiming to change the structure of an economy by promoting specific firms (Juhász, Lane, and Rodrik, 2023). While economists have long debated whether governments should engage in industrial policy, little evidence exists on *how* industrial policy is designed and implemented. Yet, understanding implementation is important because these policies are typically irreversible, expensive, and reliant on long-term gains to offset initial frictions (Greenwald and Stiglitz, 2006).

This paper examines economic restructuring in the presence of major political change, using evidence from a unique historical episode: the transformation of East Germany's state-controlled economy after the collapse of socialism. This transformation was focused on implementing an industrial policy agenda, active government policy aimed at changing the structure of economic activity by promoting specific firms (Lane, 2020a; Juhász, Lane, and Rodrik, 2023). In 1989, the German government created a public agency, the Treuhandanstalt¹ to restructure and divest the entire state-owned economy of the former German Democratic Republic (GDR). Overnight, the Treuhand became the world's largest holding company and, over the next five years, the agency transformed the entire East German firms by choosing and incentivizing private sector investors while closing down firms deemed non-competitive in a market economy.

We use newly assembled data on the economic situation of East German firms before, during, and after the privatization program that we collect from administrative records, firm surveys, privatization contracts, and credit rating data. These data allow us to measure firms' productivity at the beginning of the program, internal evaluation scores, and sales prices. We identify privatized firms' new ultimate owners

¹German for "trustee agency", abbreviated Treuhand or THA.

and follow firms' survival rates and employment levels for more than 20 years after privatization.

We describe the implementation of the Treuhand privatization program in East Germany using OLS regressions at the firm-level. Specifically, we estimate the relationship between firm conditions, firm characteristics, and privatization outcomes using control variables to account for potential confounding factors. Our focus lies on providing a descriptive account of privatization in Germany and we therefore interpret our findings as associations, rather than causal evidence. Our key variable of interest is the firms' level of productivity at the beginning of the privatization program. The Treuhand's political mandate tasked it with focusing its privatization efforts on firms who were likely to be competitive outside of public ownership. From this mandate, we derive a simple metric to assess the implementation of these policies: Did firms with higher initial productivity achieve better privatization outcomes?

Our analyses reveal four key findings. First, we find that firms with higher initial productivity were more likely to be privatized and they were privatized faster. Examining the Treuhand's internal rating policy for firms' prospects, we show that the agency was on average able to identify and promote firms with favorable initial conditions. Second, firms with higher initial productivity were sold to investors at higher prices. The Treuhand achieved better contracts for more productive firms, both in terms of cash prices and in terms of employment and investment guarantees committed by the new owners. We show that these effects are robust to discretionary targeting of specific regions or sectors by the privatization agency. Third, we show that firms with higher initial productivity were more likely to be sold to non-local owners, specifically from West Germany. Fourth, we show that firms with higher initial productivity levels achieved better economic outcomes in the post-privatization period. Specifically, higher levels of initial productivity predict higher survival rates and employment levels up to twenty years after the privatization program ended. Conditional on initial productivity, firms with West German or international owners were more likely to survive over periods of ten and twenty years, respectively.

How successful was the Treuhand in the implementation of privatization policies in East Germany? To answer this question, we conduct a counterfactual benchmark analysis that uses machine learning to evaluate the Treuhand's implementation relative to alternative privatization scenarios. Our results show that, overall, the observed ten-year survival rates of privatized firms are comparable to those of a counterfactual where privatization targets are selected purely on observed productivity. The Treuhand's implementation, however, does not achieve the success rates predicted by a counterfactual best-case scenario. We show that this gap may in part be due to differences in performance between different Treuhand entities: the agency achieved better performance in its centralized operations than in its regional subsidiaries.

Studying East Germany provides important evidence on privatization and its implementation beyond what is known from other large-scale programs in Russia and China. Like in Russia, the GDR's state sector accounted for 96 percent of GDP prior to the privatization program. Both economies were highly centralized (Fischer and Gelb, 1991; Milanovic, 1991). However, unlike Russia or any other former Soviet Bloc state, East Germany did not have to develop a market-based regulatory framework from the vestiges of communist rule (Boycko, Shleifer, and Vishny, 1996). Instead, with German reunification, the GDR adopted West German institutions with immediate effect. Hence, East Germany does not suffer from the same confounding institutional backdrop. Privatization in China, on the other hand, was also large-scale and under consistent institutions – but occurred gradually. Due to continuing state-dominance in China's economy, firms of strategic importance for the implementation of industrial policy never participated in the privatization programs. Eventually, this resulted in limited levels of private firm ownership, with state-controlled firms remaining a vital part of the economy (Hsieh and Song, 2015). In Germany, privatization was carried out with consistent institutions, was of unprecedented scale, and did not allow for strategically important firms to remain under state control. The challenge of deciding which firms to privatize and how to choose future owners is common to

all privatization programs. The Treuhand privatizations thus constitute an important test case for how to implement large-scale privatization and industrial policy programs.

The contribution of this study is threefold. First, our findings address the implementation of structural industrial policies and the key question of whether governments can identify the right firm targets for these policies (Lerner, 2002; Rodrik, 2008; Aghion, Cai, Dewatripont, Du, Harrison, and Legros, 2015; Cingano, Palomba, Pinotti, and Rettore, 2022; Branstetter, Li, and Ren, 2023). As Juhász, Lane, and Rodrik (2023) argue, closing down losers – a key component of the Treuhand program – may even be more important than picking *winners*. Empirical research in this area is "thin" (Lane, 2020b), has mostly studied industrial policies at the sectoral level, such as shipbuilding (Barwick, Kalouptsidi, and Zahur, 2019) or the heavy and chemical industry (Choi and Levchenko, 2021; Kim, Lee, and Shin, 2021; Lane, 2022), and mainly focuses on *whether* industrial policy can work (Juhász, Lane, and Rodrik, 2023). In contrast, the Treuhand's portfolio spanned all East German sectors and examining its operations allows us to study how industrial policy works: Selecting viable firms was a challenging task as the agency had to prioritize firms while complying with severe financial, bureaucratic, and time constraints. Our findings also emphasize the broader importance of institutions. State capacity is an important driver of economic development in general (Besley and Persson, 2009; Acemoglu, Garcia-Jimeno, and Robinson, 2015), but can be of particular importance in efficiently managing industrial policy (Bardhan, 2016).

Second, our analysis contributes to the literature on firm privatization. By tracing the crucial stages of the privatization program, we provide an integrated analysis of firms' initial situation, sales contracts, the ensuing ownership distribution, and firms' long-term success. Moreover, we open the black box of the privatization process itself by analyzing internal firm ratings used by the Treuhand in its decision-making. In contrast to the existing literature, we do not study the state decision to privatize or keep firms in public ownership. Instead, we study the selection of firms from state ownership into either private ownership or liquidation. We thereby demonstrate that the probability of firms to be prioritized and selected for privatization, rather than liquidation, depends on initial firm productivity. This finding contrasts with classic theories of public-to-private ownership changes which typically rationalize governments' privatization decisions based on goals to maximize excess employment or other political benefits (Boycko, Shleifer, and Vishny, 1996; Laffont and Tirole, 1991; Shleifer and Vishny, 1994). At the same time, our findings are important for the empirical privatization literature where studies typically evaluate firms' postprivatization performance. Although selection bias in the privatization process has been acknowledged as the "most difficult problem" (Brown, Earle, and Telegdy, 2010, p. 693), the selection process itself has rarely been subject to examination (Megginson and Netter, 2001). Gupta, Ham, and Svejnar (2008) study the sequencing of privatization in Czechia where the government could sell firms in one of two phases. Our finding that firms' likelihood and timing of privatization are positively selected on productivity corroborates identification concerns in post-privatization performance studies (see Estrin, Hanousek, Kočenda, and Svejnar (2009) for a review). We show that these concerns also matter for settings where the government chooses between privatization and liquidation rather than privatization and continued state ownership.

Finally, our results build upon the literature on democratization and the distribution of wealth. We extend existing work by analyzing the immediate distributive consequences from the sale of state-owned enterprises and identifying the new ultimate owners. Theories of democratization place redistribution of wealth and firm ownership at their core (Acemoglu, Naidu, Restrepo, and Robinson, 2015). Dorsch and Maarek (2019) demonstrate that democratization has different consequences on income inequality depending on equality levels prior to democratization. Egalitarian yet autocratic societies may experience increases in inequality, while previously unequal autocracies may experience an income-leveling effect. Post-communist countries such as Russia and China exhibit increasing wealth concentration at the top, which may be fueled by privatization (Novokmet, Piketty, Yang, and Zucman, 2018; Milanovic and Ersado, 2012). In contrast, the GDR's most productive companies were rarely sold to East German insiders but rather to West German investors. Documenting these ownership transitions provides a major explanation for today's East-West gap in the ownership of business assets. This gap contributes to the overall wealth gap, with household wealth being twice as high in West Germany (Fuchs-Schündeln, Krueger, and Sommer, 2010; Albers, Bartels, and Schularick, 2020).

The remainder of this paper is structured as follows. In section 2, we review the historical background of the Treuhand privatizations. Section 3 introduces our data and section 4.1 outlines the empirical strategy. We present our main results in the remainder of section 4, provide a counterfactual benchmarking analysis in section 5, and conclude in section 6.

2. Privatization in East Germany

In this section, we review the main elements of privatization in East Germany. After the fall of the Berlin Wall, the German federal government abolished the planning system in East Germany and introduced West German market institutions and regulations. It also ended public ownership of the business sector. The Treuhand Law (TreuhG) required all state-owned enterprises to be transferred to the privatization agency. The Treuhand's legal mandate, based on these laws, was to reduce the state's entrepreneurial activity as extensively and as quickly as possible through privatization (see Appendix A). Firms that could not be restructured were to be liquidated. The objective was to "enable as many companies as possible to become competitive". This legal mandate remained constant throughout the agency's existence.

After assuming ownership of the state-owned enterprises, the Treuhand transformed them into companies under private law and divided large conglomerates into individual firms. Then, the Treuhand asked firms to compile opening balance sheets and submit business plans. The *Leitungsausschuss* funded by the Ministry of Finance,

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a committee of consultants comprising auditors, financial managers and banking experts subsequently evaluated the business situation (Böick, 2018, p.285).

Privatization mainly occurred through direct sales to investors. Large-scale auctions and voucher systems, which were implemented in several other countries, were not used (Bolton and Roland, 1992). When negotiating with investors, the Treuhand asked for employment and investment guarantees in addition to a cash sales price. However, the relative importance given to each contract component was not regulated by the law and might have changed over time (Carlin and Mayer, 1992). Violations of committed guarantees were tracked by the Treuhand and penalized. Akcigit et al (2023) compute that the agency detected violations of employment pledges in about 8.6% of contracts.

The Treuhand was a public-law corporation, overseen by a supervisory board, and controlled by the Federal Ministry of Finance. The government instated the supervisory board and appointed its members from federal ministries, East German state governments, as well as business associations and unions. Internally, the Treuhand created a two-tiered organizational structure, consisting of a headquarter in Berlin and fifteen regional branch offices. The headquarter was in charge of enterprises with more than 1,500 employees (though numerous exceptions applied). Regional branch offices were responsible for companies below this threshold. The Treuhand's institutional setting resembled structures deployed in other countries, such as the state wealth management agencies in Hungary and Estonia (Carlin and Mayer, 1994; Purju, 1996; Orban, 2019). Cassell (2003) also points to parallels with the *Resolution Trust Corporation* (RTC) in the US, a temporary agency created after the savings and loan crisis of the 1980s to divest assets from insolvent banks on an immense scale.

On July 1st 1990, the Treuhand owned more than 10,000 companies with about 4 million employees. The Treuhand closed its operations on December 31st, 1994. Figure 1 shows that the Treuhand privatized almost 60 percent of the firms it formally owned. Approximatively 30 percent of firms were liquidated. The remaining firms were either restituted to former owners or municipalized, though these categories comprise an even smaller share when we account for their size in terms of initial employment or revenues. The financial loss from the Treuhand's operations eventually amounted to 256 billion DM,² absorbed by the federal government (Bundesanstalt für vereinigungsbedingte Sonderaufgaben, 1994). The Bundesanstalt für vereinigungsbedingte Sonderaufgaben, 1994). The Bundesanstalt für vereinigungsbedingte sonderaufgaben (BvS), the Treuhand's successor organization, continued contract surveillance and other remaining tasks.



Note: Relative frequencies of final firm privatization outcomes among all firms formerly owned by the Treuhand. Privatization entails the sale of a public firm to private investors. Liquidation implies the termination and dissolution of a firm. Restitution comprises the return of firm assets to former owners who lost their property through expropriation. Municipalization refers to the transfer of Treuhand companies to the regionally responsible municipalities and mostly involved public utilities. Initial employment and revenue used for weighting. *Sources:* BvS Firm Register and THA Firm Surveys.

FIGURE 1. Final Firm Outcomes of Treuhand Operations

3. Data

In this section, we describe the five key components of our data and explain the main variables. We build our data set around an administrative firm register that we supplement with additional data on initial labor productivity, firm rating scores, sales

²In January 1995, when the Treuhand had concluded its operations, this would have been equivalent to roughly 167 billion US Dollars (https://fred.stlouisfed.org/data/EXGEUS).

contract information, post-privatization firm ownership, and corporate survival. This is the first data set covering the universe of firms in the East German privatization program. We also cover firms' post-privatization outcomes, tracing them from 1990 until 2015. Our analyses focus on five sets of outcomes: (i) whether a firm was privatized, (ii) when it was privatized, (iii) under which conditions it was privatized, (iv) which investors it was sold to, and (v) how economically successful it was after privatization.

BvS Firm Register. An administrative register of 12,874 firms owned by the Treuhand forms the core of our sample, which we supplement with further data sources. The register includes the population of Treuhand firms and builds on original Treuhand records. We obtained the register from the Treuhand's successor agency BvS (Bundesanstalt für vereinigungsbedingte Sonderaufgaben, 2016). In addition to basic firm information, it includes the firms' status at the end of the privatization program. A firm's status indicates whether it was privatized, liquidated, restituted to its former (expropriated) owners, or municipalized (see Figure 1 in the previous section). In our analyses, we focus on the 10,316 firms that were either privatized or liquidated and have location information at the Federal state level. Decisions to restitute or municipalize were largely taken outside the Treuhand's purview and followed predetermined criteria. We also exclude firms headquartered outside the former GDR, as well as operations solely providing active labor market programs.

Treuhand Firm Surveys. We compile baseline labor productivity measures from surveys of Treuhand firms conducted during and after their privatization (Kühl, Schaefer, and Wahse, 1991). Starting in April 1991, the SÖSTRA Institute, Berlin, on behalf of the Treuhand and German Federal Employment Agency, conducted these surveys biannually. Surveys were answered by firm executives. Using the employment and revenue items included in the survey, we develop two indicators of labor productivity: revenue per worker and revenue per hour worked. While the former is a standard measure of firm-level productivity, the latter measure additionally captures differences in firms' use of short-time work schemes. By February 1991, 22 percent of East German employees were in short-time schemes (Akerlof, Rose, Yellen, and Hessenius, 1991). To construct a cross-section of firms' initial labor productivity, we use the earliest response available for each firm. In more than 80 percent of all cases, the labor productivity variable refers to 1991. Surveys conducted after September 1993 also include the value of external inputs as a share of total revenues, thus allowing us to compute a measure of firms' gross value added. Due to the late survey dates and lower number of observations, we use this indicator only for sensitivity analyses. All financial variables are deflated to the base year 2000 using price indices from OECD (2015). We follow the suggestion of Bollinger and Chandra (2005) and apply a one percent winsorizing rule to these variables due to potential measurement error. Labor productivity indicators are available for 6,190 Treuhand firms. For privatized firms, the data includes the month of privatization.

Treuhand Firm Ratings. Next, we employ internal rating scores that were assigned to firms administered by the Treuhand's headquarters. We extract these scores from meeting protocols of the Treuhand's *Leitungsausschuss* ("steering committee"), which we collected from the German Federal Archive (Bundesarchiv, 2019). We obtain all available rating scores awarded until June 1991, covering the first year of the Treuhand's four and a half years of existence. These data comprise 588 scores for firms that can be matched with the BvS firm register. Restricting the data to ratings awarded in the first year ensures that scores plausibly represent the internal assessment of a firm, rather than the demand from investors that the Treuhand potentially internalized later on. Scores follow a grading scheme with values ranging from one (profitable, no need for further restructuring) to six (direct liquidation, not viable even with further restructuring).

Treuhand Privatization Contracts. The Treuhand's internal data management system (ISUD) tracked the privatization contracts for all firms in the agency's portfolio. We obtain these data from the Federal German Archives (Bundesarchiv) and we extract the purchase price, employment and investment guarantees of each finalized contract at the level of the privatized company (Treuhand, 2023). By linking multiple data tables from ISUD as detailed in the Data Appendix, we extract 13,514 contracts with our variables of interest. We sum the contract variables for each firm, obtaining 3,902 firms whose contracts were recorded in the central database and had no missing information in any of contract variables.

MUP Firm Register. We link the data on Treuhand-administered firms with information on post-privatization ownership and corporate survival from the Mannheim Enterprise Panel (MUP). The MUP is based on commercial register data provided by Creditreform, Germany's largest corporate credit rating agency (Bersch, Gottschalk, Mueller, and Niefert, 2014). These data encompass all economically active firms in East Germany from 1993 onward. We collect data at the firm-level on ownership,



Notes: Each node indicates the data source and final sample size after matching along the direction of the arrows. Firms without match or missing information about productivity are excluded. Starting point for the dataset construction process is the BvS administrative firm register. We focus on the Treuhand firms that were either privatized or liquidated. We exclude firms that were restituted to previously expropriated owners or municipalized. We test sample representativeness in Table 1 and Table 2.

FIGURE 2. Dataset Construction

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ownership location, closure date, and legal form. Ownership information include the owners' addresses, information on whether the owner is a firm or a natural person, as well as indicators for the type of ownership (shareholding, owner-manager etc.) and share of ownership that they hold in a firm. We use this information to investigate higher levels of ownership by building a network of ownership relations within our data set. We can follow firms through this network until we identify an ultimate owner or an ownership edge leaves East Germany. In these cases, we only observe the first-level direct ownership link between a privatized firm and a non-East German owner. As a consequence, we apply the "ultimate ownership" definition by searching through the corporate networks until we either reach a final node within East Germany or a final external link.

We combine available information on firm closures from the MUP and the BvS register to measure survival. Survival is measured relative to the official conclusion of the Treuhand's privatization efforts in 1995. We define four binary variables as outcomes for our analyses: 5 year survival measures whether a firm was still active in 2000, 10 year survival in 2005, 15 year survival in 2010, and 20 year survival in 2015. We omit firms that, according to the BvS register, have merged with another entity from our analyses because we cannot reliably track their economic performance over time. We jointly observe ownership, survival data, and labor productivity indicators for 2,566 firms privatized by the Treuhand.

Sample Comparison. Figure 2 demonstrates the data construction process. Table C.1 contains summary statistics of our main variables. We use different subsets of our data set to analyze the Treuhand's privatization priorities, decisions, and outcomes. For each step of the analysis, we subset the universe of Treuhand firms to those for which the necessary information items are available. To gauge the representativeness of these different data subsets for the firm population in the Treuhand's portfolio, we provide mean values and mean difference tests for the respective samples in Table 1 and Table 2.

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	Full Sample	Survey	Sample	Ratings	s Sample
	Ι	II	I-II	III	I-III
	Mean	Mean	P-val	Mean	P-val
Privatization Outcomes					
Privatization $(0/1)$	0.680	0.676	0.632	0.646	0.096
Firm Characteristics					
State: East Berlin $(0/1)$	0.099	0.090	0.058	0.088	0.366
State: Brandenburg $(0/1)$	0.145	0.146	0.848	0.143	0.879
State: Mecklenburg West. Pom. $(0/1)$	0.113	0.106	0.157	0.056	0.000
State: Saxony-Anhalt $(0/1)$	0.171	0.170	0.846	0.199	0.096
State: Saxony $(0/1)$	0.308	0.328	0.007	0.338	0.129
State: Thuringia $(0/1)$	0.164	0.159	0.490	0.175	0.470
N gross	10316	8883	-	588	-
N net	10316	6190	-	588	-
Sources					
BvS Firm Register	\checkmark	\checkmark	\checkmark	\checkmark	\checkmark
Treuhand Firm Surveys		\checkmark	\checkmark	\checkmark	\checkmark
Treuhand Firm Ratings				\checkmark	\checkmark
Treuhand Privatization Contracts					
MUP Firm Register					

Note.– Columns I, II and III represent samples used in specific sections in this study. Columns I-II and I-III show the p-values of two sample t-Tests for equal means. N gross indicates the number of firms after matching. N net shows the sample size after dropping firms with missing information in the key variables of interest.

TABLE 1. Sample Comparison: Privatized and Liquidated Firms

The basis of our study is the administrative BvS Firm Register covering all firms that were part of the Treuhand's portfolio. However, this administrative register only comprises limited information beyond the identity and final privatization status of the respective firms. In our analyses, we therefore use the THA survey data to assess the Treuhand's selection of firms for privatization and the respective outcomes. Table 1 shows that the sample of surveyed firms (column II) is broadly representative of the Treuhand firm population overall (column I) in terms of privatization incidence and geographical distribution. Column (III) shows that firms included in the ratings sample are larger, less productive and more likely to be in manufacturing industries. However, these differences stem from the fact that only the largest and most important GDR firms were rated by the Leitungsausschuss (Treuhandanstalt, 1994). Based on this relative representativeness of the Treuhand surveys, Table 2 assesses differences between the samples of privatized firms (Treuhand Privatization Contracts and MUP Firm Register) and privatized firms in the Treuhand surveys. We find that the firms in the Contracts sample (Section 4.3) are smaller (381 vs. 337 employees on average) and less productive than the corresponding sample in the surveys, but that the economic magnitude of these differences remains minor. Similarly, we find differences in the share of manufacturing firms and in some geographic indicators used in Sections 4.4 and 4.5 that are statistically different from zero but likely of limited economic and econometric relevance. These firms are also slightly smaller on average (381 vs. 344 employees at the mean).

	Survey Sample Contracts Sample		Post-Priv	r. Sample	
	I	II	I-II	III	I-III
	Mean	Mean	P-val	Mean	P-val
Firm Characteristics					
Number of Employees	372.604	337.411	0.049	344.611	0.099
Log Rev. per Worker (DM/capita)	4.430	4.332	0.000	4.447	0.471
Log Rev. per Hour Worked (DM/hour)	3.867	3.775	0.000	3.880	0.562
Manufacturing $(0/1)$	0.659	0.725	0.000	0.710	0.000
State: East Berlin $(0/1)$	0.080	0.080	0.971	0.097	0.022
State: Brandenburg $(0/1)$	0.155	0.177	0.027	0.131	0.006
State: Mecklenburg West. Pom. $(0/1)$	0.115	0.148	0.000	0.099	0.046
State: Saxony-Anhalt $(0/1)$	0.178	0.201	0.030	0.182	0.652
State: Saxony $(0/1)$	0.308	0.377	0.000	0.312	0.772
State: Thuringia $(0/1)$	0.164	0.016	0.000	0.179	0.113
N gross	5453	2020	-	6652	-
N net	4076	2020	-	2566	-
Sources					
BvS Firm Register	\checkmark	\checkmark	\checkmark	\checkmark	\checkmark
Treuhand Firm Surveys	\checkmark	\checkmark	\checkmark	\checkmark	\checkmark
Treuhand Firm Ratings					
Treuhand Privatization Contracts		\checkmark	\checkmark		
MUP Firm Register				\checkmark	\checkmark

Note.– Columns I, II and III represent samples used in specific sections in this study. Columns I-II and I-III show the p-values of two sample t-Tests for equal means. N gross indicates the number of firms after matching. N net shows the sample size after dropping firms with missing information in the key variables of interest.

TABLE 2. Sample Comparison: Privatized Firms

The combined information from the BvS and MUP firm registers enables us to track firm exits over time and to assess the balance of our final sample regarding survival. Importantly, the MUP data allow us to observe firms and their last active records even after the exit date. We compare survival rates by sample composition in Figure C.1 and find only small differences between the various data (sub-)sets. Although Figure C.1 suggests that we are slightly more likely to observe ownership for firms that survive at least the first few years under Treuhand ownership, these differences diminish over time. While we observe smaller sample sizes as we combine more data sources, this is primarily due to missing information rather than firm exit patterns.

4. The Role of Labor Productivity for Privatization Decisions and Long-Run Firm Outcomes

4.1. Empirical Approach. In this section, we describe our empirical approach to measuring how privatization decisions, conditions, and outcomes varied along the firm productivity distribution. For each firm in its portfolio, the Treuhand had to decide whether it should be privatized or liquidated. To evaluate the choices taken by the agency, we build on its legal mandate and derive a simple metric to assess its implementation of privatization policies: Did firms with higher initial productivity achieve better privatization outcomes?

The Treuhand's tasks were explicitly defined by the German government and chief among them was "privatization through the sale of shares or assets, ensuring the efficiency and competitiveness of companies" (see Appendix A for key sections from the *Treuhandgesetz* law). Otherwise, firms were to be liquidated. The Treuhand's mandate focused on maximizing competitiveness, based on the premise that maximizing productivity would ultimately also secure jobs and employment. In a framework with profit maximizing firms with heterogeneous productivity, these objectives are aligned since more productive firms will hire more workers (see Appendix B for a stylized conceptual framework). The value of privatizing a firm is therefore solely determined by initial productivity, regardless of how much weight the agency places on employment or firm profits.

Hence, our main hypothesis for an agency following its mandate is that the probability of privatization as opposed to liquidation should increase with productivity. In addition, we test whether productivity predicts, first, more favorable contracts with buyers of firms and, second, higher probabilities of post-privatization survival.

Our analysis combines parametric and non-parametric approaches. We begin our analysis of the privatization process by plotting the quantiles of the productivity distribution across firms against the outcomes of interest. This enables us to assess the relationship without relying on strong parametric assumptions.³ In the next stage, we estimate ordinary least squares regressions to condition on other regressors. In particular, we estimate models of the form

$$Y_i = \alpha + \gamma Productivity_i + \delta_s + \mu_l + \nu_t + \varepsilon_i \tag{1}$$

where Y_i denotes an outcome variable of firm *i* that is either the probability to be privatized, the time to privatization, privatization contract characteristics, or post-privatization survival. In addition to the intercept term α , we regress the firm outcome on a firm productivity measure with γ being our coefficient of interest. The regression further includes industry fixed effects δ_s at the three-digit level and state fixed effects μ_l (including East Berlin) in all base specifications to capture differences in privatization costs. Finally, survey fixed effects ν_t are dummies for the survey wave from which the productivity variables have been collected. They control for the measurement timing of these variables since they reflect macroeconomic and seasonal conditions, while also capturing survey-specific factors. We use robust standard errors throughout.

 $^{^{3}}$ Focusing on percentile ranks further offers a simple and effective safeguard against potential outliers and nonlinearities.

We assume that other factors that could confound our estimates can be captured using control variables. In robustness tests, we use alternative sets of controls: Firm employment size categories to capture differences in the privatization process for larger and smaller firms (e.g. related to union interests and political incentives), agency branch fixed effects to capture institutional confounders varying between Treuhand subsidiaries (e.g. related to bureaucratic capacity or conflicts of interest), regional fixed effects to control for spatial differences (e.g. related to agglomeration economies or political representation), and narrow (four-digit) industry fixed effects to capture sector-specific variation (e.g. related to technology or competitive pressure). Observables and unobservables not captured by these controls are assumed to vary randomly between firms.

4.2. Privatization Decisions.

4.2.1. The Role of Labor Productivity in Privatization Decisions. In this section, we analyze whether higher levels of initial labor productivity are associated with a higher probability of privatization, as opposed to liquidation. Then, focusing on the sample of privatized firms, we test whether more productive firms were privatized faster. We first summarize our findings graphically. The left-hand panel in Figure 3 presents the association between firms' percentile ranks in the overall labor productivity distribution and the share of privatized firms per rank. Figure 3 shows that higher initial productivity levels are associated with higher probability of privatization: Firms at the bottom of the labor productivity distribution were privatized at a rate of less than 40 percent, whereas firms at the top of the distribution experienced privatization rates of about 70 percent.

Conditional on privatization, the right-hand panel of Figure 3 presents a similar correlation between labor productivity and time until privatization. The least productive firms found an investor after 29 months, on average, whereas the most productive firms could expect privatization to take place within 24 months. These patterns suggest that initial productivity differences affected privatization.



Note: Left panel shows mean privatization shares by firms' percentile rank in the labor productivity distribution (N=6,190). Right panel depicts mean time to privatization by firms' percentile rank in the labor productivity distribution (N=4,076). This panel excludes liquidated firms. Rank coefficients are calculated using Hazen's rule. Smoothing procedure uses an Epanechnikov kernel function of degree zero. *Sources:* BvS Firm Register and THA Firm Surveys.

FIGURE 3. Privatization, Time to Privatization, and Baseline Productivity

One concern may be that these results reflect differences across industries. For instance, if investors were more interested in specific market segments than in generally productive firms. In Table 3 we therefore provide results of OLS regressions in which we control for industry fixed effects, state fixed effects, and survey-time fixed effects. Columns (1) and (2) show that the probability of privatization increases significantly in productivity, while columns (3) and (4) show that time until privatization (in months) is significantly lower for more productive firms.

Table C.2 (privatization probability) and Table C.3 (privatization timing) show that these results are robust to alternative specifications: Column (1) adds employment size dummies, column (2) limits the analysis to the subsample of manufacturing firms,

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	(1) Privatization	(2) n Probability	(3) Months to F	(4) Privatization
Log Revenue per Worker	0.076^{***} (0.007)		-1.161^{***} (0.266)	
Log Revenue per Hour	· · · ·	$\begin{array}{c} 0.074^{***} \\ (0.007) \end{array}$, , ,	-1.578^{***} (0.281)
Mean Y	0.68	0.68	26.36	26.36
R-squared	0.103	0.099	0.241	0.244
Observations	6,190	$6,\!190$	4,076	4,076

Notes.– Each column presents an OLS regression with industry FE (3-digit), state FE, and survey-time FE. The outcome variable for columns (1) and (2) is a dummy equaling 1 if a firm was privatized at the end of 1994 and 0 otherwise. For column (3) and (4) the outcome is the number of months until privatization, which is restricted to the set of privatized firms. Robust standard errors given in parentheses. * p < 0.1; ** p < 0.05; *** p < 0.01. Sources.– BvS Firm Register and THA Firm Surveys.

TABLE 3. Privatization, Time to Privatization and Productivity

column (3) uses gross value added as an alternative measure of productivity, column (4) adds fixed effects for the responsible Treuhand office (branch or headquarter) for each firm's privatization decision, column (5) adds district fixed effects, and column (6) adds more granular industry fixed effects at the four-digit level. None of these alternate specifications affect the results in a meaningful way. Table C.4 shows that results are robust to using a subsample of firms whose initial labor productivity was measured in the same year as, or before, the privatization decision. We re-aggregate firms to the GDR-combine level in Table C.5 and find the same results. Table C.6 shows that there is no significant decline in the privatization probability for firms with the highest initial productivity. In addition, Figure C.3 demonstrates, using a second degree polynomial of productivity, that any potential non-monotonicity is due to differences between sectors. Finally, we show that our results are robust to including fixed effects for the year in which the privatization decision was taken (Table C.7). The resulting OLS coefficient slightly decreases in magnitude, but remains highly significant.

4.2.2. The Role of Treuhand Policies in Privatization Decisions. To examine how the agency distinguished between productive and non-productive firms, we analyze

internal firm rating scores assigned to firms managed by the agency headquarters. Firms managed by the branch offices, typically smaller in size, did not receive standardized firm rating scores. These rating scores commonly determined whether a firm would retain continued financial support and privatization assistance. If these ratings reflected a screening mechanism, better scores would also predict higher privatization rates and shorter time to privatization.



Note: Left panel shows mean privatization shares by internal firm rating scores (N = 588). Right panel depicts mean time to privatization by internal firm rating scores, i.e. excluding liquidated firms (N = 377). Smoothing procedure uses an Epanechnikov kernel function of degree zero. The sample contains firms that were rated between July 1990 and June 1991. Sources: BvS Firm Register, THA Firm Surveys, and THA Firm Ratings.

FIGURE 4. Privatization, Time to Privatization, and Firm Rating Scores

Figure 4 presents the results. The left panel depicts firms' percentile ranks in the revenue per worker distribution for the subset of rated firms. The upward slope suggests that better internal rating scores go hand in hand with higher privatization shares. The best rating score is associated with privatization shares amounting to approximately 80 percent, whereas firms rated with the worst score were sold in

about half of the cases.⁴ The right panel shows that worst rated firms are on average privatized after almost 31 months, about five months later than firms with a top rating.

Next, we examine the relationship between rating scores and firm productivity. Appendix Figure C.2 illustrates the correlation between rating scores and labor productivity, confirming that higher levels of labor productivity are associated with better ratings (better ratings are coded as lower values). Table 4 reports OLS coefficients predicting rated firms' privatization probability using both productivity and ratings. Column (1) shows that higher initial productivity significantly predicts higher privatization probabilities. Column (2) shows that lowering a firm's rating by one grade is associated with an 9.4 percentage point decrease in its privatization probability. Column (3) reports OLS estimates including both productivity and ratings. While the OLS coefficient on initial productivity is positive, it is smaller than in column (1) (0.041 vs. 0.056) and decreases in significance. The coefficient on rating scores decreases only slightly in magnitude and remains highly significant, suggesting that ratings likely contained additional information on firms' prospects beyond initial productivity.⁵

An alternative explanation for correlation between firm ratings and privatization outcomes is that ratings express the Treuhand's assessment of private sector demand for firms, rather than firm quality per se. To rule out this alternative mechanism, we investigate the role of investor demand using industry-level data (Figure C.4). The results suggest that (i) initial investor inquiries for Treuhand firms are not significantly associated with initial productivity, and (ii) investor inquiries are not

⁴The fact that every second firm with the worst score was not liquidated could be seen from different perspectives. The share could considered as high with the argument that the worst rating was labelled with the recommendation to liquidate the firm by external accounting experts. It could also be considered as low, given the depth of fundamental uncertainties inherent in investing in the economy in Germany's East as argued by Demougin and Sinn (1994). Our approach conducts a relatively minimal test, on whether the ranking system was implemented or not at all ($\beta = 0$).

⁵As we show in Table C.10, we find similar patterns when we study the relationship between survival, productivity, and ratings. Better rating scores predict significantly better survival prospects, while productivity is insignificant conditional on rating scores.

	(1)	(2)	(3)
	Priva	atization Proba	bility
Log Revenue per Worker	0.056^{**}		0.041*
	(0.023)		(0.022)
Rating $(1=best, 6=worst)$		-0.094***	-0.088***
		(0.018)	(0.018)
Mean Y	0.65	0.65	0.65
R-squared	0.167	0.199	0.204
Observations	588	588	588

Notes.– Each column presents an OLS regression with industry FE (3-digit), state FE, and survey-time FE. The outcome variable for columns (1), (2) and (3) is a dummy equaling 1 if a firm was privatized at the end of 1994 and 0 otherwise. Robust standard errors given in parentheses. * p < 0.1; ** p < 0.05; *** p < 0.01.

Sources.- BvS Firm Register and THA Firm Surveys.

TABLE 4. Privatization, and Productivity and Ratings

sectors. Overall, these results suggest that the agency relied on the screening by experts to implement its mandate.

4.3. Privatization Conditions. In this section, we examine whether the Treuhand achieved more favorable privatization contracts for firms with higher levels of initial labor productivity. Figure 5 plots sales prices, job guarantees, and investment promises against percentiles of labor productivity. We observe upward sloping curves across all outcomes in privatization contracts with increasing labor productivity. More favorable contract patterns are associated with more productive firms. Both measures of labor productivity exhibit similar patterns.

To account for potential confounding factors, we regress each contract criterion separately on labor productivity as well as state, industry (3-digits), and survey-time fixed effects. Columns (1) and (2) in Table 5 suggest that a 10% increase in our measures of initial productivity is associated with increases in sales prices by on average 5.6%, and 4.8%, respectively. One standard deviation in log productivity is associated with increases by 50.0% and 40.0% respectively. Hence, the Treuhand was more likely to sell productive firms at higher prices as opposed to less productive firms. This correlation is robust when controlling for variation across survey-times, states,



Note: The panels show on the vertical axis the logarithm of positive values of, left positive sales prices, middle employment guarantees and right investment guarantees. The horizontal axis in all panels shows percentile ranks of firms in the labor productivity distribution. Rank coefficients calculated using Hazen's rule. Smoothing procedure uses an Epanechnikov kernel function of degree zero. N = 2020. *Sources:* THA Firm Surveys, THA Contract Data and own calculations.

FIGURE 5. Sales Prices, Employment and Investment Guarantees, and Productivity

and industries. The elasticity of employment guarantees with respect to productivity in columns (3) and (4) is estimated to be 0.15 and 0.13, respectively. In standard deviations, the associated increases are by 13.1% and 11.1%. Investment guarantees in columns (5) and (6) increase by 1.3% on average when firm productivity increases by 10%. When expressed in standard deviations, the increases in investment pledges are 11.8% and 10.7%.

Table C.11 (for sales prices), Table C.12 (for employment pledges), and Table C.13 (for investment pledges) show that these results are robust to alternative specifications: Column (1) adds employment size dummies, column (2) limits the analysis to the subsample of manufacturing firms, column (3) uses gross value added as an alternative measure of productivity, column (4) adds fixed effects for the responsible Treuhand office (branch or headquarter) for each firm's privatization decision, column (5) adds

	Log	Price	Log Empl	oyment Pledge	Log Inves	tment Pledge
	(1)	(2)	(3)	(4)	(5)	(6)
Log Rev. per Worker	0.562^{***} (0.131)		0.148^{***} (0.041)		0.133^{**} (0.057)	
Log Rev. per Hour		$\begin{array}{c} 0.479^{***} \\ (0.133) \end{array}$	`` ,	$\begin{array}{c} 0.133^{***} \\ (0.042) \end{array}$	`` ,	0.127^{**} (0.059)
Mean Y N	$10.78 \\ 2,020$	$10.78 \\ 2,020$	$3.67 \\ 2,020$	$3.67 \\ 2,020$	$13.59 \\ 2,020$	$13.59 \\ 2,020$

Notes.- * p < 0.1; ** p < 0.05; *** p < 0.01. Each column presents average marginal effects from linear regression models with survey-time FE, industry FE (3-digit), and state FE. The outcome variables are log sales price (column 1 & 2), log guaranteed number of employees (column 3 & 4) and log contractual investment pledge (column 5 & 6). Robust standard errors given in parentheses.

TABLE 5. Contractual Outcomes and Productivity

district fixed effects, and column (6) adds more granular industry fixed effects at the four-digit level. None of these alternate specifications affect the results in a meaningful manner. As a particular concern, anecdotal evidence hints at undervalued insider sales in the Treuhand's Halle branch office (Renken and Jenke, 2001). Results in Table C.11 show that the correlation between productive efficiency and sales prices holds within local branches across the entire sample. Table C.14 interacts privatization with a decentralization dummy suggesting there was no significant difference in the productivity slope with respect to contract outcomes. In summary, contract outcomes become more favorable for the agency with increasing labor productivity. A limitation of our approach is that we are not able to disentangle the role of the privatization agency from the valuation of buyers.

4.4. Post-Privatization Firm Ownership. In this section, we analyze which new owners privatized firms were sold to. Specifically, we test whether new ultimate owners were more likely to come from East or West Germany.

To begin, we look at the distribution of ownership for firms privatized by the Treuhand. Figure 6 plots majority ownership at the end of official Treuhand activities in 1995.

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Note: Shares of privatized firms with a majority of ultimate owners from East Germany/West Germany/Outside of Germany in 1995. Unweighted, weighted by initial revenue, and weighted by initial employment. N = 2,566. Sources: BvS Firm Register and MUP Firm Register.

FIGURE 6. Majority Ultimate Ownership distribution of privatized firms in 1995

The figure displays a measure of majority ownership based on the absolute number of shareholdings.⁶

The mean values depicted in Figure 6 document a prevalence of West German ownership in Treuhand firms. 45.2 percent of privatized Treuhand firms are majority-owned by West German investors. When firms are weighted by their initial employment and revenue, the share of West German majority ownership rises to 55.8 percent and 59.7 percent, respectively. These results support the notion that most East German firms ended up in West German ownership. In particular, the results using employment and revenue weights imply that this trend is more pronounced for larger firms. In Table C.15, we include ownership into the regressions of contractual outcomes on labor productivity from the previous section. Holding productivity constant, contracts for West German buyers featured higher sales prices, employment

⁶Majority ownership is attributed to West German or international owners if they represent, or are tied for, the largest group of ultimate owners. Majority shareholdings based in the reunified Federal State of Berlin are attributed to East Germany.

guarantees and investment guarantees than East German buyers. These correlations point to several different interpretations. First, assuming future revenue streams are a function of productivity, West Germans likely had better access to credit which made it possible for them to purchase firms at lower borrowing cost. Second, West German corporate buyers might have been able to create more value due to better management practices, market knowledge or vertical integration, increasing their valuation of target companies and resulting in higher bids.⁷ Third, West German investors may have had better institutional knowledge and connections. We do not find evidence that West German buyers might have been offered more favorable conditions by the agency.⁸

Given the overall distribution of post-Treuhand firm ownership, we now investigate which types of firms were most likely to end up in East German respectively West German ownership. In particular, we study how majority ownership varies depending on firm-level productivity. As before, we focus on initial labor productivity as an indicator of firm efficiency and quality. Figure 7 displays percentile rank plots for East and West German majority ownership across the productivity distribution of privatized firms. The plots illustrate that most variation in majority ownership occurs in the upper half of the productivity distribution. Neither East nor West German majority ownership strongly correlates with productivity below the 60th productivity percentile. However, noticeable divergence emerges above the 60th percentile. West German ownership is positively correlated with productivity, while East German ownership suggests a negative correlation for these firms.

We complement this graphical summary of our results with a regression analysis in Table 6. Here, we regress binary indicators of majority ownership from East Germany, West Germany, and outside Germany on measures of initial firm productivity and

⁷See Giorcelli (2019) for a study illustrating the long-lasting benefit of management training on firms, using historic variation in management training in Italian firms after World War II.

⁸Conditional on initial firm productivity, there are no significant differences in the cash price East and West Germans paid for privatization objects. West German investors, however, committed significantly higher investment and employment guarantees for firms of average productivity (Table C.15).



Revenue per Worker – Revenue per Hour

Note: Share of privatized firms with a majority of ultimate owners based in West (East) Germany in 1995. Rank coefficients calculated using Hazen's rule. Smoothing procedure uses an Epanechnikov kernel function of degree zero. Firms with international majority ownership are not depicted (6.7% of privatized firms). N = 2,566.

Sources: BvS Firm Register, Treuhand Firm Surveys, and MUP Firm Register.

FIGURE 7. Majority Ultimate Ownership by Initial Productivity (Privatized Firms)

several controls. The results emphasize the heterogeneity in ownership outcomes across the productivity distribution. We find significant correlations for both East and West German ownership. East German majority ownership significantly decreases in firm productivity, while West German majority ownership significantly increases with productivity. An increase in log productivity by one standard deviation is associated with an increase of 2.0 to 3.1 percentage points in West German majority ownership.

We test the robustness of our findings by employing a number of alternative specifications, documented in Tables C.16 to C.21. Table C.24 repeats the analysis using a multinomial logit model. Our results remain fundamentally unchanged when using firm-size controls, when using 4-digit instead of 3-digit industry codes, and when using gross value added as an alternative measure of initial productivity. When limiting the sample of firms to the manufacturing sector and using district

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	East Ownership		West Ov	wnership
	(1)	(2)	(3)	(4)
Revenue per Worker	-0.028^{**} (0.012)		0.021^{*} (0.012)	
Revenue per Hour		-0.041^{***} (0.012)		0.035^{***} (0.013)
Number of Owners	$\begin{array}{c} 0.015^{***} \\ (0.002) \end{array}$	$\begin{array}{c} 0.015^{***} \\ (0.002) \end{array}$	-0.013^{***} (0.002)	-0.013^{***} (0.002)
Mean Y Observations R-squared	$0.480 \\ 2,566 \\ 0.067$	$0.480 \\ 2,566 \\ 0.069$	$0.452 \\ 2,566 \\ 0.053$	$0.452 \\ 2,566 \\ 0.054$

Note: Table 6 reports results from regressing indicators for West German and East German majority ultimate firm ownership on log initial (pre-privatization) productivity with survey-time FE, industry FE (3-digit), and state FE. International ownership is the omitted category. Ownership indicators measure whether a majority of owners were based in the respective geography in 1995. The sample encompasses only privatized firms. Robust standard errors in parentheses. *** p < 0.01 ** p < 0.05 * p < 0.1 Sources: BvS Firm Register, Treuhand Firm Surveys, and MUP Firm Register.

TABLE 6. Majority Ultimate Ownership by Initial Productivity for Privatized Firms

or Treuhand local-branches instead of state-level fixed-effects, our results are less precisely estimated when measuring productivity as revenue per worker.

In summary, we observe that West Germans acquired a substantial share of formerly state-owned firms in East Germany, especially larger and initially more productive firms.

4.5. Post-Privatization Firm Success. In this section, we investigate short- and long-term firm survival to assess how initial productivity and post-privatization ownership relate to firm success.

Figure 8 displays measures of privatized firms' success over time. The panel on the left depicts post-Treuhand survival rates plotted against the respective firms' percentile rank of initial productivity. The panel on the right depicts privatized firms employment over time relative to their initial employment level, plotted against productivity percentile ranks. Both series are measured five, ten, 15 and 20 years after the end of the privatization program.



Note: Left: Survival rates calculated as the percentage of firms still active 5, 10, 15, and 20 years after the dissolution of the Treuhandanstalt. Right: Current employment as share of initial employment, measured 5, 10, 15 and 20 years after the dissolution of the Treuhandanstalt. Non-survivors' employment is coded to zero for all years following their exit from the market. Rank coefficients calculated using Hazen's rule. Smoothing procedure uses an Epanechnikov kernel function of degree zero. N = 2,566. Sources: BvS Firm Register, Treuhand Firm Surveys, and MUP Firm Register.

FIGURE 8. Firm Success by Initial Productivity (Privatized Firms)

While there are notable level shifts in survival rates affecting the entire productivity distribution, we observe a similar trend across the four points in time considered. Firms that are more productive are more likely to survive and continue operations. Nonetheless, we observe a considerable amount of attrition. Even among the most productive firms, four in ten businesses are no longer operating after 15 or 20 years. As we show for a subset of these firms in Figure D.1 in Appendix D, privatized firms' survival rates generally fall below the survival rates of comparable firms in West Germany. However, the firms with the highest levels of initial productivity actually display survival rates on par with comparable West German firms, even slightly exceeding these for extended time horizons. Analyzing privatized firms' employment over time reveals a similar pattern. There are some level shifts across time, yet all four series follow a similar trend across the productivity distribution. Relative to

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their pre-privatization employment, firms with higher levels of initial productivity employ more staff after privatization than those with lower initial productivity levels. While average rates of current to initial employment increase in productivity for the entire set of firms considered, the difference is even more pronounced for firms ranking in the top quartile of the productivity distribution. These firms show considerably higher rates of current to initial employment than lower ranking ones, even though relative employment rates reach a plateau or even decline again for fifteen and twenty year measurements. Figure 8 highlights the magnitude of employment reduction at privatized firms. While employment reduction is lower at initially highly productive firms, within 5 years even the most productive firms had their work force reduced to less than 60% of pre-privatization levels. These results highlight two important observations: First, the transformation of East Germany's economy continued after the official conclusion of privatization activities in 1994. Second, higher levels of initial productivity predict better firm-level outcomes even conditional on privatization.

We analyze the relationship between ownership and survival in Table 7. We use ordinary least squares regressions of survival indicators to assess the correlation between specific ownership types and survival rates controlling for initial firm productivity. We do not find a significant association of West German majority ownership and five-year survival rates for privatized firms. However, West German ownership predicts higher survival rates over the ten, 15 and 20-year time frames. These point estimates are increasing as the time horizon widens. For all time frames, we find that firms with higher initial productivity have greater rates of survival. We also find a positive relationship between international ultimate ownership and firm survival, albeit only for time horizons of 15 years and longer. The negative interaction effect between West German and international ownership suggests that these different ownership traits are substitutes rather than complements. Table C.22 in the appendix confirms these results for using revenue per hour as our measure of productivity.

In Table 8, we further analyze the relationship between initial firm productivity, postprivatization ownership, and firms' long-term rate of current to initial employment.

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	5y Survival	10y Survival	15y Survival	20y Survival
	(1)	(2)	(3)	(4)
Majority West Ownership	0.009	0.042**	0.070***	0.086***
	(0.020)	(0.021)	(0.021)	(0.021)
Any Int'l Ownership	0.004	0.050	0.067^{*}	0.078^{**}
	(0.033)	(0.035)	(0.036)	(0.035)
Majority West & Any Int'l Ownership	-0.048	-0.093	-0.134*	-0.145**
	(0.072)	(0.074)	(0.074)	(0.073)
Number of Owners	0.000	-0.000	-0.002	-0.002
	(0.002)	(0.002)	(0.002)	(0.002)
Initial Revenue per Worker	0.024**	0.038***	0.036***	0.039***
-	(0.011)	(0.011)	(0.011)	(0.011)
Mean Y	0.685	0.574	0.521	0.494
Observations	2,566	2,566	2,566	2,566
R-squared	0.043	0.058	0.060	0.065

Note: Table 7 reports results from regressing indicators for 5, 10, 15, and 20-year survival of privatized firms on majority ultimate ownership indicators, log initial (pre-privatization) productivity, and additional controls with survey-time FE, industry FE (3-digit), and state FE. Ownership indicators measure whether a majority of ultimate owners was based in the respective geography in 1995. The sample encompasses only privatized firms. Robust standard errors are in parentheses. *** p < 0.01 ** p < 0.05 * p < 0.1

 TABLE 7. Majority Ultimate Ownership, Initial Revenue per Worker and Firm

 Survival

Ordinary least squares regressions show no significant association between West German majority ownership and employment rates for privatized firms. However, we find that firms with higher initial productivity have significantly higher rates of current to initial employment for all four time horizons. Table C.23 in the Appendix repeats these analyses and confirms our results using revenue per hour as measure of productivity.

The positive correlation between West German majority ownership and subsequent firm survival may in part be explained by higher shares of corporate investors (rather than natural persons) among West German owners: 60.7% of West German ultimate owners are corporate investors, compared with 32.2% of East German owners. Integration into existing corporations may have considerable advantages for privatized firms. For instance, the firms likely benefit from the corporate investors' executive capabilities and may have greater access to financial resources, all of which may positively contribute to the firms' post-privatization performance. In addition,

	5y Employment (1)	10y Employment (2)	15y Employment (3)	20y Employment (4)
Majority West Ownership	-0.021	0.013	0.046	0.057
	(0.041)	(0.043)	(0.044)	(0.047)
Any Int'l Ownership	-0.116***	-0.045	-0.022	0.015
	(0.042)	(0.043)	(0.044)	(0.053)
Majority West & Any Int'l Ownership	0.011	-0.042	-0.079	-0.087
	(0.074)	(0.079)	(0.081)	(0.105)
Number of Owners	0.003	0.000	0.001	0.001
	(0.003)	(0.003)	(0.003)	(0.003)
Initial Revenue per Worker	0.083***	0.054^{***}	0.039**	0.044^{***}
	(0.019)	(0.018)	(0.016)	(0.016)
Mean Y	0.341	0.256	0.232	0.221
Observations	2,167	2,050	2,012	1,985
R-squared	0.062	0.046	0.040	0.038

Note: Table 8 reports results from regressing privatized firms' rate of current to initial employment measured 5, 10, 15, and 20 years after the dissolution of the Treuhand on majority ultimate ownership indicators, log initial (pre-privatization) productivity, and additional controls with survey-time FE, industry FE (3-digit), and state FE. Ownership indicators measure whether a majority of ultimate owners was based in the respective geography in 1995. The sample encompasses only privatized firms. Non-survivors are coded to zero employment for all years after they have exited the market. For years in which individual firms' post-privatization employment levels cannot be observed, we impute these values by taking averages of non-missing employment counts within two years of the missing observation. When imputation is not possible, the respective firm-years are omitted from the sample. We further remove ten firms that are listed at an initial employment of zero. Robust standard errors are in parentheses. *** p < 0.01 ** p < 0.05 * p < 0.1

TABLE 8. Majority Ultimate Ownership, Initial Revenue per Worker and Firms' Long-Term Employment Rates

if corporate investors benefit from advantageous access to financial capital, they may have also enjoyed such benefits in acquiring firms from the Treuhand to begin with.

The positive correlation between West German ownership and survival is consistent with economic benefits of foreign ownership. One explanation for the higher survival rates of firms with West German majority ownership may be the differences in market knowledge or managers' human capital (Rosen, 1992; Barberis, Boycko, Shleifer, and Tsukanova, 1996). However, survival also appears to be closely linked to initial firm productivity: Higher survival rates under West German ownership may in part be explained by West German ownership being more common among to the most productive firms. The finding that productivity is an important driver of long-term firm survival after privatization also corroborates the importance of the privatization agency's screening function for the success of privatization programs. That said, it should be noted that survival rates may overestimate the number of firms still operating at a given point in time. Survival is a lagging indicator of firm success as, for instance, de-registration from the trade register only takes effect after a firm has ceased to operate.

5. Benchmarking the Treuhand's Performance with Simulated Counterfactuals

In this section, we examine the Treuhand's privatization decisions relative to potentially available alternatives to provide a back-of-the-envelope assessment of the agency's performance. This allows us to analyze the degree to which the Treuhand was able to select the *right* firms for privatization from its portfolio. The Treuhand faced a task common to industrial policy settings: selecting a set of firms from a large portfolio of candidates for the allocation of limited resources. We use a machine learning approach to compare the Treuhand's actual choice with hypothetical choice sets of firms and benchmark the actual privatization program's outcomes against these counterfactual scenarios.

We rely on predictive modeling to assess whether firms liquidated by the Treuhand could have been operating successfully if they had been privatized instead. To predict these firms' counterfactual outcomes, we train a random forest algorithm on available pre-privatization characteristics which were observable to the privatization agency.

For model optimization, we split our data into a training data set (80 percent of observations) and a test data set (20 percent). After optimizing model performance on the test data, we then train this model on all privatized firms and predict counterfactual outcomes for firms that were liquidated. For additional detail on the modeling process and predictive performance refer to Appendix F. In the Appendix, we also provide an alternative approach that employs a more flexible neural network algorithm to assess the robustness of our predictions.

We select average firm survival as performance criterion for our benchmark analysis. Survival is credibly related to competitive market performance and, unlike other performance measures, is broadly comparable across industries and geographies without further normalization. Moreover, firm survival and continued economic activity constitute relevant policy targets for the privatization agency.

In addition, we report the initial employment levels of surviving firms.⁹ We evaluate average survival over a ten-year time frame. This time horizon provides a compromise between being early enough to be considered (and affected) by the Treuhand's decisionmaking and being late enough to capture meaningful differences in the firms' ability to survive in a competitive market. Our analysis proceeds as follows: To begin, we compute average survival, predicted survival and initial employment for the firms actually selected for privatization. In the relevant sample, 65.77 percent of eligible firms were privatized by the Treuhand. We use this percentage as our measure of how constrained the Treuhand was in its privatization priorities. Adopting this constraint in the construction of counterfactual privatization scenarios implicitly assumes that the allocation of resources necessary for privatization is constant across all firms, irrespective of whether they were actually privatized or liquidated. For the validity of our back-of-the-envelope comparisons, it is further crucial that the Treuhand indeed had to choose how to allocate limited resources. We assume that failed privatizations were not solely the consequence of lack of interest among investors, but the result of the privatization agency not being able to dedicate the necessary resources to achieve successful privatization.¹⁰

⁹We use initial employment of surviving firms as an additional benchmark indicator as it is observable for both privatized and liquidated firms. For later years, the availability of employment figures is conditional on the actual privatization status of a firm such that counterfactual post-privatization employment figures cannot be attained.

¹⁰While the federal budget would absorb a large amount of the financial privatization cost, there was short supply of time, personnel, investor contacts and political goodwill from West Germany. As such, using resources effectively and finding the right priorities for firm privatization were imperatives shaping the privatization process. We find further support for this assumption in the Treuhand's timing of liquidations. The end of Treuhand operations in 1994 coincides with a significant spike in the number of firm liquidations. While these firms had been maintained in the Treuhand's portfolio at the expense of public funds, they eventually had to be liquidated because time available to privatize them literally ran out. Similarly, parliamentary inquiries into

Based on our predictive model, we construct a best-case scenario. To derive an upper bound for privatization in East Germany, we sort firms by their predicted survival probability. The top 65.77 percent of this sorting form the set of best candidates for privatization based on our ex-post machine learning approach. Similarly, the lowest 65.77 percent of these firms offer us a worst-case scenario of what performance could have looked like if the firms with the lowest probability of surviving in a competitive market would have been selected for privatization. Lastly, we sort firms by their initial productivity and again compute performance benchmarks for the top 65.77 percent of firms. This intermediate scenario represents a decision rule focusing on observable labor productivity to guide the selection of firms for privatization.

Firms Selected for Privatization	Actual Allocation		Simulated Counterfactual		
	Firm	Survivors'	Firm	Survivors'	Share of
	Survival	Initial	Survival	Initial	Best
	Share	Employ-	Share	Employ-	Firms
		ment		ment	Selected
Actual Treuhand	0.668	933,076	0.713	1,001,769	0.699
Selection					
Scenario 1: Worst			0.555	753,536	0.479
Candidates			0 717	206 621	0 609
Productivity Sorting			0.717	890,081	0.092
(Rev./Worker)					
Scenario 3:			0.720	$1,\!056,\!530$	0.675
Productivity Sorting					
(Rev./Hour)					
Scenario 4: Best			0.967	$1,\!323,\!104$	1.000
Candidates					

Note: Table 9 reports average 10 year survival rates for factual and counterfactual privatization scenarios as well as initial employment figures related to the surviving firms. Survival rates are calculated as averages over the selected set of firms using a composite indicator that combines actual survival for firms that were privatized by the Treuhand with predicted survival for firms that were liquidated by the Treuhand. *Sources:* BvS Firm Register, Treuhand Firm Surveys, and MUP Firm Register.

TABLE 9. Benchmarks: 10 Year Survival & Employment

the Treuhand's privatization activities documented additional constraints, including the agency's inability to find sufficient numbers of experienced liquidators to staff its regional branch offices.
Table 9 summarizes average privatization performance across the different factual and counterfactual scenarios. Of the firms that were actually selected for privatization, 66.8 percent are still operating after ten years. Our machine learning model predicts survival for 71.3 percent of these firms.

These surviving firms accounted for almost a million jobs initially. For comparison, the set of worst privatization candidates in Scenario 1 only reach a counterfactual survival rate of 55.5 percent. The surviving firms among these further account for significantly fewer initial jobs. However, the actual privatization performance also clearly falls short of the simulated counterfactual performance achievable for the set of best privatization candidates in Scenario 4. The firms with the highest predicted survival probability are forecast to survive for at least ten years in 96.7 percent of cases. They account for more than 1.3 million initial jobs. Strikingly, the results in Table 9 seem to corroborate our findings showing that the Treuhand seemingly prioritized firms in line with sorting on initial firm-level productivity in Scenario 3. Productivity sorting yields a predicted survival rate of 71.7 percent. This survival rate is on par with the survival rate predicted for the Treuhand's actual selection of firms. However, the firms actually selected for privatization account for more initial employment than the firms that would be selected by mere productivity sorting (Scenario 2). The last column in Table 9 reports which share of the firms selected in our best-case simulation have been selected in the respective scenario. Similarly, the results emphasize that the actual Treuhand selection is relatively close to a selection based on productivity-sorting. The worst-case scenario selects less than half of the firms predicted to have the highest survival probability.

Overall, comparing the Treuhand's performance to simulated counterfactual outcomes suggests that the privatization agency avoided the counterfactual worst-case scenario but also fell short of reaching counterfactual best-case outcomes. Both in terms of surviving firms and initial employment preserved, the Treuhand's decision-making comes closest to sorting by the observable initial productivity of firms in its portfolio. In Figures 9 and 10, we augment our analysis by repeating this exercise separately for



Note: Mean 10 year survival rates for factual (left hand panel) and counterfactual (right hand panel) privatization scenarios. HQ firms are privatization objects centrally handled by the Treuhand headquarter in Berlin. Non-HQ firms are privatization objects handled by the Treuhand's 15 regional subsidiaries. Survival rates are calculated as averages over the selected set of firms using a composite indicator that combines actual survival for firms that were privatized by the Treuhand with predicted survival for firms that were liquidated by the Treuhand. Figure 9 includes 95% confidence intervals for average survival in each scenario. *Sources:* BvS Firm Register, Treuhand Firm Surveys, and MUP Firm Register.

FIGURE 9. Benchmarks: Ten Year Survival by Treuhand Entity

firms that were managed by the Treuhand headquarters in Berlin and those managed by the 15 local Treuhand branches. Arguably, the Treuhand headquarters had greater access to financial resources for managing privatizations effectively. The Treuhand headquarters may also have had better access to information on firms, their business model, and future prospects. In particular, firm ratings as analyzed in Section 4.2.2 were only prepared for firms managed by the Treuhand headquarters. With these additional resources, the Treuhand headquarters may have been more effective at screening firms and, as a result, making informed privatization decisions. While the availability of resources should be an important determinant of privatization success, comparing firms managed at the Treuhand headquarters with those managed locally



Note: Sum of initial employment for 10 year survivor firms in factual (left hand panel) and counterfactual (right hand panel) privatization scenarios. Initial employment is added up for all firms that in Table 9 and Figure 9 are designated as survivors in the respective privatization scenario. HQ firms are privatization objects centrally handled by the Treuhand headquarter in Berlin. Non-HQ firms are privatization objects handled by the Treuhand's 15 regional subsidiaries.

Sources: BvS Firm Register, Treuhand Firm Surveys, and MUP Firm Register.

FIGURE 10. Benchmarks: Initial Employment of Survivors by Treuhand Entity

can be challenging if privatization success is a function of firm size. As firms were assigned to the headquarters based on a size cutoff, this sorting could then induce correlation mechanically. Although there will still be meaningful variation in firm size due to the plentitude of exceptions to the size cutoff, these results should be interpreted cautiously.

Figure 9 confirms that firms privatized by the Treuhand headquarters have significantly higher average survival rates than firms that were privatized by local Treuhand branches. This performance gap also exists in a counterfactual scenario where privatizations are decided based on simple positive productivity sorting, albeit to a considerably smaller extent. Tentatively, this suggests that the Treuhand headquarters outperformed the local branches. That said, this difference may also result from higher firm 'quality' in the headquarters' portfolio. Other potential explanations could be the personnel in the branch offices, and its selection or connections. Comparing privatization performance based on initial employment differences between actual and simulated survivors in Figure 10 further emphasizes this point. In particular, the Treuhand headquarters seems to outperform productivity sorting with its actual allocation while the local branches do not.

Our simulation of counterfactual privatization selection using the best and worst privatization candidates provides objective bounds to the Treuhand's potential performance. It is worth emphasizing that we exploit knowledge about the actual survival of firms to derive these performance bounds. This information was not available to the Treuhand ex-ante and the agency instead faced considerable amounts of uncertainty about firms' economic prospects. Similarly, many of the Treuhand's decision-making constraints - in particular with regards to limited amount of time available to conclude privatizations - may have finally stood in the way of achieving even better results. This finding is further emphasized by the contrast in privatization performance between the Treuhand headquarters and local branch offices.

6. Conclusion

This paper provides the first comprehensive analysis of privatization in East Germany, arguably the most radical privatization program in history and described as the "fire sale of the century" (Eisenhammer, 1995). By combining the universe of firms from administrative data with firm surveys and archival data, we are able to assess the representativeness of samples of East German firms and trace them from the beginning of the privatization process until two decades later. Adopting this long-term view of the privatization program and its consequences allows us to investigate the footprint of the Treuhand's actions on the development of the East German economy.

We provide an empirical assessment of the Treuhand's implementation of its industrial policy mandate. Our results show that firms with higher productivity were more likely to be privatized, privatized faster, and sold at higher prices. We also document that the Treuhand assigned higher quality ratings to firms that were more productive. In addition to documenting the privatization process, we study short- and long-term privatization outcomes. We find that more productive firms were more likely to be privatized to non-local owners, especially from West Germany. Firms with higher productivity also display higher survival rates on average. Over a time horizon of ten years or more, we find that firms sold to new owners from West Germany have higher survival rates even after conditioning on baseline productivity. Based on a comparison with simulated counterfactuals, we find that – with regards to the aggregate survival rate – the Treuhand's set of firms chosen for privatization is comparable to a selection on productivity.

Which broader lessons for the implementation of industrial and privatization policies can the Treuhand privatizations offer? First, a key feature of the institutional set-up in East Germany was the committee of financial experts located at the Treuhand headquarter. This committee screened firms systematically and provided guidance on privatization decisions. Our results confirm that privatization decisions were on average aligned with the recommendations of the committee. We conclude that the Treuhand followed a simple economic logic and privatized companies as a function of competitiveness, a development which was aided by the standardized expert ratings. Second, the high number of liquidations during the transition might have contributed to a temporary drop in output, but raised average labor productivity in the short run. Privatized firms with higher initial productivity levels survived longer after privatization. Third, privatization through direct sales, rather than auctions or other sales methods, granted the Treuhand high levels of control over whom to sell firms to. Based on low levels of East German ownership, it seems unlikely that former East German regime insiders benefited directly from gaining control over privatized firms. Our results also point to open questions for future research on the implementation

of industrial policy, in particular relating to the medium- and long-run impacts of active policy programs. While investors generally fulfilled their employment pledges upon the end of the program in 1994 (Deutscher Bundestag, 1994), we document considerable variation in firm's survival and employment rates in subsequent years. Understanding the drivers behind this variation in *post-program* performance will have important implications for policy design and implementation.

In East Germany, public discontent about the privatization program still looms large even thirty five years after reunification. The stylized facts we provide in this paper might point to several explanations. First, the level of firm ownership remaining in East German control was low. Large segments of the population did not benefit from privatization by becoming owners themselves (Boycko, Shleifer, and Vishny, 1994). This finding contrasts anecdotal evidence suggesting that the Treuhand was aware of these concerns and attempted to foster East German ownership. In March 1991, the Treuhand launched a program called "Mittelstandsoffensive" designed to include East German managers and employees in management-buyout privatizations. The agency's failure to preserve the "East German identity" of privatization targets may have contributed to the program's low public support among East Germans. Second, roughly a third of firms were shut down by the agency and almost half of privatized firms closed within two decades. Considering the difficulty of picking future winners in an uncertain competitive market environment, the immense speed of transition might be put into question. Third, the political strategy of "reconciliation through secrecy" was incapable of preventing divisions in society (Hoffmann, 2020). More transparent communication, coupled with thorough evaluation, could have spared misguided expectations and subsequent disappointments. Our results highlight the importance of the Treuhand legacy for the transformation of East Germany's economy.

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APPENDIX (For Online Publication)

Appendix A. The Government Agency's Mandate

The "Treuhandgesetz" (eng: Treuhand law) was enacted in July 1990 by the last East German government (Treuhandgesetz, 1990). The law was written in the context of the state treaty between East and West Germany in May that paved the way to German reunification. With the enactment of the law, the Treuhand took over the full ownership of all East German state-owned companies. The oversight of the agency moved from the East German executive branch ("Ministerrat") to the German ministry of Finance ("Bundesfinanzministerium") with German reunification in October 1990.

The Treuhand law's preamble defines the objectives of the Treuhand:

- Reduce the entrepreneurial activity of the state through privatization as quickly and as far as possible

- Enable as many companies as possible to become competitive and thus secure jobs and create new ones

- Make land available for economic purposes

§ 8 defines the Treuhand's key tasks:

(1) The Treuhand shall, with the assistance of management consulting companies as well as banks and other suitable enterprises, ensure that the following tasks are performed in an entrepreneurial and largely decentralized manner:

- Privatization through the sale of shares or assets,
- Ensuring the efficiency and competitiveness of companies,

- Closure and utilization of the assets of companies or parts of companies that cannot be restructured. While the Treuhand law sets explicit goals on speed (as quickly as possible), scale (as extensively as possible), and prioritization (competitive and efficient firms) of privatizations, the mandate did not impose constraints on the selection of buyers (aside from that they should be private investors) or other targets.

Appendix B. A Discrete Choice Framework of Privatization and Liquidation

We present a simple framework of a privatization agency choosing winners for privatization and losers for liquidation. The objective function of the agency is modeled on its government mandate (see Section A). We derive testable conditions from the model with the aim to evaluate the agency's empirically observed decision. The government agency owns N firms and faces the choice between selling each firm i to a new private owner, constrained by privatization costs, or closing the firm. Firms operate in perfectly competitive markets in which we normalize prices to one without loss of generality. The production technology of firms features decreasing returns to scale $\alpha < 1$ with initial productivity under government ownership ϕ_i that varies across firms. Firms maximize profits by hiring workers l_i paying a wage rate w and fixed costs f

$$\max_{l_i} \pi(\phi_i, l_i) = \max_{l_i} \phi_i l_i^{\alpha} - w l_i - f.$$
(2)

Setting the first order condition equal to zero, we obtain the following optimal level of labor input and corresponding profits

$$l_i^*(\phi_i) = \left(\frac{\alpha}{w}\phi_i\right)^{\frac{1}{1-\alpha}} \quad \pi^*(\phi_i) = \phi_i^{\frac{1}{1-\alpha}} \left(\left(\frac{\alpha}{w}\right)^{\frac{\alpha}{1-\alpha}} - w\left(\frac{\alpha}{w}\right)^{\frac{1}{1-\alpha}}\right) - f = \phi_i^{\frac{1}{1-\alpha}}\gamma - f \quad (3)$$

The government agency takes profit maximization by firms as given. The agency's objective function is assumed to be decomposable into social value from observed factors V_i and unobserved factors ϵ_i . The observed value of privatization of company i to the agency consists of several gains and losses. First, a welfare gain from the

sale of firm *i*, equal to a fraction *s* of profits π^* that the agency is able to obtain in sales negotiations from the acquirer. Second, the agency values firm profits directly with λ_2 . Third, the agency obtains a weighted gain from employment level l_i^* in the privatized firm. Moreover, the agency incurs privatization costs c_i that may correspond to search and advertisement costs. In addition, the agency might need to provide financial support (e.g. grants, loans, guarantees) to cover fixed costs and render the company sufficiently attractive for investors. In our empirical application, we assume that these types of costs that constrain the agency's choice are either constant across firms or that they vary across firms, but can be captured by firm characteristics such as industry, location, and employment size categories. The agency's value from privatization of firm *i* can be written as follows

$$U_{ip} = V_{ip} + \epsilon_{ip}$$

= $\beta_{0p} + \underbrace{\lambda_1 s \pi^*}_{\text{Gain from Sale}} + \underbrace{\lambda_2 \pi^*}_{\text{Gain from Profits}} + \underbrace{\lambda_3 l^*}_{\text{Gain from Employment}} - \underbrace{\beta_3 c_i}_{\text{Loss Priv. Costs}} + \epsilon_{ip}.$

Using expressions in 3 obtained from the profit maximization of firms we can rewrite

$$U_{ip} = \beta_{0p} + \phi_i^{\frac{1}{1-\alpha}} \left(\gamma \lambda_1 s + \gamma \lambda_2 + \lambda_3 (\frac{\alpha}{w})^{\frac{1}{1-\alpha}} \right) - (\lambda_1 s + \lambda_2) f - \beta_3 c_i + \epsilon_{ip}$$
$$= \beta_{0p} + \beta_1 \phi_i^{\frac{1}{1-\alpha}} - \beta_2 f - \beta_3 c_i + \epsilon_{ip}.$$

Furthermore, we assume that the agency's value from the liquidation of firm i is equal to

$$U_{il} = V_{il} + \epsilon_{il}$$
$$= \beta_{0l} + \epsilon_{il}$$

where the firm exits the market and lays off all its workers. The probability to privatize company i can therefore be expressed as

$$Pr(\text{Privatization}_i) = Pr(\epsilon_{il} - \epsilon_{ip} < V_{ip} - V_{il} = \beta_{0p} - \beta_{0l} + \beta_1 \phi_i^{\frac{1}{1-\alpha}} - \beta_2 f - \beta_3 c_i).$$
(4)

Assuming further that the difference in unobserved errors follows specific distributions, we can estimate equation 4 with a logit or linear probability model. The main qualitative implication of the model is that β_1 is positive. Only when the gain derived from the contractual agreement with the buyer, from profits, and from employment is larger than the loss from privatization and fixed costs, the agency will prefer privatization over liquidation. Irrespective of the weight the agency attaches to employment, revenue from the firm sale, or profits, labor productivity should be a positive predictor of the probability to privatize a firm instead of liquidating it, conditional on costs. We evaluate the agency's choice by testing this implication of the model in Section 4.2.

The constant s in the model can also be interpreted as a function of contractual components (sales price and guarantees) that is increasing in firm profits and therefore productivity. The increasing shape of this function can be due to higher bargaining power of the agency or higher ability of buyers to commit. We test this conjecture that the contract components increase in productivity in Section 4.3.

We are also interested in the survival of firms following privatization. We assume that privatized firms are restructured by their new owners, transforming productivity ϕ_i with the function $g(\phi_i) = \phi_i + \nu_i$ where ν_i follows a random distribution. The probability for firm *i* to survive is assumed to be pinned down by their ability to make non-negative profits

$$Pr(\text{Survival}_i) = Pr\left(\frac{f}{\gamma} \le g(\phi_i)^{\frac{1}{1-\alpha}}\right).$$
 (5)

The probability for a privatized firm to survive increases therefore in the initial productivity of the firm, even though any restructuring by the new owners will introduce noise. We test this implication in Section 4.4.

Appendix C. Supplementary Graphs and Tables



Supplementary Graphs

Note: The figure shows the shares of surviving firms in each year for our post-privatization sample in Section 4.4 with two supersets of firms. The post-privatization sample A. includes firms with information on productivity, ownership and survival. The sample B. does not contain productivity information from the THA Firm Surveys and sample C. does not contain productivity from the surveys nor ownership information from the MUP Firm Register. 95% confidence intervals are plotted as error bars. *Sources.*– BvS Firm Register, THA Firm Surveys, MUP Firm Register.

FIGURE C.1. Survival Rates of Privatized Firms



Note: The Figure shows mean productivity percentiles by internal firm rating scores for two labor productivity indicators. Rank coefficients calculated using Hazen's rule. Smoothing procedure uses an Epanechnikov kernel function of degree zero. The sample contains firms that were rated between July 1990 and June 1991. N = 588. Sources: BvS Firm Register, THA Firm Surveys, and THA Firm Ratings.

FIGURE C.2. Firms' Labor Productivity and Rating Scores



With 3-Digits Industry Fixed-Effects

Without 3-Digits Industry Fixed-Effects

Note: The figures plot predicted probabilities of privatization with 95% confidence intervals from the baseline specification linear probability models adding a second degree polynomial of productivity. The right panel excludes industry fixed effects. *Sources:* BvS Firm Register, THA Firm Surveys.

FIGURE C.3. Predicted Privatization Probabilities with 2nd Order Polynomial of Productivity



Note: Associations between investor demand and four components of privatization policies at the sector level (N=10). Investor demand represents the average number of requests from interested parties to the Treuhand by sector. Analyses are conducted at the sector-level as investor demand information are only available at this aggregated level. All variables are residualized by regressing them on the number of firms in each sector. We scale the residualized variables by multiplying them with their averages. Estimated slopes and standard errors of the dotted linear relationships are presented below each panel.

Sources: BvS Firm Register, THA Firm Surveys, Investor Inquiries from Siegmund (2001).

FIGURE C.4. Investor Inquiries for Treuhand Firms

Supplementary Tables

	Mean	SD	Min	Max	Ν	Source
Privatization Outcomes						
Privatization $(0/1)$	0.680	0.466	0.000	1.000	10316	BvS Firm Register
Time to Privatization (months)	26.365	14.453	0.000	53.000	4076	Treuhand Firm Surveys
Privatization Price (DM)	10.783	4.675	0.000	18.666	2020	Treuhand Privatization Contracts
Employment Guarantee $(0/1)$	3.667	1.356	0.000	8.780	2020	Treuhand Privatization Contracts
Investment Guarantee $(0/1)$	13.587	2.193	0.000	21.976	2020	Treuhand Privatization Contracts
Majority East German Ownership $(0/1)$	0.480	0.500	0.000	1.000	2566	MUP Firm Register
Majority West German Ownership $(0/1)$	0.452	0.498	0.000	1.000	2566	MUP Firm Register
Majority International Ownership $(0/1)$	0.067	0.251	0.000	1.000	2566	MUP Firm Register
5 Years Post-THA Survival (0/1)	0.685	0.465	0.000	1.000	2566	MUP Firm Register
10 Years Post-THA Survival $(0/1)$	0.574	0.495	0.000	1.000	2566	MUP Firm Register
15 Years Post-THA Survival (0/1)	0.521	0.500	0.000	1.000	2566	MUP Firm Register
20 Years Post-THA Survival $(0/1)$	0.494	0.500	0.000	1.000	2566	MUP Firm Register
Firm Characteristics						
Log Revenue per Worker (DM/capita)	4.298	1.053	0.439	7.948	6190	Treuhand Firm Surveys
Log Revenue per Hour Worked (DM/hour)	3.759	0.973	0.131	7.220	6190	Treuhand Firm Surveys
Firm Rating (1=best, 6=worst)	3.673	1.156	1.000	6.000	588	Treuhand Firm Ratings
Firm Rating (1=best, 6=worst), rounded	3.753	1.160	1.000	6.000	588	Treuhand Firm Ratings
Log Revenue per Worker (DM/capita)	4.298	1.053	0.439	7.948	6190	Treuhand Firm Surveys
Log Revenue per Hour Worked (DM/hour)	3.759	0.973	0.131	7.220	6190	Treuhand Firm Surveys
Number of Employees	377.937	720.504	0.000	5308.000	6190	Treuhand Firm Surveys
Revenue (1000 DM)	27582.304	111050.470	0.000	3824609.500	6190	Treuhand Firm Surveys
State: East Berlin $(0/1)$	0.099	0.299	0.000	1.000	10316	BvS Firm Register
State: Brandenburg $(0/1)$	0.145	0.352	0.000	1.000	10316	BvS Firm Register
State: Mecklenburg West. Pom. $(0/1)$	0.113	0.317	0.000	1.000	10316	BvS Firm Register
State: Saxony-Anhalt (0/1)	0.171	0.376	0.000	1.000	10316	BvS Firm Register
State: Saxony $(0/1)$	0.308	0.462	0.000	1.000	10316	BvS Firm Register
State: Thuringia $(0/1)$	0.164	0.370	0.000	1.000	10316	BvS Firm Register

Sources.– BvS Firm Register, THA Firm Surveys, THA Firm Ratings, THA Contract Data, MUP Firm Register.

TABLE C.1. Descriptive Statistics

THE	BIG	SELL
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		Outcome	Variable: P	rivatization	Indicator	
	(1)	(2)	(3)	(4)	(5)	(6)
Log Rev. per Worker	0.077^{***} (0.007)	0.095^{***} (0.009)		0.073^{***} (0.007)	0.076^{***} (0.007)	0.079^{***} (0.007)
Log Gross Val. Add.	~ /	· · · ·	0.053^{***}			
			(0.004)			
Mean Y	0.68	0.68	0.82	0.67	0.68	0.68
Geo-FE	State	State	State	Local	District	State
				Branch		
Industry-FE	3-digits	3-digits	3-digits	3-digits	3-digits	4-digits
Sample	Manuf. $+$	Manuf.	Manuf. $+$	Manuf. $+$	Manuf. $+$	Manuf. $+$
	Serv.		Serv.	Serv.	Serv.	Serv.
Observations	$6,\!190$	4,033	$3,\!282$	$5,\!837$	$6,\!189$	$6,\!190$

Notes.-* p < 0.1; ** p < 0.05; *** p < 0.01. Each column presents a different estimation of equation (1). Column (1) controls for three firm employment size dummies. Column (2) restricts the sample to manufacturing only. Column (3) uses alternative productivity measure log gross value added. Column (4) has 15 local Treuhand branch + 1 headquarter fixed-effects. Column (5) uses district fixed-effects. Column (6) has more narrow 4-digit industry fixed-effects. The outcome variable is a dummy equaling 1 if a firm was privatized at the end of 1994 and 0 otherwise. Robust standard errors given in parentheses. Sources.- BvS Firm Register and THA Firm Surveys.

TABLE C.2. Privatization - Alternative Specifications

	Outcome Variable: Months to Privatization since July 1990				y 1990	
	(1)	(2)	(3)	(4)	(5)	(6)
Log Rev. per Worker	-1.144^{***} (0.267)	-1.586^{***} (0.359)		-1.324^{***} (0.285)	-1.272^{***} (0.276)	-1.082^{***} (0.283)
Log Gross Val. Add.	. ,		-1.046^{***} (0.189)	. ,		. ,
Mean Y	26.36	24.92	26.49	26.32	26.36	26.36
Geo-FE	State	State	State	Local Branch	District	State
Industry-FE	3-digits	3-digits	3-digits	3-digits	3-digits	4-digits
Sample	Manuf. $+$	Manuf.	Manuf. $+$	Manuf. $+$	Manuf. $+$	Manuf. $+$
	Serv.		Serv.	Serv.	Serv.	Serv.
Observations	4,076	$2,\!685$	$2,\!631$	$3,\!805$	4,075	4,076

Notes.-* p < 0.1; ** p < 0.05; *** p < 0.01. Each column presents a different estimation of equation (1). Column (1) controls for three firm employment size dummies. Column (2) restricts the sample to manufacturing only. Column (3) uses alternative productivity measure log gross value added. Column (4) has 15 local Treuhand branch + 1 headquarter fixed-effects. Column (5) uses district fixed-effects. Column (6) has more narrow 4-digit industry fixed-effects. The outcome variable is the number of months until privatization since July 1990. Robust standard errors given in parentheses. Sources.- BvS Firm Register and THA Firm Surveys.

TABLE C.3. Time to Privatization - Alternative Specifications

	(1) Privatization	(2) 1 Probability	(3) Months to H	(4) Privatization
Log Revenue per Worker	0.072^{***} (0.007)		-0.585^{**} (0.264)	
Log Revenue per Hour		0.068^{***} (0.008)		-0.904^{***} (0.280)
Mean Y R-squared Observations	$0.64 \\ 0.087 \\ 5,386$	$0.64 \\ 0.084 \\ 5,386$	$29.60 \\ 0.285 \\ 3,317$	$29.60 \\ 0.286 \\ 3,317$

Notes.– * p < 0.1; ** p < 0.05; *** p < 0.01. Each column presents an OLS regression with industry FE (3-digit), state FE, and survey-time FE. The outcome variable is the number of months until privatization since July 1990. The subsample includes all firms whose first measures of labor productivity were taken before the agency's decision. Robust standard errors given in parentheses.

Sources.– BvS Firm Register and THA Firm Surveys.

TABLE C.4. Firms surveyed before agency decision

	(1)	(2)	(3)	(4)
	Privatization	Probability	Months to I	Privatization
Log Revenue per Worker	0.068***		-1.637***	
	(0.008)		(0.341)	
Log Revenue per Hour		0.065^{***}		-2.087***
		(0.009)		(0.354)
Mean Y	0.66	0.66	1.00	1.00
R-squared	0.108	0.105	0.299	0.303
Observations	4,496	$4,\!496$	2,923	2,923

Notes.– Each column presents an OLS regression at the level of Volkseigene Betriebe (VEB) with industry FE (3-digit), state FE, and survey-time FE. We aggregate Treuhand firms to VEBs by averaging outcomes and productivity levels and using modes for fixed-effect variables. The outcome variable for columns (1) and (2) is the share of firms belonging to a given VEB that was privatized at the end of 1994. For column (3) and (4) the outcome is the average number of months until privatization. The sample excludes firms indicated as spin-offs that cannot directly be linked to a former VEB. Robust standard errors given in parentheses. * p < 0.1; ** p < 0.05; *** p < 0.01.

Sources.– BvS Firm Register and THA Firm Surveys.

TABLE C.5. Privatization, Time to Privatization and Productivity at the VEBlevel

THE BIG SELL

	(1) Privatization Probability			
Log. Rev. per W. Deciles=2	0.084^{***} (0.026)			
Log. Rev. per W. Deciles=3	0.217^{***} (0.026)			
Log. Rev. per W. Deciles=4	0.214^{***}		F-stat	P-value
Log. Rev. per W. Deciles=5	(0.026) 0.230^{***}	2th = 10th	44.6	0.000
Log Pow por W Decilos-6	(0.027)	3 th = 10 th 4 th = 10 th	$\begin{array}{c} 4.8\\ 5.3\end{array}$	$0.029 \\ 0.021$
Log. Rev. per w. Deches-0	(0.026)	5th = 10th	3.0	0.085
Log. Rev. per W. Deciles= 7	0.292^{***}	6tn = 10tn 7th = 10th	0.5 0.3	$0.492 \\ 0.607$
Log. Rev. per W. Deciles=8	(0.026) 0.266^{***} (0.027)	8th = 10th $9th = 10th$	$\begin{array}{c} 0.2 \\ 0.4 \end{array}$	$\begin{array}{c} 0.642 \\ 0.507 \end{array}$
Log. Rev. per W. Deciles=9	(0.027) 0.296^{***} (0.027)			
Log. Rev. per W. Deciles=10	(0.027) 0.278^{***} (0.029)			
Mean Y	0.68			
R-squared Observations	$0.114 \\ 6,190$			
Observations	6,190			

Notes.– The left table presents an OLS regression with a dummy equaling 1 if a firm was privatized at the end of 1994 and 0 otherwise as outcome variable. Dummies for each decile of log revenue per worker are included, omitting the first decile. The specification includes industry FE (3-digit), state FE, and survey-time FE. The right table presents F-test statistics and p-values from the null hypothesis that each decile is equal to then 10th decile. Robust standard errors given in parentheses. * p < 0.1; ** p < 0.05; *** p < 0.01. Sources.– BvS Firm Register and THA Firm Surveys.

TABLE C.6. Privatization, Time to Privatization and Productivity Deciles

	P(Privatization)	
	(1)	(2)
Log Rev. per Worker	0.043***	0.066***
	(0.006)	(0.018)
Year of Decision=1991 \times Log Rev. per Worker		-0.050^{++}
Var of Decision $-1002 \times I$ og Roy, por Worker		(0.021)
Teal of Decision-1992 × Log Rev. per worker		(0.003)
Year of Decision= $1993 \times \text{Log Rev. per Worker}$		-0.050**
		(0.023)
Year of Decision=1994 \times Log Rev. per Worker		-0.021
		(0.020)
Year of Decision=1991	0.004	0.235^{**}
	(0.016)	(0.105)
Year of Decision=1992	-0.122***	-0.090
V (D :: 1000	(0.016)	(0.103)
Year of Decision=1993	-0.005	0.224^{**}
Very of Decision-1004	(0.019) 0.510***	(0.112) 0.408***
Teal of Decision-1994	-0.510	-0.408
	(0.013)	(0.100)
Mean Y	0.69	0.69
Observations	$5,\!866$	5,866

Notes.- * p < 0.1; ** p < 0.05; *** p < 0.01. The outcome variable is a dummy equaling 1 if a firm was privatized at the end of 1994 and 0 otherwise. Robust standard errors given in parentheses.

Sources.– BvS Firm Register and THA Firm Surveys.

TABLE C.7. Privatization - Productivity Interacted with Decision Year

THE	BIG	SELL
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	Log Price	Log Empl. Pledge	Log Invest. Pledge
	(1)	(2)	(3)
Log Rev. per Worker	0.578***	0.196***	0.258***
	(0.215)	(0.059)	(0.094)
Majority West Ownership	-0.503	0.796^{**}	2.168^{***}
	(1.433)	(0.367)	(0.550)
Maj. Int'l Ownership	-0.283	-0.285	0.834
	(2.579)	(0.790)	(1.006)
Log Rev. per W. x Maj. West Ownership	0.224	-0.091	-0.326***
	(0.319)	(0.083)	(0.125)
Log Rev. per W. x Maj. Int'l Ownership	0.091	0.131	-0.013
	(0.577)	(0.185)	(0.231)
Mean Y	10.89	10.89	10.89
N	$1,\!325$	1,325	1,325

Notes: OLS estimates of privatization contract outcomes on interactions of labor productivity and ownership. Regression specifications include 3-digits industry FE, state FE, and survey time FE.

	Outcome Variable						
	$\operatorname{P(Priv)}_{(1)}$	P(Priv) (2)	P(Priv) (3)	$\begin{array}{c} P(Priv) \\ (4) \end{array}$			
$I(Rating \ge 1)$	0.186^{**} (0.094)						
$I(Rating \ge 2)$		0.159^{***} (0.053)					
$I(Rating \ge 3)$			0.178^{***} (0.043)				
Rating score				-0.098^{***} (0.017)			
Estimation	matching	matching	matching	fixed-effects			
R-squared	0.008	0.013	0.033	0.212			
Observations	350	516	571	566			

TABLE C.8. OLS Estimates: Privatization Contracts and Ownership

Notes.– Each column regresses the probability of privatization as opposed to liquidation on the firm rating. The first three columns use coarsened-exact matching to match firms that received a rating above or equal a certain threshold with firms that received grade below the threshold. Matching covariates used are state, 2 digit industries, local branch or headquarter privatization and firm size. The last column uses the discrete rating score from 1 (best) to 6 (worst) as a predictor in a linear regressions using state, 3 digit industries, local branch or headquarter and firm size as controls. Robust standard errors given in parentheses. * p < 0.1; ** p < 0.05; *** p < 0.01.

Sources.– BvS Firm Register, THA Firm Surveys, and THA Firm Ratings.

TABLE C.9. Privatization Outcomes, Firm Ratings, and Productivity

	5y Survival			10y Survival			
	(1)	(2)	(3)	(4)	(5)	(6)	
Ln(Rev./Worker)	0.042^{***}		-0.011	0.048^{***}		-0.013	
Rating	(0.001)	-0.035^{*} (0.020)	(0.010) -0.036^{*} (0.020)	(0.001)	-0.074^{***} (0.018)	(0.010) -0.076^{***} (0.019)	
Mean Y	0.541	0.511	0.511	0.384	0.359	0.359	
Observations	6,066	554	554	6,066	554	554	
R-squared	0.034	0.069	0.069	0.051	0.114	0.115	
		5y Survival			10y Surviva	1	

		by burvival		ity burvivar			
	(7)	(8)	(9)	(10)	(11)	(12)	
Ln(Rev./Worker)	0.049^{***} (0.006)		-0.006 (0.019)	0.048^{***} (0.006)		-0.007 (0.019)	
Rating	. ,	-0.062^{***} (0.018)	-0.062^{***} (0.018)	· · ·	-0.063^{***} (0.018)	-0.064^{***} (0.018)	
Mean Y Observations R-squared	$\begin{array}{c} 0.342 \\ 6,066 \\ 0.052 \end{array}$	$\begin{array}{c} 0.325 \\ 554 \\ 0.109 \end{array}$	$\begin{array}{c} 0.325 \\ 554 \\ 0.110 \end{array}$	$0.323 \\ 6,066 \\ 0.048$	$\begin{array}{c} 0.312 \\ 554 \\ 0.110 \end{array}$	$\begin{array}{c} 0.312 \\ 554 \\ 0.110 \end{array}$	

Notes: OLS estimates of survival probabilities at the firm level. Regression specifications include 2-digit industry FE, state FE, and survey time FE. Lower ratings are indicative of better grades, with the highest attainable score being 1 and the lowest attainable score being 6. Sample includes liquidated firms.

TABLE C.10. OLS Estimates: Ratings and Long-Term Survival

THE BIG SELL

			Outcome	Variable:		
	(1)	(2)	(3)	(4)	(5)	(6)
Log Rev. per Worker	0.590***	0.715***		0.521***	0.529***	0.459***
	(0.130)	(0.160)		(0.133)	(0.134)	(0.148)
Log Gross Val. Add.	· /	· · · ·	0.603***	. ,	. ,	. ,
-			(0.085)			
Mean Y	10.78	10.98	10.72	10.74	10.78	10.78
Firm Size	\checkmark					
Geo-FE	State	State	State	Local	District	State
				branch		
Industry-FE	3-digits	3-digits	3-digits	3-digits	3-digits	4-digits
Sample	Manuf.	Manuf.	Manuf.	Manuf.	Manuf.	Manuf.
	+ Serv.		+ Serv.	+ Serv.	+ Serv.	+ Serv.
Ν	2,020	$1,\!464$	1,284	$1,\!937$	2,020	2,020

Notes.- * p < 0.1; ** p < 0.05; *** p < 0.01. Each column presents a different estimation of equation (1). Column (1) controls for three firm employment size dummies. Column (2) restricts the sample to manufacturing only. Column (3) uses alternative productivity measure log gross value added. Column (4) has 15 local Treuhand branch + 1 headquarter fixed-effects. Column (5) uses district fixed-effects. Column (6) has more narrow 4-digit industry fixed-effects. The outcome variable is log sales price. Robust standard errors given in parentheses.

Sources.- THA Contract Data and THA Firm Surveys.

TABLE C.11. Sales Prices in Privatization Contracts - Alternative Specifications

	Outcome Variable:					
	(1)	(2)	(3)	(4)	(5)	(6)
Log Rev. per Worker	0.171***	0.152***		0.134***	0.129***	0.177***
	(0.038)	(0.052)		(0.040)	(0.042)	(0.046)
Log Gross Val. Add.	. ,	. ,	0.420***	. ,	. ,	
			(0.029)			
Mean Y	3.67	3.85	3.71	3.66	3.67	3.67
Firm Size	\checkmark					
Geo-FE	State	State	State	Local	District	State
				branch		
Industry-FE	3-digits	3-digits	3-digits	3-digits	3-digits	4-digits
Sample	Manuf.	Manuf.	Manuf.	Manuf.	Manuf.	Manuf.
	+ Serv.		+ Serv.	+ Serv.	+ Serv.	+ Serv.
Ν	2,020	$1,\!464$	1,284	$1,\!937$	2,020	2,020

Notes.- * p < 0.1; ** p < 0.05; *** p < 0.01. Each column presents a different estimation of equation (1). Column (1) controls for three firm employment size dummies. Column (2) restricts the sample to manufacturing only. Column (3) uses alternative productivity measure log gross value added. Column (4) has 15 local Treuhand branch + 1 headquarter fixed-effects. Column (5) uses district fixed-effects. Column (6) has more narrow 4-digit industry fixed-effects. The outcome variable is log employment guarantees. Robust standard errors given in parentheses.

Sources.- THA Contract Data and THA Firm Surveys.

 TABLE C.12. Employment Pledge in Privatization Contracts - Alternative Specifications

THE BIG SELL

	Outcome Variable:					
	(1)	(2)	(3)	(4)	(5)	(6)
Log Rev. per Worker	0.159***	0.088		0.122**	0.111*	0.155^{**}
	(0.054)	(0.065)		(0.056)	(0.060)	(0.066)
Log Gross Val. Add.		. ,	0.428^{***}	. ,	. ,	. ,
			(0.046)			
Mean Y	13.59	13.79	13.61	13.55	13.59	13.59
Firm Size	\checkmark					
Geo-FE	State	State	State	Local	District	State
				branch		
Industry-FE	3-digits	3-digits	3-digits	3-digits	3-digits	4-digits
Sample	Manuf.	Manuf.	Manuf.	Manuf.	Manuf.	Manuf.
	+ Serv.		+ Serv.	+ Serv.	+ Serv.	+ Serv.
Ν	2,020	$1,\!464$	1,284	$1,\!937$	2,020	2,020

Notes.- * p < 0.1; ** p < 0.05; *** p < 0.01. Each column presents a different estimation of equation (1). Column (1) controls for three firm employment size dummies. Column (2) restricts the sample to manufacturing only. Column (3) uses alternative productivity measure log gross value added. Column (4) has 15 local Treuhand branch + 1 headquarter fixed-effects. Column (5) uses district fixed-effects. Column (6) has more narrow 4-digit industry fixed-effects. The outcome variable is log investment guarantees. Robust standard errors given in parentheses. Sources.- THA Contract Data and THA Firm Surveys.

 TABLE C.13. Investment Pledge in Privatization Contracts - Alternative Specifications

	Log Price	Log Employment Pledge	Log Investment Pledge
	(1)	(2)	(3)
Log Rev. per Worker	0.334^{*}	0.122^{*}	0.159^{*}
	(0.200)	(0.063)	(0.083)
Branch	-2.780^{**}	-0.633^{**}	-0.465
	(1.117)	(0.319)	(0.449)
Log Rev. per Worker x Branch	0.388	0.056	-0.038
	(0.245)	(0.070)	(0.099)
Mean Y N	$10.74 \\ 1,937$	$3.66 \\ 1,937$	$13.55 \\ 1,937$

Notes.- * p < 0.1; ** p < 0.05; *** p < 0.01. Each column presents average marginal effects from a linear regression model with survey-time FE, industry FE (3-digit), state FE and employment categories. The outcome variables are log sales price (column 1 & 2), the guaranteed log number of employees (column 3 & 4) and contractual log investment pledge (column 5 & 6) in nominal Deutsche Mark (DM). The explanatory variables are the log revenue per worker and a dummy indicating the privatization through one of the 15 branches. Robust standard errors given in parentheses.

	Log Price (1)	Log Empl. Pledge (2)	Log Invest. Pledge (3)
Log Rev. per Worker	0.578***	0.196***	0.258***
	(0.215)	(0.059)	(0.094)
Majority West Ownership	-0.503	0.796^{**}	2.168^{***}
	(1.433)	(0.367)	(0.550)
Maj. Int'l Ownership	-0.283	-0.285	0.834
	(2.579)	(0.790)	(1.006)
Log Rev. per W. x Maj. West Ownership	0.224	-0.091	-0.326***
	(0.319)	(0.083)	(0.125)
Log Rev. per W. x Maj. Int'l Ownership	0.091	0.131	-0.013
	(0.577)	(0.185)	(0.231)
Mean Y	10.89	10.89	10.89
Ν	$1,\!325$	1,325	1,325

TABLE C.14. Contract Outcomes: Interaction of Productivity with Decentralization

Notes.- * p < 0.1; ** p < 0.05; *** p < 0.01. OLS estimates of privatization contract outcomes on interactions of labor productivity and ownership. Regression specifications include 3-digit industry FE, state FE, and survey time FE.

TABLE C.15. OLS Estimates: Privatization Contracts and Ownership

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	0	Outcome Variable: Majority Ownership East $(1/0)$						
	(1)	(2)	(3)	(4)	(5)	(6)		
Log Revenue per Worker	-0.034***	-0.028*		-0.016	-0.022*	-0.039***		
	(0.011)	(0.015)		(0.012)	(0.012)	(0.013)		
Log Gross Value Added			-0.077***					
			(0.008)					
Mean Y	0.48	0.45	0.49	0.49	0.48	0.48		
Firm Size	\checkmark							
Geo-FE	State	State	State	Local	District	State		
				Branch				
Industry-FE	3-digits	3-digits	3-digits	3-digits	3-digits	4-digits		
Sample	Manuf. $+$	Manuf.	Manuf. $+$	Manuf. $+$	Manuf. $+$	Manuf. $+$		
	Serv.		Serv.	Serv.	Serv.	Serv.		
Observations	2,566	1,822	$1,\!689$	$2,\!404$	2,566	2,566		

Notes.- * p < 0.1; ** p < 0.05; *** p < 0.01. Each column presents a different estimation of equation (1). Column (1) controls for three firm employment size dummies. Column (2) restricts the sample to manufacturing only. Column (3) uses alternative productivity measure log gross value added. Column (4) has 15 local Treuhand branch + 1 headquarter fixed-effects. Column (5) uses district fixed-effects. Column (6) has more narrow 4-digit industry fixed-effects. The outcome variable is an indicator for East majority ownership. Robust standard errors given in parentheses.

Sources.– THA Firm Surveys and MUP Firm Register.

 TABLE C.16. Majority Ownership East Germany by Initial Revenue per Worker

 - Alternative Specifications

	Outcome Variable: Majority Ownership West $(1/0)$					
	(1)	(2)	(3)	(4)	(5)	(6)
Log Revenue per Worker	0.026^{**} (0.012)	0.019 (0.015)		0.014 (0.012)	0.017 (0.012)	0.028^{**} (0.013)
Log Gross Value Added		× ,	0.066^{***} (0.008)			× ,
Mean Y	0.45	0.48	0.44	0.45	0.45	0.45
Firm Size	\checkmark					
Geo-FE	State	State	State	Local	District	State
				Branch		
Industry-FE	3-digits	3-digits	3-digits	3-digits	3-digits	4-digits
Sample	Manuf.	Manuf.	Manuf.	Manuf.	Manuf.	Manuf.
	+ Serv.		+ Serv.	+ Serv.	+ Serv.	+ Serv.
Observations	2,566	1,822	$1,\!689$	$2,\!404$	2,566	2,566

Notes.-* p < 0.1; ** p < 0.05; *** p < 0.01. Each column presents a different estimation of equation (1). Column (1) controls for three firm employment size dummies. Column (2) restricts the sample to manufacturing only. Column (3) uses alternative productivity measure log gross value added. Column (4) has 15 local Treuhand branch + 1 headquarter fixed-effects. Column (5) uses district fixed-effects. Column (6) has more narrow 4-digit industry fixed-effects. The outcome variable is an indicator for West majority ownership. Robust standard errors given in parentheses. Sources.- THA Firm Surveys and MUP Firm Register.

 TABLE C.17. Majority Ownership West Germany by Initial Revenue per Worker

 - Alternative Specifications

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	Outcome Variable: Majority Ownership Int'l $\left(1/0\right)$					
	(1)	(2)	(3)	(4)	(5)	(6)
Log Revenue per Worker	0.009 (0.006)	$0.008 \\ (0.007)$		0.002 (0.006)	$0.005 \\ (0.006)$	0.011 (0.007)
Log Gross Value Added			0.011^{**} (0.004)			
Mean Y	0.07	0.07	0.07	0.06	0.07	0.07
Firm Size	\checkmark					
Geo-FE	State	State	State	Local Branch	District	State
Industry-FE	3-digits	3-digits	3-digits	3-digits	3-digits	4-digits
Sample	Manuf.	Manuf.	Manuf.	Manuf.	Manuf.	Manuf.
	+ Serv.		+ Serv.	+ Serv.	+ Serv.	+ Serv.
Observations	2,566	1,822	$1,\!689$	2,404	2,566	2,566

Notes.-* p < 0.1; ** p < 0.05; *** p < 0.01. Each column presents a different estimation of equation (1). Column (1) controls for three firm employment size dummies. Column (2) restricts the sample to manufacturing only. Column (3) uses alternative productivity measure log gross value added. Column (4) has 15 local Treuhand branch + 1 headquarter fixed-effects. Column (5) uses district fixed-effects. Column (6) has more narrow 4-digit industry fixed-effects. The outcome variable is an indicator for international majority ownership. Robust standard errors given in parentheses. Sources.- THA Firm Surveys and MUP Firm Register.

 TABLE C.18. Majority Ownership International by Initial Revenue per Worker

 - Alternative Specifications
| | Outcome Variable: Majority Ownership East $(1/0)$ | | | | | |
|-----------------------|---|-----------|-----------|-----------|----------|-----------|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Log Revenue per Hour | -0.046*** | -0.044*** | | -0.030** | -0.033** | -0.055*** |
| | (0.012) | (0.016) | | (0.013) | (0.013) | (0.014) |
| Log Gross Value Added | | | -0.077*** | | | |
| - | | | (0.008) | | | |
| Mean Y | 0.48 | 0.45 | 0.49 | 0.49 | 0.48 | 0.48 |
| Firm Size | \checkmark | | | | | |
| Geo-FE | State | State | State | Local | District | State |
| | | | | Branch | | |
| Industry-FE | 3-digits | 3-digits | 3-digits | 3-digits | 3-digits | 4-digits |
| Sample | Manuf. + | Manuf. | Manuf. + | Manuf. + | Manuf. + | Manuf. + |
| - | Serv. | | Serv. | Serv. | Serv. | Serv. |
| Observations | 2,566 | 1,822 | $1,\!689$ | $2,\!404$ | 2,566 | 2,566 |

Notes.- * p < 0.1; ** p < 0.05; *** p < 0.01. Each column presents a different estimation of equation (1). Column (1) controls for three firm employment size dummies. Column (2) restricts the sample to manufacturing only. Column (3) uses alternative productivity measure log gross value added. Column (4) has 15 local Treuhand branch + 1 headquarter fixed-effects. Column (5) uses district fixed-effects. Column (6) has more narrow 4-digit industry fixed-effects. The outcome variable is an indicator for East majority ownership. Robust standard errors given in parentheses.

Sources.- THA Firm Surveys and MUP Firm Register.

TABLE C.19. Majority Ownership East Germany by Initial Revenue per Hour -Alternative Specifications THE BIG SELL

	Outcome Variable: Majority Ownership West $(1/0)$					
	(1)	(2)	(3)	(4)	(5)	(6)
Log Revenue per Hour	0.039***	0.034**		0.030**	0.029**	0.046***
	(0.013)	(0.016)		(0.013)	(0.013)	(0.014)
Log Gross Value Added			0.066^{***}			
			(0.008)			
Mean Y	0.45	0.48	0.44	0.45	0.45	0.45
Firm Size	\checkmark					
Geo-FE	State	State	State	Local	District	State
				Branch		
Industry-FE	3-digits	3-digits	3-digits	3-digits	3-digits	4-digits
Sample	Manuf.	Manuf.	Manuf.	Manuf.	Manuf.	Manuf.
_	+ Serv.		+ Serv.	+ Serv.	+ Serv.	+ Serv.
Observations	2,566	1,822	$1,\!689$	$2,\!404$	2,566	2,566

Notes.- * p < 0.1; ** p < 0.05; *** p < 0.01. Each column presents a different estimation of equation (1). Column (1) controls for three firm employment size dummies. Column (2) restricts the sample to manufacturing only. Column (3) uses alternative productivity measure log gross value added. Column (4) has 15 local Treuhand branch + 1 headquarter fixed-effects. Column (5) uses district fixed-effects. Column (6) has more narrow 4-digit industry fixed-effects. The outcome variable is an indicator for West majority ownership. Robust standard errors given in parentheses. Sources.- THA Firm Surveys and MUP Firm Register.

TABLE C.20. Majority Ownership West Germany by Initial Revenue per Hour -Alternative Specifications

	Outcome Variable: Majority Ownership Int'l $(1/0)$					
	(1)	(2)	(3)	(4)	(5)	(6)
Log Revenue per Hour	$0.007 \\ (0.007)$	0.010 (0.009)		-0.000 (0.007)	$0.004 \\ (0.007)$	0.009 (0.008)
Log Gross Value Added	· · ·	х <i>У</i>	0.011^{**} (0.004)			
Mean Y	0.07	0.07	0.07	0.06	0.07	0.07
Firm Size	\checkmark					
Geo-FE	State	State	State	Local	District	State
				Branch		
Industry-FE	3-digits	3-digits	3-digits	3-digits	3-digits	4-digits
Sample	Manuf.	Manuf.	Manuf.	Manuf.	Manuf.	Manuf.
	+ Serv.		+ Serv.	+ Serv.	+ Serv.	+ Serv.
Observations	2,566	1,822	$1,\!689$	$2,\!404$	2,566	2,566

Notes.- * p < 0.1; ** p < 0.05; *** p < 0.01. Each column presents a different estimation of equation (1). Column (1) controls for three firm employment size dummies. Column (2) restricts the sample to manufacturing only. Column (3) uses alternative productivity measure log gross value added. Column (4) has 15 local Treuhand branch + 1 headquarter fixed-effects. Column (5) uses district fixed-effects. Column (6) has more narrow 4-digit industry fixed-effects. The outcome variable is an indicator for international majority ownership. Robust standard errors given in parentheses. Sources.- THA Firm Surveys and MUP Firm Register.

TABLE C.21. Majority Ownership International by Initial Revenue per Hour -Alternative Specifications

	5y Survival (1)	10y Survival (2)	15y Survival (3)	20y Survival (4)
Majority West Ownership	0.008	0.041**	0.070***	0.085***
· · ·	(0.020)	(0.021)	(0.021)	(0.021)
Any Int'l Ownership	0.004	0.052	0.068^{*}	0.079**
	(0.033)	(0.035)	(0.036)	(0.036)
Majority West & Any Int'l Ownership	-0.047	-0.092	-0.133*	-0.144**
	(0.071)	(0.074)	(0.074)	(0.073)
Number of Owners	0.000	-0.000	-0.002	-0.002
	(0.002)	(0.002)	(0.002)	(0.002)
Initial Revenue per Hour	0.028**	0.035***	0.032**	0.035^{***}
_	(0.012)	(0.013)	(0.013)	(0.013)
Mean Y	0.685	0.574	0.521	0.494
Observations	2,566	2,566	2,566	2,566
R-squared	0.043	0.056	0.058	0.063

Note: Table C.22 reports results from regressing indicators for 5, 10, 15, and 20-year survival of privatized firms on majority ownership indicators, log initial (pre-privatization) productivity, and additional controls with survey-time FE, industry FE (3-digit), and state FE. Ownership indicators measure whether a majority of owners was based in the respective geography in 1995. The sample encompasses only privatized firms. Robust standard errors are in parentheses. *** p < 0.01 ** p < 0.05 * p < 0.1

TABLE C.22. Majority Ownership, Initial Revenue per Hour and Firm Survival

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	5y Employment Share (1)	10y Employment Share (2)	15y Employment Share (3)	20y Employment Share (4)
Majority West Ownership	-0.024	0.011	0.046	0.057
	(0.041)	(0.043)	(0.045)	(0.047)
Any Int'l Ownership	-0.113***	-0.043	-0.020	0.017
	(0.042)	(0.043)	(0.045)	(0.054)
Majority West & Any Int'l Ownership	0.011	-0.042	-0.077	-0.086
	(0.074)	(0.079)	(0.081)	(0.105)
Number of Owners	0.002	-0.000	0.001	0.001
	(0.003)	(0.003)	(0.003)	(0.003)
Initial Revenue per Hour	0.091^{***}	0.055**	0.034^{*}	0.040*
	(0.022)	(0.022)	(0.020)	(0.021)
Mean Y	0.341	0.256	0.232	0.221
Observations	2,167	2,050	2,012	1,985
R-squared	0.061	0.045	0.039	0.037

Note: Table C.22 reports results from regressing privatized firms' rate of current to initial employment measured 5, 10, 15, and 20 years after the dissolution of the Treuhand on majority ultimate ownership indicators, log initial (pre-privatization) productivity, and additional controls with survey-time FE, industry FE (3-digit), and state FE. Ownership indicators measure whether a majority of ultimate owners was based in the respective geography in 1995. The sample encompasses only privatized firms. Non-survivors are coded to zero employment for all years after they have exited the market. For years in which individual firms' post-privatization employment levels cannot be observed, we impute these values by taking averages of non-missing employment counts within two years of the missing observation. When imputation is not possible, the respective firm-years are omitted from the sample. We further remove ten firms that are listed at an initial employment of zero. Robust standard errors are in parentheses. *** p < 0.01 ** p < 0.05 * p < 0.1

TABLE C.23. Majority Ownership, Initial Revenue per Hour and Firms' Long-Term Employment Rates Mergele, Hennicke, and Lubczyk

	Majority Ultimate Ownership				
	(1)	(2)	(3)	(4)	
	West	International	West	International	
Log Revenue per Worker	0.113**	0.184^{*}			
	(0.050)	(0.099)			
Log Revenue per Hour			0.178^{***}	0.184^{*}	
			(0.056)	(0.107)	
Number of Owners	-0.073***	-0.083***	-0.074***	-0.082***	
	(0.011)	(0.025)	(0.011)	(0.025)	
Constant	-0.166	-1.896**	-0.340	-1.774*	
	(0.495)	(0.934)	(0.491)	(0.917)	
Pseudo R-squared	0.054		0.055		
Prob > chi2	0.000		0.000		
LL	-2168.225		-2166.190		
Observations	2,566		2,566		

Note: Table C.24 reports results from running a multinomial logit model on majority ownership indicators, log initial (pre-privatization) productivity, and additional controls with survey-time FE, industry FE (3-digit), and state FE. Ownership indicators measure whether a majority of owners was based in the respective geography in 1995. The sample encompasses only privatized firms. East German majority ownership is selected as base category. Standard errors are in parentheses. *** p < 0.01 ** p < 0.05 * p < 0.1

TABLE C.24. Majority Post-Privatization Ownership – Multinomial Logit

Appendix D. Firm Survival Benchmark

To complement our analysis of post-privatization firm survival rates in Section 4.5, we construct a benchmark survival rate based on West German firms and assess the relative performance of privatized firms. To construct a benchmark, we use matching on observables and identify a set of West German firms comparable to the ones privatized by the Treuhand. For this purpose, we draw additional firm level information from the MUP. However, detailed firm level information for West German businesses is only available from the year 2000 onwards (Bersch, Gottschalk, Mueller, and Niefert, 2014). We therefore construct our benchmark survival rate only for privatized firms that survived until the year 2000 at least. For this set of five-year-survivors, we gather survival rates for West German firms of similar size, age, and industry. Firm size is measured as firms' employment count in 1995. Starting from the privatized firms' distribution of firm size, we assign both East and West German firms to the quartiles of this distribution (0 employees, 1 to 9 employees, 10 to 51 employees, 52 employees and more). We omit firms for which we do not observe employment counts in 1995. Firm age is measured as an indicator variable for whether a firm was founded in 1990 or earlier. As we do not observe the exact date of firm foundation for the privatized firms, we also impose this censoring on the West German data and remove all firms that do not fulfill this criterion from the matching pool. Finally, we use firms' industry code as an additional matching criterion. To do so, we take each firms five digit NACE Rev. 2 industry code from the MUP. In cases where this industry code is missing for privatized firms, we assign them to the mode of five digit codes within their three digit industry while we remove West German firms with missing industry codes from the matching pool. We then count the number of West German firms observed in each industry-size cell, calculate the respective survival rates and assign these to the privatized firms in the same strata. The resulting average survival rates for 10, 15 and 20 year time horizons reflect benchmarks based on the firm size and industry-weighted sample of privatized

firms. We compare these West German benchmark survival rates with privatized firms' survival throughout the initial productivity distribution in Figure D.1.



Note: Figure shows mean survival rates by revenue per worker rank for firms from East Germany. Survival rates calculated as the percentage of firms still active 10, 15, and 20 years after the dissolution of the Treuhandanstalt - conditional on having survived at least 5 years after privatization. West German benchmark survival rate calculated for firms of comparable size, age, and industry code. Rank coefficients calculated using Hazen's rule. Privatized firms with unobserved 1995 employment omitted. N = 1, 617. Sources: BvS Firm Register, Treuhand Firm Surveys, and MUP Firm Register.

FIGURE D.1. Survival Relative to West German Benchmark by Revenue per Worker

Across the productivity distribution, the survival rates of privatized East German firms are generally below the benchmark survival rates of West German firms. This result holds for all three time horizons considered. However, while this is true for most of the privatized firms, the most productive East German firms achieve survival rates that are comparable to their West German counterparts. In fact, for time horizons of 15 and 20 years, the most productive East German firms display slightly higher survival rates than the West German benchmark case.

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Appendix E. Data Appendix

Extending the information summarized in Section 3, the following paragraphs provide further details on the individual data segments we use.

BvS Firm Register. We obtained identifiers of the entire universe of Treuhand firms by filing a Freedom of Information Request with the Bundesanstalt für vereinigungsbedingte Sonderaufgaben (BvS), the legal successor organization of the Treuhand still in existence. The register contains the final privatization status of all firms as of May 31st 2016 - the last modification date of the file we received. The relevant variables are the internal identifier used by the Treuhandanstalt which uniquely identifies a company, the new name of the company under legal status in reunited Germany, the former name as it was known in the GDR and the Federal State of its location. We group privatization outcomes used by the administrative source as follows; First, privatization contains a. sale of assets ("Geschäftsanteil/Vermögenswert rückübertragen") and b. merger ("Unternehmen ist fusioniert"). Second, Liquidation contains a. liquidation in progress ("in Liquidation") and b. liquidation finalized ("Unternehmen ist liquidiert") such as c. foreclosure ("Gesamtvollstreckung"). Third, restitution remains a single category ("Geschäftsanteil/Vermögenswert rückübertragen"). The register does not contain municipalized firms. Breaking down the 13,378 firms by Federal State, 157 firms are based outside East Germany, which we exclude from the sample. Using unique firm identifiers, we complement the BvS Firm Register with firm location information at the city level from an earlier firm register published by the Treuhandanstalt (Treuhandanstalt, 1994).

Treuhand Firm Surveys. This section describes the collection, the coverage, and preparation of the Treuhand firm surveys. It thereby complements a series of survey reports that summarizes individual waves of Treuhand firm surveys (Kühl, Schaefer, and Wahse, 1991, 1992b,a; Wahse, Dahms, and Schaefer, 1993).

The implementation of the Treuhand firm surveys was based on an agreement between the Treuhand and the Bundesanstalt für Arbeit, the federal employment agency.¹¹ As Treuhand companies accounted for a major share of East German employment, the survey was to act as an early warning system that anticipates likely job losses across industries and locations (Kühl, Schaefer, and Wahse, 1991). The research institute of the Bundesanstalt, the IAB, commissioned the Berlin-based Soestra institute to conduct the survey. Soestra launched the first survey among Treuhand-owned companies in April 1991. An official cover letter by the head of the Treuhand encouraged firms to reply. Starting in October 1991, an analogous survey was conducted with companies already privatized by the Treuhand. Both surveys were repeated semi-annually until the Treuhand closed its operations in 1994, resulting in a total of 14 surveys during that time. The survey of former Treuhand companies continued in annual intervals from 1995 until October 2003 but with diminished participation from the firms' side.

The Treuhand questionnaires focus on the current and expected future employment structure but also include a broader range of topics that varied among survey waves. Most waves also cover firms' revenues, allowing for the computation of labor productivity indicators. Figure E.1 in the appendix shows an excerpt of the questionnaire from April 1991's survey. In addition to the survey responses, the data includes firm background information provided by the THA to the Soestra institute to conduct the surveys. This information is based on the Treuhand's internal administrative data. It includes three-digit industry codes, the district of firm location, the Treuhand department assigned to each firm, firm status, and the month when Treuhand ownership ended.

Overall, response rates for individual survey waves were between 20 and 65%. These response rates favorably compare to similar company surveys. The one-time firm survey of Treuhand companies by Dyck (1997) in 1992 reached an effective response

 $^{^{11}\}mbox{Leitlinien}$ für eine Zusammenarbeit zwischen der Treuhandanstalt und der Bundesanstalt für Arbeit, 11 April 1991

rate of 23%. The German KfW/ZEW Start-up Panel realized a response rate of 26% (Fryges, Gottschalk, and Kohn, 2009), the Survey on the Access to Finance of Enterprises (SAFE) by the European Central Bank achieved 14%, and the IAB's Establishment Panel reaches rates of up to 40% for first-time respondents (Janik and Kohaut, 2012). Due to the high response rate, the Treuhand firm survey authors Kühl, Schaefer, and Wahse (1991) affirm "structural equivalence" of responding and non-responding firms. They imply that the large coverage of firms leaves little scope for systematic selection into the survey responses. Indeed, our own assessments in Table 1 support this view.

To prepare the data for our analysis, we pool all surveys and always keep the earliest instance of our variables of interest if multiple responses are available, creating a cross-sectional dataset. The reason is that we aim to keep the information that is least affected by potential firm restructuring by the Treuhand or new management teams. As summarized in Table E.1, the resulting data includes responses from 1991 and 1992 in almost 94 percent of all cases. For the remaining firms, we use responses from 1993 or 1994. In our regression models, survey wave fixed effects account for the measurement timing of these variables since they rely on macroeconomic and seasonal conditions, while also capturing survey-specific factors (see Section 4.1). We merge the Treuhand Firm Survey variables with the BvS Firm Register based on the Treuhand's internal firm identifiers. This procedure provides survey information for 6,190 firms among the 10,877 relevant entries in the BvS Firm Register, amounting to a coverage rate of 57%. The coverage rate is slightly lower than the highest individual response rate as the given overall response rates also include responses from the subgroup of municipalized firms, which is not part of the analysis sample (see Section 3) but frequently participated in the survey.

Overall, the Treuhand Firm Survey provides unusually rich and early information on Treuhand firms, which is particularly valuable as other major firm-level datasets from the Federal Statistical Office, the Institute for Employment Research (IAB), or Bureau van Dijk do not cover this period.

Year of Collection	Frequency	Percent	Cumulated
1991	5,096	82.33	82.33
1992	703	11.36	93.68
1993	151	4.05	97.74
1994	140	2.26	100.00
Total	6.190	100.00	

 TABLE E.1. Treuhand Firm Surveys: Collection Years of Earliest Available

 Productivity Items

Notes.– Table presents the earliest available year where the items necessary for the construction of our labor productivity indicators (revenue per worker, revenue per hour) were collected within the Treuhand Firm Surveys. *Sources.*– THA Firm Surveys.

Treuhand Firm Ratings. The Treuhand Firm Ratings are scores internally used by the Treuhand in order to prioritize firms. These scores were prepared by the Treuhand's Leitungsausschuss, a committee of auditors, financial experts, and business consultants. We collected the meeting protocols of the Leitungsausschuss from the German Federal Archive (Bundesarchiv, 2019), starting with the inaugural meeting on 30 July 1990. We manually extract internally used rating scores from these minutes. Such scores were awarded to firms administered by the Treuhand's headquarters. As the headquarters administered the largest Treuhand firms, it is expected that the resulting sample covers firms with more employees, relative to the average Treuhand firm (see Table 1). Ratings scores are not awarded to firms that are already being privatized, municipalized, or liquidated. Scores comprise values between one and six. A score of *one* implies that a firm is profitable, and has no need for further restructuring. Conversely, a score of six means that the firm was not considered viable even with further restructuring and recommended direct liquidation. There was no formula to compute these ratings as the committee considered financial indicators and qualitative analyses of business plans alike.

We obtain all available rating scores awarded until June 1991, covering the first year of the Treuhand's four and a half years of existence. Restricting ourselves to the ratings awarded in the initial year ensures that scores plausibly represent the internal assessment of a firm, rather than the demand from investors that the Treuhand would observe over time. If a firm was rated multiple times as it revised its business plan in response to the evaluation of the Leitungsausschuss, we extract the most recent rating score. The resulting data comprises 584 scores for firms that can be matched with the BvS firm register. We match firm ratings with other firm information using internal Treuhand firm identifiers. A matching was not possible for four firms as internal Treuhand firm identifiers were unavailable in these cases.

Treuhand ISUD Data. We extract information on privatization contracts from the Treuhand's internal data management system (ISUD) obtained from the Federal German Archives (Bundesarchiv). The ISUD system comprises of more than 500 different data tables that are linked with identifiers. Since there is no official documentation, we proceed similar to Akcigit, Alp, Diegmann, and Serrano-Velarde (2023) to extract the purchase price, employment and investment commitments by buyers of privatized Treuhand firms from the data files. We first obtain contracts identified by a contract number, along with the contract date, a firm identifier, and sales price from the tables ASVA02T, VATVT, VATVTH, and ASLG02T. Moreover, we drop observations where any of these variables contains missing information. We disregard all contracts dates outside of the range of years 1990 to 2020.

In the next step, we retrieve employment commitments and their dates at the contract level from the tables ASLG12T, VAPST, VAPSTH, and ASVA12T. We keep only observations with non-missing information, disregard contracts that date outside of 1990 and 2020 and deduplicate at the contract level. We proceed analogously for investment pledges assembled from the tables VAZST, VAZSTH, ASVA15T, and ASLG15T. We merge the contract data set including sales prices and firm links with employment and investment commitments at the contract level such that we keep a contract with firm link whenever we can find an investment or employment commitment. We obtain 13,514 contracts with unique employment commitments summing up to 410,906 employees. Finally, we aggregate commitments and sales prices at the firm

level by taking the sum of all contract variables per firm to obtain a sample of 3,902 firms with non-missing contract details.

MUP Firm Register. We obtain post-privatization ownership information from the MUP for the first cross-section of owners after a firm has been privatized. We identify the relevant firms by linking the MUP with the BvS Firm Registry in a fuzzy string matching procedure. We compare information on firm names, firm addresses and trade registry numbers to find candidate matches and evaluate the match accuracy manually. We then retrieve ownership data on the sample of firms matched between the two data sets. This data includes information on the type of owner, the owner's geographical location, as well as their ownership share. We remove non-qualifying types of ownership (such as liquidators and insolvency administrators) and generate indicators for ownership origin (East German, West German, International) based on the owners' geographical location. We do not remove manager-owners from our sample, which may result in a slight overestimation of East German ownership shares if new owners from outside of East Germany relocated to the location of the privatized firm. We use available information on firm names, address data and trade registry identifiers to link data from the MUP to our other data sources in a fuzzy string matching procedure.

Ultimate Owners. Company ownership typically involves pyramid-like structures, where companies hold subsidiaries. A company j can hold shares in other companies such that ultimate owners of company j can exercise control on these subsidiaries indirectly. We build on the cross-section of shareholders at the company-level where each shareholder i holds a capital share of a_{ij} in company j. To identify the ultimate owners we build a directed network with adjacency matrix **A** whose ij-th element equals the capital share a_{ij} held by i (a natural person or a company) in j. To identify an owner's final share in a company j, one needs to multiply all shares along one possible path to company j via other company holdings. If multiple paths along the firm network exist to company j, multiplied shares are summed up. To

implement this multiplication we use the following simple algorithm using adjancency matrix \mathbf{A} of the directed ownership network:

- Delete iteratively all nodes in A which are not Treuhand companies and have an outdegree of zero i.e. have no subsidiaries.
- (2) Trace indirect holdings of shareholder *i* of degree 1, 2, 3, ... through the network by expontentiation and addition and making use of the fact that A + A² + A³ + ... = (I − A)⁻¹. The resulting inverted sparse matrix' elements are final ultimate ownership shares between each potential node.

Capital Shares. We calculate capital shares a_{ij} based on the relative ownership weight of a specific owner in a given firm. This information is taken directly from the MUP but differs slightly between firms of different legal form. For limited liability companies (GmbH) we retrieve information on the actual distribution of capital ownership between the different owners listed in our data. For stock companies (AG) we do not observe the actual distribution of capital between different owners but can retrieve information on the percentage of capital attributed to a specific owner. Where information on ownership shares is missing , we apply the following imputations:

- Any firm with missing capital shares but only a single qualifying owner will be characterized as being wholly-owned by said owner.
- Capital shares that do not sum up to 100 per cent are smoothed, retaining the relative ownership shares between the owners listed. Implicitly, this means that potential minor shareholders in stock companies (AG) will be ignored in our data. As the focus of our analyses is on controlling ownership, the impact of this should be negligible.
- For firms where ownership weights are missing entirely, we assume equidistributed ownership between the owners listed. As such, any owner will receive an ownership weight of 1/N where N is the number of owners holding a share in the respective company.

• For firms where ownership weights are missing partly, we assume edistributed ownership between the owners with missing capital shares. Each of these owners will receive an ownership weight of (1 - X) * (1/M) where X is the share of company ownership attributed to owners with non-missing capital shares and M is the number of owners with missing information on capital shares

In addition, we calculate a simplified ownership metric based on the number of owners holding a share in a company and assuming equidistributed ownership between them. We disregard available information on capital shares held and assign to each owner an ownership weight of 1/N where N is the number of owners holding a share in the respective company. We confirm our results using this alternative definition of ownership weights a_{ij} . To identify ultimate owners we also consider firm observations for which some of the variables we use in our further analyses may be missing. This way, we ensure that we observe latent ownership links that tie together otherwise separate ownership networks. FIGURE E.1. Treuhand Firm Surveys Questionnaire, April 1991

VC	n Treuhand	unternehmen		
1.	THA-Firmennuma	er (voa Unternehaen u	nbedingt auszufülle	m1) 1
	Postleitzahl			0
	Betriebsnummer (falls vom årb	der Bundesanstalt fü witsamt schon vergeber	n Arbeit	
2.	Vie entwickelt	sich die Beschäftigt	enzahl insgesamt im	Unternehmen?
	Stand am	Beschäftigte insgesant	beschäftigte Frauen	Teilzeitkräfte insg. (unterhalb der tarifl. Vollzeitarbeit, keine Kurzarbeiter)
	1.1.1991	21		22 23
	1.4.1991	24		25 26
	1.7.1991	27		28 29
	1.1.1992	21		211 21
3.	Wie hoch war d (ausgeübte Tät	ie Zahl der Beschäftigkeit) am 1.4.1991?	gten in den folgend	en Qualifikationsstufen
			Beschäftigte insgesant	beschäftigte Frauen
	a) Beschäftigt und Beschäf schlossene	e ait Teilausbildung tigte ohne abge- Berufsausbildung		31 32
	b) Facharbeite	r		33 54
	c) Meister/Tec	chniker		35 36
	d) Fachschulab	solventen		32 38
	e) Hochschulab	solventen		307 310
4.	Vie viele Besc	häftigte gehörten am	1.4.1991 zu den fol	genden Altersgruppen?
	a) unter 18 Ja	hre		41
	b) zwischen 18	und 25 Jahren		42
	c) zwischen 50	und 56 Jahren		43
	d) zwischen 57	und 65 Jahren		44
5.	Wie viele Besc	häftigte varen am 1.4	1991 in Kurzarbeit	?
			Insgesant	Kurzarbeiter mit 100 %
	Kurzarheiter			S1 S1
	THE POLLOT COL			

Note: Figure shows the first page of the Treuhand Firm Surveys questionnaire as fielded in April 1991. The postcode item ("Postleitzahl") is included in the questionnaire but is not included in the data we retrieved. The social security number ("Betriebsnummer der Bundesanstalt für Arbeit") is included but cannot be used to link our data with social security records as firms were not asked for consent. Employees by qualification (3.) and by age groups (4.) were not always asked in subsequent survey waves.

Sources: THA Firm Surveys.

Appendix F. Machine Learning Appendix

We train a machine learning model to predict counterfactual outcomes for firms which were liquidated rather than privatized by the Treuhand. In particular, we focus on predicting whether these firms would have been able to survive and continue to stay economically active for ten years after the end of the privatization program. We use a binary indicator of ten year survival to interpret this question as a supervised classification problem. We employ the observed, factual ten year survival outcomes for firms that were privatized as input to discipline machine learning algorithms predicting counterfactual survival for firms which were liquidated before they could ever be exposed to competitive market conditions. We run our classification task using a decision tree-based random forest algorithm. Random forest algorithms are commonly used on prediction tasks because they combine good predictive performance with high levels of conceptual interpretability. However, there are some limitations as to the types of class-boundaries they can uncover. To probe the robustness of our predictions based on the random forest algorithm, we also use a second, more flexible predictive approach and repeat our classification exercise using a neural network algorithm. Neural networks provide additional modeling flexibility at the cost of substantial losses in model intepretability.

Data. To train our machine learning model, we pool available information on all firms in the Treuhand's portfolio which were privatized and for which we can observe survival outcomes. We end up with 6,410 firm observations, 2,438 of which do not survive 10 years after the end of the privatization program and 3,972 of which who do. To achieve a balanced sample in which both class outcomes occur with similar frequencies, we *upsample* the non-survivor class by repeatedly sampling observations from this group with replacement to obtain evenly sized classes. We then randomly split this pooled data set into a training data set, encompassing 80 percent of observations, and a test data set covering the remaining 20 percent of observations. We use this test data set as a holdout sample upon which we can

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evaluate the performance of the algorithms trained on the training data set. The training-test data split is conducted using stratified random sampling to ensure that both survivors and non-survivors are part of both data subsets and that a balanced representation of both outcomes is maintained across the new subsamples.

Feature Selection and Processing. Machine learning algorithms can combine large amounts of input features flexibly to produce predictions of class membership. We use the following variables as input features into our prediction model:

- firms' initial revenue
- firms' initial employment
- firms' initial labor productivity
- interactions of firms' initial revenue and employment
- firms' average gross wages paid
- the share of female employees among firms' initial employment
- the share of workers with university level training among firms' initial employment
- the share of workers with vocational training among firms' initial employment
- the share of workers without further training among firms' initial employment
- a full set of dummies for 5-digit NACE industry codes
- a full set of dummies for geographic location (federal states)
- a full set of dummies for the Treuhand branch office responsible for administering the firm

We use median imputation for missing values of all features. Moreover, we include in the model a set of dummies specifying when a particular feature is missing for an observation in the underlying raw data. All features are scaled to values between zero and one for both training and test data samples.

Random Forest Algorithm. We build a random forest algorithm using the python library *scikit learn* (Pedregosa, Varoquaux, Gramfort, Michel, Thirion, Grisel,

Blondel, Prettenhofer, Weiss, Dubourg, Vanderplas, Passos, Cournapeau, Brucher, Perrot, and Duchesnay, 2011). As a decision tree-based learning method, a random forest uses recursive sample splitting rules to sort the training data into subgroups (*leafs*) so as to maximize the purity of class outcomes within these. We measure within-*leaf* purity as entropy. A random forest regrows many of these trees on the data set, using a different random subset of all available features each time. The calibration of a random forest algorithm involves choosing hyperparameters for the number of trees to be grown, the depth of trees to be grown, the number of input features to use per tree, as well as measures for defining which minimum improvement in *leaf*-purity is needed to justify an additional split, and when a grown tree should be pruned back.

Neural Network Algorithm. We also use a neural network algorithm to generate predictions for firms' class membership. In particular, we use a preconstructed *multi-layer perceptron* (MLP) classifier algorithm from the python library *scikit learn* (Pedregosa, Varoquaux, Gramfort, Michel, Thirion, Grisel, Blondel, Prettenhofer, Weiss, Dubourg, Vanderplas, Passos, Cournapeau, Brucher, Perrot, and Duchesnay, 2011). Neural networks combine multiple layers of input nodes to predict class outcomes based on combinations of scaled input features. While decision tree-based methods result in generally still interpretable sample splitting rules, the architecture of a neural network is not easily translated into meaningful decision rules. Due to their layered architecture, neural networks are capable of handling increasingly complex and non-linear functional patterns between inputs and outputs. The calibration of the neural network algorithm involves choosing hyperparameters for the number of layers to be used, the number of nodes to be used in each layer, the rate at which the algorithm learns the training data, as well as the number of iterations to be used until training is stopped.

Model Training and Performance. We use the training data set to train both of the above algorithms and select values for the relevant hyperparameters using 10-fold cross-validation. To moderate the computational effort required to train the algorithms, we implement cross-validation based on a randomized parameter grid search. We specify possible distributions for all relevant hyperparameters to construct a grid of all potential parameter combinations. The algorithms are then trained using 1,000 random draws out of all possible parameter combinations. The data is randomly split into ten equally sized bins and each algorithm is optimized by iteratively selecting nine out of ten bins as training data and the tenth as a test subset. We evaluate model performance using a confusion matrices in Tables F.1 and F.2, respectively, as well as by investigating the area under the receiveroperating characteristic curve in Figure F.1. For both machine learning algorithms, the performance evaluation suggests strong performance in the training data set. Both the random forest as well as the neural network reach close to 97 percent accuracy within the sample they were trained with. While these results increase our confidence in the predictive power of the algorithms, performance in the training sample should be strong. Performance in the test sample reaches more than 81 percent for the random forest algorithm and just below 78 percent for the neural network. As expected, these accuracy scores are slightly lower than the training sample performance. However, they still indicate that our prediction model also performs reasonably well when only using observations that were not part of the training process. The task the Treuhand faced in selecting firms for privatization was subject to considerable degrees of uncertainty. Nonetheless, we are able to correctly predict the survival outcomes for more than 4 out of 5 firms in our sample. We evaluate the receiver-operating curves of the two algorithms as an additional measure of performance. The receiver-operating curve graphically illustrates the trade-offs between true positive rate (TPR) and false positive rate (FPR) implicit in a binary classification problem by plotting the respective rates as the classification threshold is varied along a 0-to-1 grid of minimum predictive probabilities. The receiver-operating curve also shows how predictive performance rates relative to a naive baseline. The final predictions that we use in our analyses in Section 5 are based on the slightly

better performing random forest model being trained on the entirety of test and training data described in this appendix. Actual model performance on the firms liquidated by the Treuhand is unobservable and the test error rates reported here can merely provide guidance as to potential model accuracy.

Training Data				Test Data	
	Predicted Non- Survivor	Predicted Survivor		Predicted Non- Survivor	Predicted Survivor
Actual Non- Survivor	3055	123	Actual Non- Survivor	630	164
Actual Survivor	88	3089	Actual Survivor	135	660
Precision	0.97	0.96	Precision	0.82	0.80
Recall	0.96	0.97	Recall	0.79	0.83
Accuracy	0.9	668	Accuracy	0.8	118

TABLE F.1. Predictive Performance - Random Forest: Training & Test Data

Note: Table F.1 reports classification performance metrics from predicting 10 year survival for privatized and liquidated firms using a random forest algorithm. Columns 2 and 3 report performance measures for the observations used in training the algorithm, Columns 5 and 6 report performance measures for the observations held out for testing. Precision is defined as the ratio of true positives to the sum of true positives and false positives. Precision indicates the algorithm's ability to not label non-survivors as surviving. Recall is defined as the ratio of true positives to the sum of true positives and false negatives. Recall indicates the algorithm's ability to find survivors. Accuracy is defined as the share of correctly classified observations.

Training Data				Test Data	
	Predicted Non- Survivor	Predicted Survivor		Predicted Non- Survivor	Predicted Survivor
Actual Non- Survivor	3044	134	Actual Non- Survivor	655	139
Actual Survivor	85	3092	Actual Survivor	226	569
Precision	0.97	0.96	Precision	0.74	0.80
Recall Accuracy	$0.96 \\ 0.9$	0.97	Recall Accuracy	0.82	0.72 703

TABLE F.2. Predictive Performance - Neural Network: Training & Test Data

Note: Table F.2 reports classification performance metrics from predicting 10 year survival for privatized and liquidated firms using a multi-layer perceptron neural network algorithm. Columns 2 and 3 report performance measures for the observations used in training the algorithm, Columns 5 and 6 report performance measures for the observations held out for testing. Precision is defined as the ratio of true positives to the sum of true positives and false positives. Precision indicates the algorithm's ability to not label non-survivors as surviving. Recall is defined as the ratio of true positives to the sum of true positives and false negatives. Recall indicates the algorithm's ability to find survivors. Accuracy is defined as the share of correctly classified observations.

TABLE F.3. Hyperparameter Choice for Machine Learning Algorithms

Random Fo	rest	Neural Network		
Number of Trees	3,000	Hidden Layers	5	
Purity measure	Entropy	Number of Neurons	512,256,128,64,32	
Max. Depth per Tree	None	Activation Function	Hyperbolic tan	
Min. Observations	2	Solver	LBFGS	
for Additional Split				
Max. Features for	$\log(M)$	L2 Regularization	0.00001	
Random Selection		Parameter		
Min. Purity Gain for	1e-7	Initial Learning Rate	0.00001	
Additional Split				
Tree Pruning	1e-9	Learning Rate	Adaptive	
Parameter		Schedule		

Note: Table F.3 reports hyperparameter choices for the trained machine learning algorithms. Values were selected using 10-fold cross validation where appropriate. We implement cross-validation based on a randomized parameter grid search using *scikit learn*'s Randomized-SearchCV. We specify possible distributions for all relevant hyperparameters to construct a grid of all potential parameter combinations. The algorithms are then trained using 1,000 random draws out of all possible parameter combinations. The data is randomly split into ten equally sized bins and each algorithm is optimized by iteratively selecting nine out of ten bins as training data and the tenth as a test subset.



FIGURE F.1. Predictive Performance: Receiver-Operating Characteristic

Note: Receiver-operating curve based on the trained random forest and neural network binary classification algorithm. The receiver-operating curve displays the achieved combinations of true positive rate (survivors classified as survivors) and false positive rates (non-survivors classified as survivors) for different classification thresholds. Iteratively, the minimum probability threshold for belonging to the positive (survivor) class is raised from 0 to 100 percent. The receiver-operating curve is drawn by connecting these value pairs.

Appendix G. Data Availability Statement

The data used in this paper are partly proprietary and can therefore not all be published by the authors. We describe how researchers can access the data:

- BvS Firm Register We will make these data publicly available.
- Treuhand Firm Surveys These data are property of the SOESTRA institute. Researchers should contact Dr. Frank Schiemann (schiemann@soestra.de) to request data access. In our experience, researchers should be able to access these data without incurring any financial cost.
- Treuhand Firm Ratings We will make these data publicly available.
- Treuhand Privatization Contracts These data are available for scientific purposes at the German Federal Archive. Researchers should contact berlin@bundesarchiv.de to request data access. Depending on the mode of data delivery, researchers may have to pay shipment fees (in our experience less than 30 EUR). Additional information on submitting an application for access can be found here: https://www.bundesarchiv.de/en/research-ourrecords/view-and-use-archive-material/submit-a-usage-application/
- MUP Firm Register These data are available for scientific purposes at ZEW Mannheim. We will make the data subset used in our analyses available in the ZEW Research Data Center. Researchers should contact fdz@zew.de to request data access. In our experience, researchers should be able to access these data without incurring any financial cost.