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 government interventions attempting to target the *right* firms to promote industrial policy goals.

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1. Introduction

How do governments select targets for industrial policy interventions? Industrial policy aims at fundamentally changing the industrial structure of an economy (Lane, 2020; Juhász, Lane, Oehlsen, and Pérez, 2022). Industrial policy instruments may include state loans, capital injections, equity stakes, or tariffs. Due to their structural nature, industrial policies often imply high switching costs. Dynamic efficiency gains in the long-term are expected to make up for initial regulatory friction and costs (Greenwald and Stiglitz, 2006). Consequently, an industrial policy's long-term effects depend on the policy *process* implemented in the short-term (Rodrik, 2004). We provide new evidence on how government targeting balances the inherent trade-offs between efficient policy implementation in the short-term and equitable allocations in the long-term. In particular, we study government decision-making and its consequences for what was arguably one of the 20th century's largest cases of irreversible industrial policy: the transformation of East Germany's state-controlled economy after the collapse of socialism.[1]

After the fall of the Berlin Wall in 1989, the German government instated a public agency, the Treuhandanstalt ("trustee agency", abbreviated Treuhand or THA), to reorganize and divest the entire state-owned economy of the former German Democratic Republic (GDR). There was no blueprint for this herculean task where, overnight, the Treuhand became the world's largest holding company. Nonetheless, every firm in the former GDR was privatized or liquidated within less than five years.[2] The Treuhand's privatization and liquidation decisions evoked furious protests, including hunger strikes and the assassination of the Treuhand's president

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[1]The main vehicle of economic transformation in East Germany was mass privatization, which in scale and scope fulfills the criteria defining industrial policy. In particular, active government decisions determined which firms and sectors were to continue to operate and who was to own them. These decisions had a profound and lasting impact on the country's economy, introducing the structural changes typically associated with industrial policy agendas.

[2]There were a few predefined exceptions. Some firms were transferred into municipal ownership or to previously expropriated owners. See Section 2 for details.

Detlef Rohwedder.[3] The German government demanded that privatizations and restructuring be completed in as little time as feasible. Yet, the Treuhandanstalt had profound implications for the economic transformation of East Germany in the long-term. Three decades later, only ten percent of East Germans judge the agency's work as successful (mdr, 2020). Most people associate the program with "sellouts" and "winding-up firms" (Goschler and Böick, 2017).[4]

In this paper, we assess the German privatization program in its entirety using stylized facts from previously unavailable data. We start by assessing the efficiency of the Treuhand's decision-making. To assess whether the Treuhand was able to identify the most productive assets in its protfolio, we study its initial grading of firms and examine privatization decisions as well as the key parameters of the sales contracts. We then study the allocative consequences of initial privatization decisions by tracing ownership networks and following the development of privatized firms over the next 20 years after the end of the program. On this basis, we examine the underlying premise that privatization programs share with other industrial policy measures: that successful intervention relies on the government being able to identify the *right* targets. Specifically, we assess the Treuhand's legal mandate of privatizing companies based on competitiveness as opposed to preserving certain industries or regional clusters of firms. We analyze the privatization agency's actions by examining firms' initial labor productivity as an indicator of their competitiveness and evaluate how privatization outcomes vary across the productivity distribution. These outcomes comprise the selection of firms for privatization, the speed of privatization, and the privatization contract's main components, including the sales price. Next, we

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[3]Recently showcased in a 2020 *Netflix* production highlighting the controversial nature of the privatization program. Rohwedder's murder is attributed to the "Red Army Faction", a West German terrorist organization.

[4]Public dissatisfaction is echoed by the strengthening of Germany's populist left and extreme right parties, which have advocated for a new parliamentary inquiry into the Treuhand privatizations. Björn Höcke, *Alternative for Germany* (May 1, 2019): "The impoverishment and homeland destruction here with us has a name. That name is Treuhand." Dietmar Bartsch, *The Left* (June 27, 2019): "The Treuhandanstalt privatized one hundred times more companies in one year than Maggie Thatcher privatized in ten years. [...] The Treuhand deindustrialized on a large scale and thus set back the East to this day." (Adler, 2019; von Lieben, 2019).

examine how initial firm-level productivity under state ownership shaped the new ownership allocation as well as firms' long-term survival and employment levels up to 20 years following privatization. Finally, we conduct a counterfactual evaluation to assess whether the Treuhand could have improved the program's long-run outcomes by privatizing a different set of firms from its portfolio.

The East German setting advances the understanding of privatization beyond what is known from other countries that implemented large-scale programs, in particular Russia and China. Similar to Russia, the GDR's state sector accounted for 96 percent of GDP prior to the privatization program. Both economies also exhibited a similar degree of centralization (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, German reunification entailed that the former GDR adopted existing West German institutions with immediate effect, such that privatization activities took place under the realm of a developed market economy. Hence, the East German case exemplifies a large-scale privatization event without the confounding backdrop of a dynamically evolving political transition context. Privatization in China, on the other hand, was also of enormous scale and occurred within a consistent institutional environment but took place more gradually. Due to the continuing dominance of China's state-controlled economic institutions, 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 element of the economy (Hsieh and Song, 2015). In Germany, privatization was carried out within established regulatory frameworks, was of unprecedented scale, and completed without strategically important firms remaining under state control. Nevertheless, all programs faced the challenge of deciding which firms to privatize and how to choose future owners. As such, the Treuhand's privatization program continues to be a test case for whether large-scale privatization programs can be implemented effectively.

Our dataset builds upon a series of newly available sources. The starting point is an administrative register of all the Treuhand's firms and their privatization outcomes. We then draw upon firm surveys to construct labor productivity indicators at the beginning of the program. These are the common measures of single-factor productivity (Syverson, 2011) and provide an easily interpretable overview of firms' initial economic conditions. From newly accessible data of the German National Archives, we digitize firm rating scores used internally by the Treuhand. Moreover, we retrieve privatization contract data on sales prices and employment as well as investment pledges made by investors. Finally, we exploit private register data that enables the tracing of privatized firms under their new ownership for more than 20 years. This allows us to study the relevance of post-reunification privatizations right up to the most recent past. Our dataset is unique in exploiting internal firm rating scores issued by a privatization authority, observing privatization prices (Lopez-de Silanes (1997) is another exception here), and studying privatized firms' corporate survival over a period of 20 years.

Using firm-level regressions, we document that the Treuhand was more likely to privatize firms with higher labor productivity. These were also privatized faster. By examining the Treuhand's internal firm rating scores, we show that the privatization agency was able to identify and prioritize firms with favorable starting conditions and thereby contributed to these outcomes. Next, we demonstrate that the Treuhand achieved higher sales prices as well as higher employment and investment pledges for firms with higher productivity levels. Our results also rule out alternative hypotheses not covered by the Treuhand's mandate, such as strategic targeting of regional or sectoral firm agglomerations. We then identify and analyze the ultimate owners that assumed firm ownership after the conclusion of the privatization program. We reveal that more productive firms were more likely to be sold to non-local owners, especially from West Germany. In contrast to other post-Soviet economies, we find that the East German privatization program did not give rise to a class of oligarchs that concentrated large shares of corporate ownership among themselves. Finally, we show

that firms' baseline labor productivity predicts their post-privatization survival and employment in the short-, medium- and long-term. Conditional on higher baseline productivity, firms with West German or international owners were more likely to survive over periods of ten and twenty years, respectively. Complementing these analyses, we conduct a counterfactual benchmark analysis that uses machine learning techniques to evaluate overall firm survival if the Treuhand had privatized a different selection of firms. The findings suggest that ten-year survival rates among the firms privatized by the Treuhand are similar to those obtained in a hypothetical selection purely based on sorting by observable productivity.

Our study makes four contributions to the existing literature. First, our research addresses the key determinant of successful state intervention and industrial policy: whether governments are able to pick the right policy targets (Lerner, 2002; Rodrik, 2008; Aghion, Cai, Dewatripont, Du, Harrison, and Legros, 2015; Cingano, Palomba, Pinotti, and Rettore, 2022). Empirical research in this area is "thin" (Lane, 2020) and 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). In contrast, the Treuhand's portfolio spanned the entire spectrum of East German sectors. Selecting viable firms was a challenging task as the agency had to prioritize firms while complying with severe financial, bureaucratic, and time constraints. Analyses of the GDR's economy at the time of transition estimated that East German firms were generally not viable under the market conditions provided by German reunification (Akerlof, Rose, Yellen, and Hessenius, 1991). Hence, the agency was forced to actively identify and support viable firms instead of passively waiting for private investors. While our benchmark analysis suggests that the Treuhand was able to select promising firms similarly well as a simple productivity-based selection rule, the analysis also uncovers remarkable heterogeneity within the privatization agency. The choice of firms for privatization made by the Treuhand headquarters outperforms the hypothetical allocation in which firms were chosen purely based on their initial labor productivity. Conversely,

selections made by the Treuhand's regional branch offices perform worse than a purely productivity-based selection, possibly because branches had less access to information and resources. These findings suggest that governments' ability to pick winners crucially depends on the constraints imposed on the respective authority. Our findings also emphasise the importance of the institutional set-up more broadly. 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 managing industrial policy ambitions efficiently (Bardhan, 2016).

Second, our analysis contributes to the literature on firm privatization. By tracing the entire course of the privatization program, we are able to 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 for its decisions. 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 advise the empirical privatization literature where studies typically evaluate firms' post-privatization 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 related problem of sequencing in the privatization of Czech

companies where the government could sell firms either in the first or second phase of their program. Our finding that firms' likelihood and timing of privatization are positively selected on productivity corroborate 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. In addition, we assess the role of buyer motives by gauging whether West German investors engaged in "killer acquisitions" to wreck potential East German competition (Cunningham, Ederer, and Ma, 2021), a popular narrative in the public debate. Our results do not support this hypothesis as we find that Eastern firms under West German ownership boast higher rates of survival than locally owned firms.

Third, our results build upon the literature on democratization and distribution. We go beyond 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). Guriev and Rachinsky (2005) track the ultimate shareholdings of Russia's business elites. They find that today's oligarchs often started out as Soviet government insiders or politically connected bankers who exploited privatizations to acquire major stakes and build up their fortunes. In contrast, we find low levels of concentration among domestic ultimate owners of privatized firms in East Germany. This may be a consequence of the existing West German institutional framework preventing former

East German insiders from leveraging political oversight into ownership. In addition, the most productive companies were rarely sold to East Germans 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).

Finally, our work enhances the understanding of privatization in East Germany. Empirical studies on the Treuhand privatizations are strikingly rare and focus on specific aspects. Analyzing the dynamics of the Treuhand's bargaining with buyers, Hau (1998) detects a subsidy bias towards large state-owned enterprises, which increases over time. His model rationalizes this finding as the option to liquidate gradually becomes politically infeasible in sectors affected by high unemployment. In a sample of 89 East German firms, Dyck (1997) finds that privatized firms have greater levels of management replacement than firms still in Treuhand ownership. The scarcity of research may at least partly result from the German government's reluctance to bring the issue to the fore, highlighted by the fact that it never commissioned an empirical evaluation of the Treuhand program. Instead, as Hoffmann (2020) points out, the government in 1994 mandated a legal opinion advocating for a narrative of "reconciliation through secrecy". Archival data documenting the Treuhand's activities have only recently been made available for research (Bundesarchiv, 2019). Using these data, we go beyond existing studies by analyzing the internal decision-making process of the privatization agency, identifying the owners of privatized firms, and providing both a short- and long-term analysis of the privatization process.

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. Mass Privatization in East Germany

In this section, we briefly review the main elements of the Treuhand privatizations, one of the largest privatization waves in history. The program followed the fall of the Berlin Wall, which culminated in the collapse of the GDR's central planning economy. The federal government of reunified Germany abolished the planning system and introduced the existing West German market institutions as well as regulations to the East. It also ended public ownership of the business sector. The Treuhand Law (TreuhG) and preceding legislation enacted by the last socialist government required all state-owned enterprises to be transferred to the newly created Treuhand agency. On July 1ˢᵗ 1990, the Treuhand owned more than 10,000 companies with about 4 million employees. These firms composed all listings of the GDR's registry of publicly owned operations (Kühl, Schaefer, and Wahse, 1991).

The Treuhand's legal mandate was to reduce the state's entrepreneurial activity as much and as quickly as possible through privatization. Non-competitive firms were to be liquidated (TreuhG, Preamble; Bundesanstalt für vereinigungsbedingte Sonderaufgaben, 2003). 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*, a committee of consultants comprising auditors, financial managers and banking experts subsequently evaluated the business situation. Funded by the Ministry of Finance, this committee issued recommendations for action that the Treuhand's board typically followed (Böick, 2018, p.285).

The main method of privatization was direct sales to investors. Large-scale auctions and voucher systems, which were implemented in several other countries, were not used.[5] In addition to developing an efficient economic structure, the Treuhand's task was also to maintain and create employment (TreuhG, Preamble). Hence, when

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[5]See Bolton and Roland (1992) for a comparison of privatization policies in Germany, Czechoslovakia, Hungary, and Poland.

negotiating with investors, the Treuhand asked for employment and investment guarantees in addition to the sales price. Nevertheless, fierce protests by workers, unions, and politicians accompanied numerous privatization and liquidation decisions.

The Treuhand agency was a public-law corporation. However, the agency was overseen by a supervisory board and controlled by the Federal Ministry of Finance. The government instated the supervisory board and drew its members from federal ministries, East German state governments, as well as business associations and unions. The supervisory board appointed the members of the executive board and monitored their decisions. Moreover, the Federal Ministry of Finance had the right to review the Treuhand's decisions when the companies concerned exceeded certain size limits. At least partially reconstructing these limits, Figure A.1 in Appendix A indicates that the ministry largely refrained from exercising its supervisory rights, especially for larger firms.[6] Internally, the Treuhand created a two-tiered organizational structure, consisting of a headquarters in Berlin and fifteen regional branch offices. The headquarters was in charge of enterprises with more than 1,500 employees, with several exceptions. Regional branch offices were responsible for companies below this threshold, although the company database providing for a definite assignment only became available in April 1991. Despite the unique situation prevailing in East Germany, the Treuhand's institutional setting resembles 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 out 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.

Several challenges complicated the Treuhand's situation. East German firms generally suffered from overstaffing, outdated production technologies, the collapse of

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[6]The size cutoffs give rise to a potential regression discontinuity design. Unfortunately, we do not observe firm balance sheet totals such that we can only identify a subset of eligible firms. Moreover, thresholds were quite high to the extent that the number of firms potentially qualifying was low, even though their shares of total employment and revenue were systemically important.

traditional export markets in the Soviet Union, and a lack of market experience. At the same time, currency reform and union bargaining substantially increased labor costs, further deteriorating the business situation (Dornbusch and Wolf, 1994). Akerlof, Rose, Yellen, and Hessenius (1991) illustrate the extent of these problems by analyzing the business situation of the GDR's major companies. These companies regularly exported products to clients outside the Soviet Union, allowing the authors to compare domestic resource costs for these products and their market-based export value in 1989. The results paint a grim picture of the firms' competitiveness, given that the production costs of all but one of the 183 enterprises exceeded their respective revenues. The Treuhand opening balance sheet already indicated a shortfall of 250 billion DM. Within this context, the Treuhand made significant concessions to potential buyers, including capital injections, investment grants, debt redemptions, and the assumption of environmental liabilities. These types of subsidies frequently exceeded the actual sales prices (Hau, 1998). Although the government possessed great financial strength, the West German public was highly skeptical of additional support in the face of the feared billions in losses (Böick, 2018, p.454).

Personnel and time constraints posed additional challenges. To begin its operations at full strength, the Treuhand headquarters alone needed about 2,000 experienced specialists in holdings management and firm sales within a couple of months. However, finding qualified employees for a public agency with unknown prospects was tedious at a time when major West German banks would not have more than 25 experts for privatization issues (Der Spiegel, 1990). The Treuhand eventually recruited a mix of young university graduates and elder managers close to the end of their careers, though personnel shortages continued to be an unremitting bottleneck (Böick, 2018, p.349). Finally, the privatization program also operated under time restrictions as the Treuhand Law stipulated that the Treuhand should fulfill its task as soon as possible. The Treuhand Financing Act (THA KredG) provided funding only through 1994 and the Ministry of Finance clarified in 1992 that the dissolution of the authority was expected by this time (Seibel, 2005, p.319-321).

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 remainder is divided between firms restituted to former owners and firms municipalized. These 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, which was absorbed by the federal government (Bundesanstalt für vereinigungsbedingte Sonderaufgaben, 1994). The Bundesanstalt für vereinigungsbedingte Sonderaufgaben (BvS), the Treuhand's successor organization, continued contract surveillance and other remaining tasks.

FIGURE 1. Final Firm Outcomes of Treuhand Operations
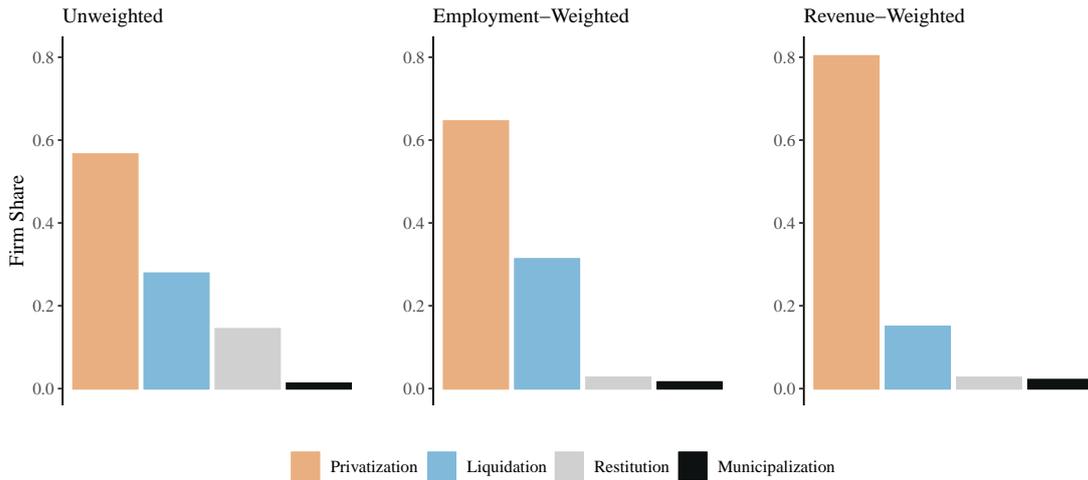
Note: Relative frequencies of final firm privatization outcomes among all firms formerly owned by the Treuhand. Privatization entails the sale of a public firm to private investors. Liquidation implies the termination and dissolution of a firm. Restitution comprises the return of firm assets to former 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.

3. Data

In this section, we describe the five key components of our data and explain its main variables. These components comprise an administrative firm register supplemented with data sources on initial labor productivity, firm rating scores, sales prices along

with other contract features, post-privatization firm ownership, and corporate survival. This is the first data set based on the whole universe of firms that was subject to the East German mass privatization program. We also cover firms' post-privatization outcomes, tracing them from 1990 until 2015.

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 full population of Treuhand firms and derives from 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. Their status indicates if a firm 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 10,877 firms that were either privatized or liquidated. 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 companies conducted during and after their privatization (Kühl, Schaefer, and Wahse, 1991). As of 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 major labor productivity indicators: revenue per worker and revenue per hour. The former is a standard indicator of firm-level productivity also used by Decker, Haltiwanger, Jarmin, and Miranda (2017), for instance. The latter indicator additionally captures differences in firms' use of short-time work schemes. As of February 1991, 22 percent of East German employees were in short-time schemes (Akerlof, Rose, Yellen, and Hessenius,

1991). As we aim to construct a cross-section of firms' initial labor productivity, we invariably 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 the 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 comprises 588 scores for firms that can be matched with the BvS firm register. Restricting ourselves to the 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 to six. The best achievable 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 would recommend direct liquidation.

Treuhand Contract Data. We employ administrative Treuhand data on privatization contracts from Hau (1998), who obtained the data directly from the Treuhand's

controlling division. For firms in 17 major manufacturing industries[7] privatized prior to December 1993, these data comprises the sales price as well as the employment and investment commitments made by the buyer during negotiations with the Treuhand. These contracts are available for 2,148 firms.

MUP Firm Register. We complement the data on Treuhand-administered firms by adding 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 the entirety of economically active firms in East Germany from 1993 onward. Hence, most firms

FIGURE 2. Dataset Construction

Universe of Treuhand Firms
N = 10,877

Privatized Firms
N = 6,929
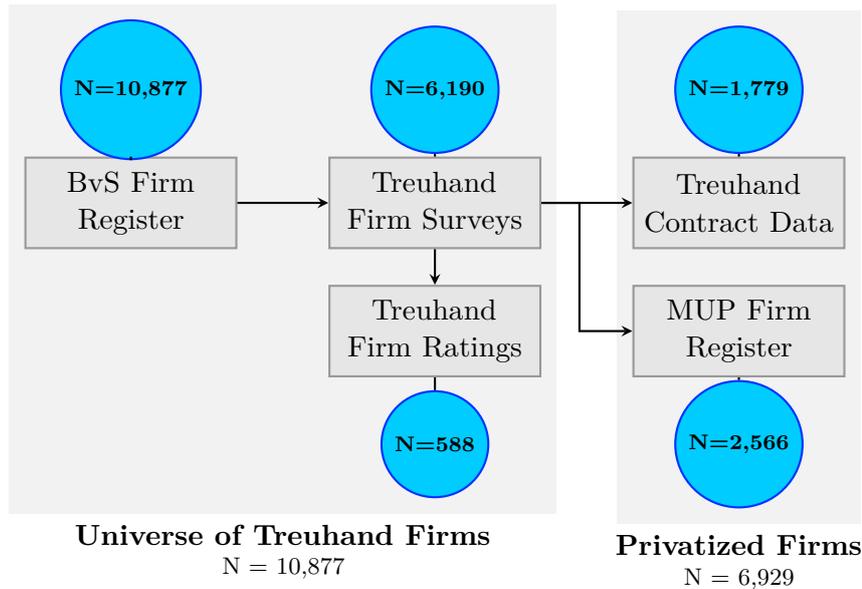
Notes: Each node indicates the data source and final sample size after matching along the direction of the arrows. Firms without match or missing information about productivity are excluded. Starting point for the dataset construction process is the BvS administrative firm register. We focus on the Treuhand firms that were either privatized or liquidated. We exclude firms that were restituted to previously expropriated owners or municipalized. An assessment of sample representativeness is reported in Table 1.
Sources: BvS Firm Register, THA Firm Surveys, THA Firm Ratings, THA Contract Data, and MUP Firm Register.

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[7]These industries include Chemicals, Plastics, Ceramics, Light metal, Steel, Machinery, Cars, Electrical, Optical, Consumer, Wood, Paper, Leather, Textile, Food, Construction, and Construction Supply.

administered by the Treuhand are included in the database. Our data collection includes information on ownership, ownership location, closure date, and legal form. Ownership information include the owners' address, information on whether they are 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 these 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 jointly observe ownership, survival data, and labor productivity indicators for 2,566 firms privatized by the Treuhand.

Figure 2 demonstrates the data construction process. Table A.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. 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. We find the sample of surveyed firms to be representative of the Treuhand firm population overall. There is no statistically meaningful difference in privatization incidence between surveyed and non-surveyed firms. In addition, the geographical distribution of the surveyed

firms broadly corresponds to the distribution of the entire firm population. While there is a statistically significant difference in the share of firms based in the state of Saxony, the actual magnitude of this difference – 32.8 percent of surveyed firms vs. 31.2 percent of the firm population – remains marginal.

To gauge the representativeness of the subsamples used in our additional analyses, we compare the available economic indicators of these subsamples to the pool of surveyed firms which we use as a proxy for the entire firm population. The mean difference tests in Table 1 document that there are only few differences between the samples used in our analyses and our approximations for the population of Treuhand firms. Notably, the firms included in the THA firm ratings data are larger, less productive, and more likely to be in manufacturing industries than the firms in the underlying population. However, these differences stem from the fact that only the largest and most important GDR firms were rated by the Leitungsausschuss and therefore a sorting pattern is to be expected. We also find that the manufacturing firms stemming from the THA contract data (analyzed in Section 4.3) are smaller (394.7 vs. 434.6 employees on average) and less productive (up to 0.071 log points difference) than the corresponding population, but the economic magnitude of these differences remains minor. Similarly, we find differences in the share of manufacturing firms (66.0 percent vs. 71.0 percent) and in some geographic indicators used in Sections 4.4 & 4.5 that are statistically different from zero but likely of limited economic and econometric relevance.

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

4.1. Assessing the Logic Behind Privatization Decisions. The Treuhand was instated as a public privatization agency tasked with administering the portfolio of formerly state-owned firms in East Germany. For all these firms, the Treuhand had to decide whether they should be sold or liquidated. This decision was to follow the criterion of whether a firm would be competitive under market conditions. We

TABLE 1. Sample Comparison

	Privatized & Liquidated Manufacturing & Services					Privatized Manufacturing			Privatized Manufacturing & Services		
	Section 2	Section 5.1.1		Section 5.1.2		Section 5.2			Section 5.3 & 5.4		
	I	II	I-II	III	II-III	IV	V	IV-V	VI	VII	VI-VII
	mean	mean	p-value	mean	p-value	mean	mean	p-value	mean	mean	p-value
Sources											
BvS Firm Register	✓	✓		✓		✓	✓		✓	✓	
Treuhand Firm Surveys		✓		✓		✓	✓		✓	✓	
Treuhand Firm Ratings				✓		✓					
Treuhand Privatization Contracts				✓		✓				✓	
MUP Firm Register							✓			✓	
Privatization Outcomes											
Privatization (0/1)	0.679	0.676	0.344	0.646	0.074	1.000	1.000	-	1.000	1.000	-
Firm Characteristics											
Employees (#)	-	375.200	-	909.500	0.000	434.600	394.552	0.035	368.900	344.611	0.061
Log Revenue per Worker (in DM/pers)	-	4.299	-	3.893	0.000	4.311	4.240	0.006	4.431	4.444	0.290
Log Revenue per Hour Worked (in DM/hour)	-	3.759	-	3.425	0.000	3.769	3.719	0.021	3.867	3.880	0.272
Manufacturing (0/1)	-	0.652	-	0.851	0.000	1.000	1.000	-	0.660	0.710	0.000
State: Brandenburg	0.144	0.147	0.297	0.144	0.422	0.143	0.144	0.446	0.155	0.096	0.000
State: Mecklenburg West. Pom.	0.112	0.106	0.113	0.056	0.000	0.090	0.089	0.423	0.115	0.131	0.024
State: East Berlin	0.098	0.090	0.058	0.089	0.455	0.059	0.061	0.372	0.080	0.099	0.003
State: Saxony	0.312	0.328	0.016	0.337	0.330	0.349	0.336	0.177	0.309	0.311	0.414
State: Saxony-Anhalt	0.174	0.169	0.202	0.200	0.037	0.175	0.178	0.411	0.177	0.182	0.277
State: Thuringia	0.162	0.159	0.304	0.173	0.196	0.184	0.192	0.246	0.164	0.180	0.041
Observations	10877	6190	-	588	-	2684	1779	-	4065	2566	-

Note.– The table provides means for major variables to compare the different data segments used in this paper. Each column represents a sample that comprises one or several data sources. BvS data is a firm register and does not include industry, firm size, or firm productivity. BvS and Söstra data represent all Treuhand firms. Treuhand contracts are only available for a subset of manufacturing firms. Leitungsausschuss only comprises firms steered by the Treuhand headquarter (i.e. larger firms). Treuhand contracts are only available for a subset of manufacturing firms. The MUP firm register encompasses the entirety of firms in East Germany. P-values of t-tests for equal means are reported.

Sources.– BvS Firm Register, THA Firm Surveys, THA Firm Ratings, THA Privatization Contracts, MUP Firm Register.

approximate firms' competitive potential by measuring firm-level productivity, an indicator of competitiveness that is both commonly used and easily comparable across firms, regions, and industries. Our analysis combines parametric and non-parametric approaches. We begin analyzing each stage of the privatization process by plotting the quantiles of the productivity distribution across firms against the outcome of interest. This enables us to assess the relationship without relying on strong parametric assumptions. In the next stage, we apply ordinary least squares regressions to condition on other regressors. In particular, we estimate models of the form

$$Y_i = \alpha + \gamma Productivity_i + \delta_s + \mu_l + \nu_t + \varepsilon_i \qquad (1)$$

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, depending on the question studied. 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 to account for potential targeting of industrial clusters. To exclude potential regional policy differences or political targeting of constituencies we use state fixed effects μ_l (including East Berlin) in all base specifications. 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 heteroscedasticity robust standard errors throughout.

We test the robustness of our correlations with alternative fixed-effects such as firm employment size categories, decentralization of decisions to local agency branches, administrative districts and four-digit industries in the appendix.

4.2. Privatization Decisions.

4.2.1. *The Role of Labor Productivity in Privatization Decisions.* We begin by examining whether more productive companies had a larger chance of being privatized. A widespread critique of privatization in East Germany has been that economically sound firms were shut down, despite the Treuhand's statutory responsibility to develop businesses that could be restructured and privatized. In order to test the agency's fulfillment of its mandate, we expect more productive firms to be associated with higher privatization rates. For successful privatization, the productivity level of a firm needed to be high enough to survive in a competitive market environment. Otherwise, the privatization agency would spend scarce financial and personnel resources on unsustainable privatization cases. Several political and economic forces threatened this goal. First, the privatization agency may experience pressure from politicians who prioritized protecting their constitutents' jobs notwithstanding the productivity of the firms (Grossman and Helpman, 1996; Faccio, Masulis, and McConnell, 2006; Hodler and Raschky, 2014). For instance, anecdotal evidence suggests that Chancellor Helmut Kohl's visit to the so-called chemical triangle around Halle (Saxony-Anhalt) in 1992 saved the major companies from liquidation. The Treuhand therefore granted generous financial support to buyers, despite an expert's report by the consulting firms Arthur D. Little and McKinsey attesting that these companies were not economically viable (Lamparter, 1992). Second, the privatization agency may have experienced institutional capture as almost the entire executive level of the Treuhand was recruited from West German companies. These companies may have feared the emergence of strong competitors from the East, and thus tried to prevent the privatization of especially productive firms.

Analogous to the link between labor productivity and privatization decisions, more productive firms would also benefit from faster privatization and receiving a higher priority from the privatization agency. If productive firms were privatized sooner, the agency could focus on the more cumbersome cases remaining in its portfolio. This practice would also be consistent with the Treuhand's mandate to privatize as soon

as possible. In the following section, we study firms' baseline labor productivity and its relationship to the privatization outcome as well as the speed of privatization.

FIGURE 3. Privatization, Time to Privatization, and Baseline Productivity
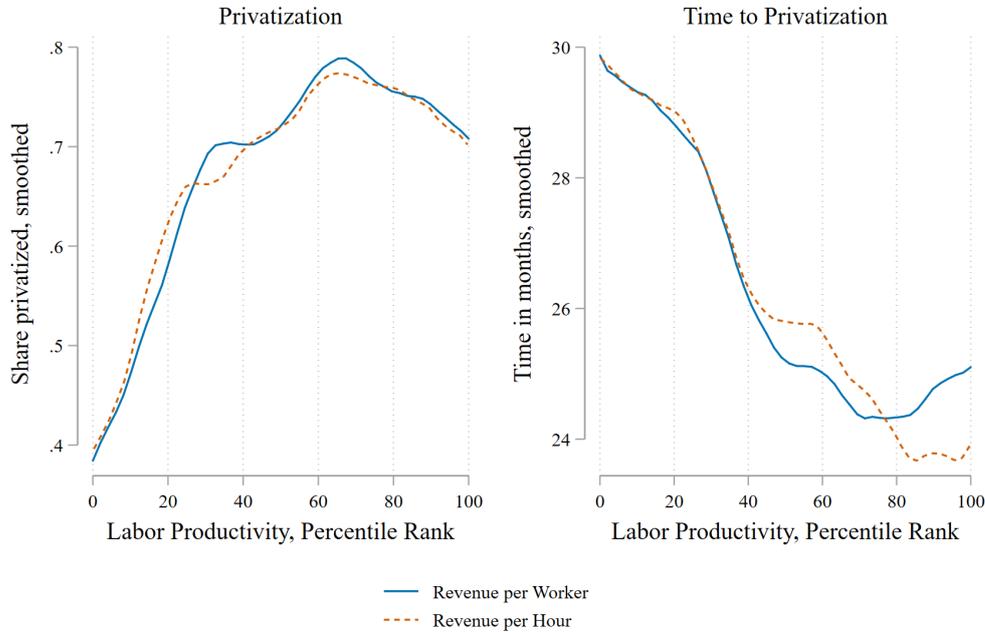
Note: Left panel shows mean privatization shares by firms' percentile rank in the labor productivity distribution ($N = 6190$). Right panel depicts mean time to privatization by firms' percentile rank in the labor productivity distribution ($N = 4076$). This panel excludes liquidated firms. Rank coefficients are calculated using Hazen's rule. Smoothing procedure uses an Epanechnikov kernel function of degree zero.
Sources: BvS Firm Register and THA Firm Surveys.

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. Focusing on percentile ranks offers an effective yet simple non-parametric safeguard against potential outliers and nonlinearities. The figure shows the overall tendency among firms with higher revenue per worker or revenue per hour to experience higher rates of privatization. Firms at the bottom of the labor productivity distribution were privatized at a rate of below 40 percent, whereas firms at the top of the distribution experienced privatization rates of about 70 percent. Given that a firm was privatized, the right-hand panel presents an analogous tendency for labor productivity and the time until privatization. The

least productive firms found an investor after some 29 months, whereas the most productive firms could expect privatization to take place as early as within 24 months. These patterns strongly support the role of productivity in privatization decisions, but a major concern is that these tendencies simply reflect industry-effects.

Table 2 provides the results of the corresponding ordinary least squares regressions that also control for industry fixed-effects, state fixed-effects, and survey-time fixed effects. Columns (1) and (2) confirm that a firm's privatization probability increases with its baseline labor productivity indicated by revenue per worker or revenue per hour. In particular, a ten percent increase in revenues per worker raises the expected privatization probability by 0.76 percentage points. Columns (3) and (4) repeat the same analysis for the group of privatized firms, using the duration until privatization takes place as the outcome. The resulting coefficients suggest that a ten percent increase in revenues per worker roughly corresponds to a 0.12-months reduction in this period; a 0.16-months reduction is suggested when using revenues per hour as our measure of labor productivity.

TABLE 2. Regression Results: Privatization, Time to Privatization and Productivity

| | (1) | (2) | (3) | (4) |
	Privatization Probability		Months to Privatization	
Log Revenue per Worker	0.076***		-1.161***	
	(0.007)		(0.266)	
Log Revenue per Hour		0.074***		-1.578***
		(0.007)		(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.

We subsequently assess the robustness of these associations by altering our basic regression model. Table A.2 in the appendix summarizes these results for the privatization probability; Table A.3 does this for the time until privatization. As

larger firms may be more productive and less likely to be liquidated, we first assess whether our specification is robust by including firm size dummies according to the classification by Haltiwanger, Hyatt, Kahn, and McEntarfer (2018). These authors differentiate firms with less than 50 employees, firms between 50 and 500 employees, and firms with more than 500 employees. The corresponding results presented in column (1) strongly reaffirm our previous estimates. We then ask whether our results are equally valid for the subsample of manufacturing firms, as major studies of privatization are restricted to the industrial sector (see, e.g. Frydman, Gray, Hessel, and Rapaczynski, 1999; Brown, Earle, and Telegdy, 2006, 2010). Column (2) suggests that the association between labor productivity and privatization is even stronger for manufacturing firms. Potential explanations might be that the concept of labor productivity is more salient for manufacturing firms and that privatized manufacturing firms are an even more selective group. In column (3), we inquire whether we reach similar conclusions with more complex measures of productivity, such as the firm's gross value added. The resulting coefficient shows that using this indicator leads to the same qualitative result. As this indicator derives from surveys further away from the base period and is only available for a smaller sample, we do not include it in our initial estimates. In the next step, we ask whether it is possible to explain the productivity-privatization link by performance differences between the Treuhand headquarters and the fifteen regional branch offices that were handling a respective firm. As column (4) demonstrates, adding a full set of fixed effects for branch offices and headquarters to our model does not alter the relationship between productivity and privatization probability or time. The model presented in column (5) analyzes the potential role of geographical heterogeneity, as firms close to West Germany could be more productive and more marketable at the same time, for instance. However, adding district fixed effects to our model corroborates the initial findings. Similarly, using a more finely tuned industry classification (four-digit level) leaves these relationships unchanged, as summarized in column (6).

Finally, we address the concern that break-ups of former publicly-owned companies (Volkseigene Betriebe, short VEB) systematically split firms along productivity differences. Productivity differences across Treuhand firms then would not originate from the GDR but the Treuhand's restructuring activities. We assess this argument by aggregating our Treuhand firm data at the level of former VEBs. In addition, we drop firms indicated as spin-offs that cannot directly be linked to a former VEB. Table A.4 presents the results based on this smaller sample. We still find the same tendencies in privatization patterns and privatization speed as observed in Table 2. The coefficient magnitude is slightly smaller for the decision to privatize and slighly larger for the time to privatization. Overall, we show that these initial estimates are robust to a wide range of plausible objections and conclude that there is a meaningful statistical association between firms' initial labor productivity and their chances of a successful privatization process.

4.2.2. *Explaining Privatization Patterns: The Role of Treuhand Policies.* We now explore the underlying reasons for the positive selection of firms into privatization. As the Treuhand held a screening function within the privatization process, an obvious choice would be to attribute this tendency to the stringent work of the privatization agency. For example, Roland (1994) argues that a privatization program must separate economically sound firms from unsound ones, since large-scale privatization of the latter would undermine the stability of the financial system. However, it is equally feasible that investors' higher demand for more productive firms leads to such a sorting pattern. To examine whether the Treuhand played a role in distinguishing between productive and non-productive firms, we analyze internal firm rating scores assigned to firms managed by the Treuhand headquarters. Firms managed by the Treuhand branch offices, typically much 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 successful screening mechanism, better scores would also predict higher privatization rates and shorter time spans to privatization.

FIGURE 4. Privatization, Time to Privatization, and Firm Rating Scores
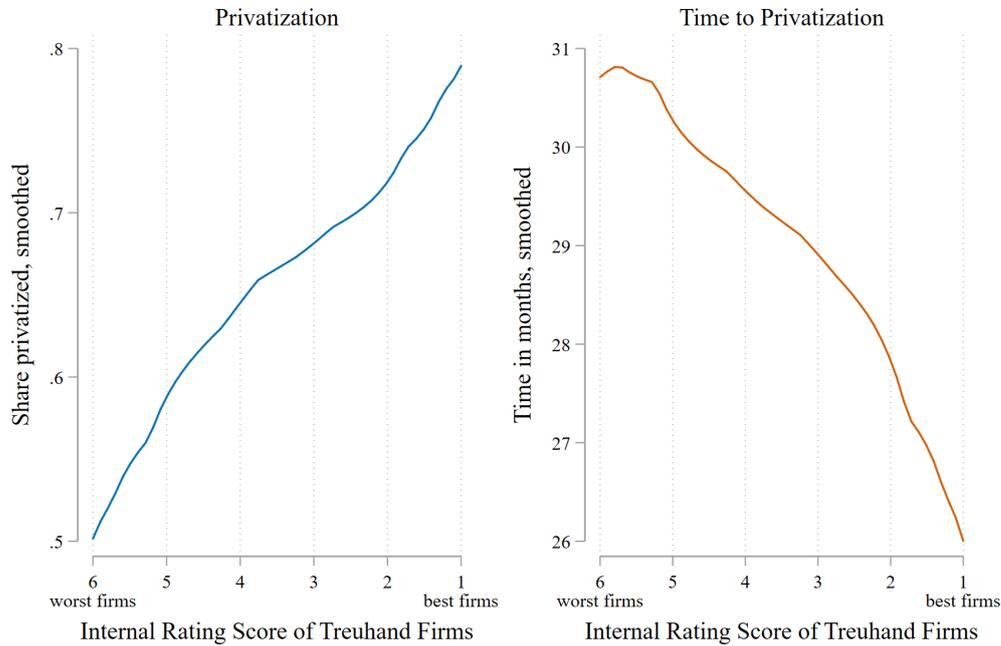
Note: Left panel shows mean privatization shares by internal firm rating scores ($N = 588$). Right panel depicts mean time to privatization by internal firm rating scores, i.e. excluding liquidated firms ($N = 377$). Smoothing procedure uses an Epanechnikov kernel function of degree zero. The sample contains firms that were rated between July 1990 and June 1991. *Sources:* BvS Firm Register, THA Firm Surveys, and THA Firm Ratings.

Figure 4 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 firms with smaller, that is 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 privatized in about half of the cases. The right panel shows that least favorably rated firms are on average privatized after almost 31 months which is about five months later than firms with a top rating. Thus, firm rating scores used internally by the Treuhand predict privatization outcomes, similar to firms' productivity indicators. In Table A.5 in the Appendix A we further corroborate that better ratings are associated with better privatization chances. To this end, we compare the privatization probability of firms achieving a certain rating threshold to

worse rated firms that exhibit matching characteristics in terms of their institutional environment, such as state and industry. Overall, this exercise and Figure 4 support the interpretation that the Treuhand's screening policies were effective in identifying productive firms independently of investor demand,[8] which later corresponds to more privatizations and fewer liquidations of productive firms.

4.3. Privatization Contracts: Sales Prices, Investment and Employment Guarantees.

In this section we examine whether the Treuhand achieved more favorable privatization contracts for more productive firms. In the public debate, it is often alleged that the Treuhand gave away companies too cheaply. For instance, in a recent parliamentary debate Dietmar Bartsch of the party *The Left* stated that "The Treuhand has turned the East into a junk shop" as it was selling several firms for the symbolic price of 1 DM. In fact, the Treuhand pursued multiple goals in its negotiations with potential buyers. Bids did not only contain a sales price, the Treuhand also demanded employment and investment guarantees, restructuring of management, and the general continuation of business activity (Treuhandanstalt, 1994). The heavy financial and employment losses, which became apparent with the end of the agency's operations, drew criticism to its sales strategy.

We use final privatization contracts negotiated between the Treuhand and respective buyers from Hau (1998). Matching contracts with surveys and adminstrative data, the resulting dataset on average contains slightly smaller and less productive firms as summarized in Table 1. This difference is likely due to the particular subset of manufacturing sectors in Hau (1998)'s contract data. We examine whether for more productive companies included contracts with higher sales prices, employment as well as investment guarantees. We expect the contractual outcomes to increase

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[8]Supplementary analyses at the industry-level as presented in Figure A.3 of the appendix indicate that (i) initial investor inquiries for Treuhand firms are not positively associated with initial productivity (ii) investor inquiries are not systematically related with privatization shares and the time to privatization.

with labor productivity, given that both the Treuhand's bargaining power and the bidders' idiosyncratic valuation of firms are increasing functions of productive efficiency of labor. Figure 5 shows upward curves for sales prices, job guarantees, and investment promises against our measures of labor productivity. Both measures of labor productivity show similar patterns. Whereas prices and investment pledges increase linearly in productivity, employment pledges reach a plateau at the 50th and 70th productivity percentile, respectively.

FIGURE 5. Sales Prices, Employment and Investment Guarantees, and Productivity
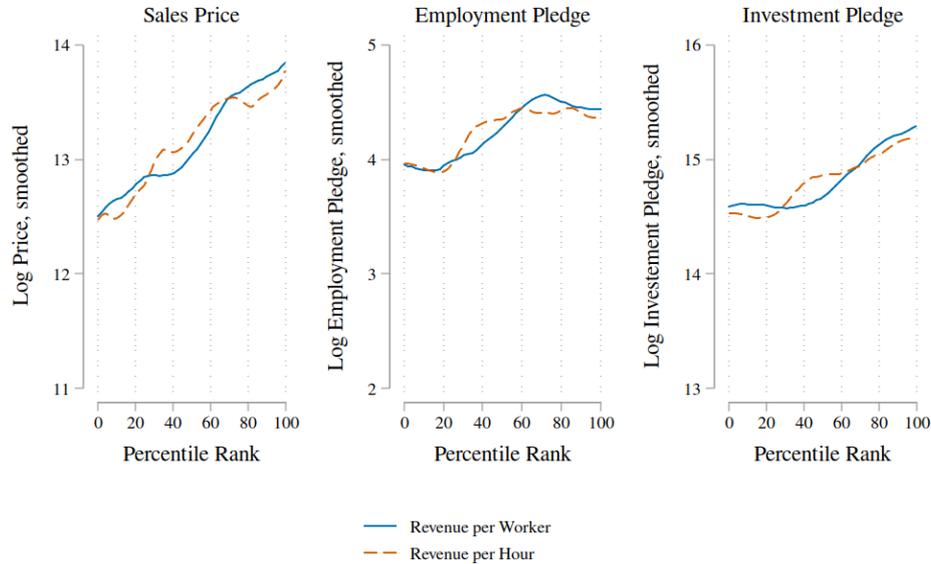
Note: The panels show on the vertical axis the logarithm of positive values of, left positive sales prices (N=1,497), middle employment guarantees (N=1,628) and right investment guarantees (N=1,549). The horizontal axis in all panels shows percentile ranks of firms in the labor productivity distribution. Rank coefficients calculated using Hazen's rule. Smoothing procedure uses an Epanechnikov kernel function of degree zero.
Sources: THA Firm Surveys, THA Contract Data and own calculations. Sample contains firms privatized between 1990 and 1993.

In order to control for confounding factos, we regress each contract criterion separately on labor productivity. A challenge confronting the analysis is that we cannot distinguish between zeros and missing values in the contract data. We therefore use truncated regressions models, truncating contract outcomes at zero. Table 3

reports average marginal effects. Column (1) suggests that a one log-point increase
in initial productivity is associated with an increase in sales prices by on average
0.36 log-points, and 0.41 log-points, 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,
and industries. The legally binding guarantees for job preservation in column (2) are
associated with increases of around 0.11 and 0.14 log-points, respectively. Investment
guarantees in column (3) increase by 0.16 to 0.20 log-points on average when firm
productivity increases by one log-point.

TABLE 3. Contractual Outcomes and Productivity

	Log Price		Log Employment Pledge		Log Investment Pledge	
	(1)	(2)	(3)	(4)	(5)	(6)
Log Rev. per Worker	0.434***		0.182***		0.209***	
	(0.114)		(0.050)		(0.067)	
Log Rev. per Hour		0.490***		0.208***		0.267***
		(0.111)		(0.046)		(0.065)
Mean Y	13.18	13.18	10.99	10.99	11.06	11.06
N	1267	1267	1267	1267	1267	1267

Notes.– * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. Each column presents average marginal effects from
left-truncated regression models with survey-time FE, industry FE (3-digit), and state FE. The
outcome variables are sales price (column 1 & 2), the guaranteed number of employees (column
3 & 4) and contractual investment pledge (column 5 & 6) in nominal Deutsche Mark (DM). As
missing values are indistinguishable from zeros the outcomes are truncated at 0. The numbers of
untruncated observations are 1,497, 1,628, and 1,549 for each outcome respectively. Positive values
are log-transformed. Robust standard errors given in parentheses.

A general concern around the estimated relationships with productivity are unob-
served financial transfers between the agency and firm in its portfolio. We perform
the same robustness checks as in the previous section and provide summaries in the
Appendix Tables A.6, A.7, and A.8. They demonstrate that our results hold for
all three outcomes with similar magnitudes and significance levels. If unobserved
financial aids were correlated with productivity but constant across employment size
classes or headquarter and branches, the coefficients would still be estimated without
bias. 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 A.6

show that the correlation between productive efficiency and sales prices hold within local branches across the entire sample.

It would be worth evaluating these magnitudes against the background that the agency did not raise enough revenue to cover its costs. Yet, as we do not observe the budget constraints faced by the agency and potential buyers, we cannot view our findings as evidence that the agency exhausted its bargaining power. In order to subject firm values and the sales process to a more systemic evaluation, detailed balance sheets of the Treuhand companies and the content of competing bids are required. It is tempting to interpret differences between coefficients as the agency's preference for maximizing revenue as opposed to guaranteeing employment. However, we do not observe the corporate cost structure of buyers to finance acquisitions, such that job guarantees could have simply been more expensive for corporate buyers than sales prices in the long-term.

4.4. Post-Privatization Firm Ownership. In this section, we analyze the owners privatized firms were sold to. We test whether privatization led to ownership concentration and whether new ultimate owners were more likely to come from East or West Germany. Existing studies of privatization have repeatedly highlighted the importance of ownership types for firm performance. However, Djankov and Murrell (2002) and Estrin, Hanousek, Kočenda, and Svejnar (2009) note that firms may not only be selected for privatization but also for different types of private ownership. Our analysis corroborates and illustrates these selection dynamics.

The Treuhand's legal mandate specified that ownership changes were to be achieved as quickly and extensively as possible (TreuhG, Preamble). In the context of East Germany, emphasizing speed and extent of ownership change might favor West German and international investors over potential new owners from the former GDR. This is because these investors plausibly had the upper hand in terms of market experience, managerial expertise, and access to financial or political capital. Post-reunification wealth was much lower in East Germany than in West Germany

(Grunert, Loose, and Ludwig, 1998). However, the privatization agency also had to account for the wider implications of redistributing firm ownership. Even in developed economies, shareholding is often highly concentrated (La Porta, Lopez-De-Silanes, and Shleifer, 1999). Concentrated and non-local capital ownership can have a negative impact on wealth equality (Piketty, 2014, 2015) and economic growth (Alesina and Rodrik, 1994). As such, ownership decisions represent a meaningful trade-off in the Treuhand privatization program.

Indeed, a prominent critique in public discourse surrounding privatizations in East Germany is that the Treuhand particularly favored West German investors and allowed them to assume majority ownership of the productive industrial assets of the East. In this section, we document the extent to which the Treuhand sold East German firms to West German investors. To this end, we use firm-level ownership data obtained from the MUP Firm Register, and match them with additional information on firms' productivity that we gather from the THA Firm Surveys.

FIGURE 6. Majority Ultimate Ownership distribution of privatized firms in 1995
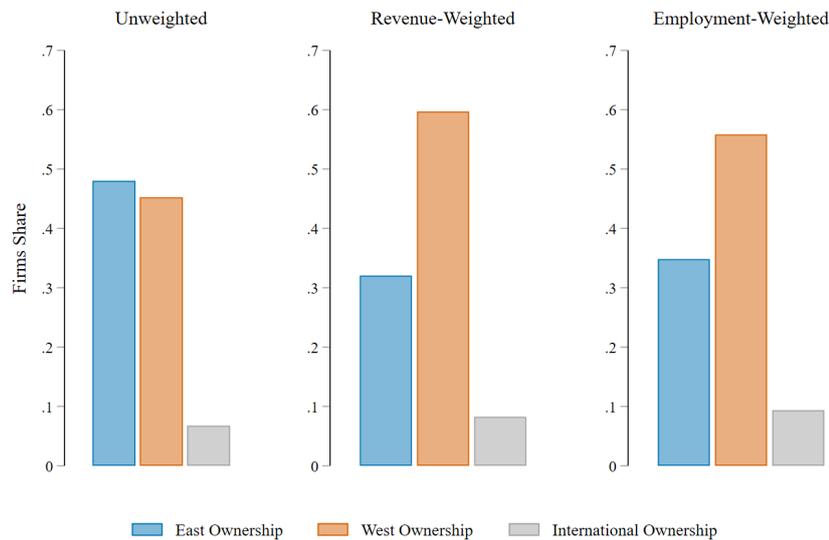
Note: Shares of privatized firms with a majority of ultimate owners from East Germany/West Germany/Outside of Germany in 1995. Unweighted, weighted by initial revenue, and weighted by intial employment. N = 2,566.
Sources: BvS Firm Register and MUP Firm Register.

First, 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. The figure displays a measure of majority ownership based on the absolute number of shareholdings. Majority ownership is attributed to West German or international owners if they represent, or are tied for, the largest group of owners. Majority shareholdings based in the reunified Federal State of Berlin are attributed to East Germany. Corporate ownership can encompass complex and layered shareholding structures. It is likely that non-local investors control at least part of their assets through holding companies set up within the territory of the former GDR. This may result in an over-representation of East Germany-based ownership when analyzing direct shareholders in privatized firms ("first-level ownership"). We account for the effects of potentially complex ownership structures by examining the ultimate owners behind the organizations that assume ownership of privatized firms following the conclusion of the Treuhand's privatization activities.[9] 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 of East German industrial capital did indeed end 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 A.9, 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 guarantees and investment guarantees than East German buyers. These correlations point to three different interpretations. First, assuming future revenue streams are

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[9]Due to the nature of our ownership data, we can only observe ownership structures within East Germany as well as the first ownership link outside of East Germany. As such, we compute ultimate owners by tracing ownership chains until they either conclude with a last link based in East Germany or link to a non-East German entity for the first time. Please refer to the data appendix for additional detail.

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 or vertical integration, increasing their valuation of target companies and resulting in higher bids.[10] Third, East German buyers might have been offered more favorable conditions by the agency.

Next, we take a closer look at the concentration of post-privatization ownership across individual ultimate owners. A common concern associated with privatization programs in transition economies is that the sale of public assets can result in high levels of domestic corporate ownership concentration. In particular, increased ownership concentration may be worrying if pre-transition insiders can leverage their existing political capital to gain financial advantages in the transition process. Guriev and Rachinsky (2005) illustrate these concerns by documenting the extensive degree of control oligarchs wield in the Russian industrial sector. Similarly, Gorodnichenko and Grygorenko (2008) show that concentrated ownership through oligarchs plays a large role in post-transition Ukraine. Using a large sample of stock companies, they reveal that the firms owned by oligarchs are on average larger, more profitable, and produce more value added than firms outside of oligarchic control. Table 4 displays measures of ownership concentration for the first cross-section of firms in East Germany following the conclusion of the privatization program. We display the amount and share of initial pre-privatization revenue and employment that is controlled by the most dominant post-privatization ultimate owners. The revenue or employment controlled by an ultimate owner is calculated as the product of their ownership share in a privatized firm and that firm's initial revenue or employment. We use this measure to rank individual ultimate owners by the economic significance of their shareholdings. Post-privatization, the twenty most dominant ultimate owners control 7.89 percent of employment in our sample and 14.93 percent of firm revenues. For comparison, Guriev and Rachinsky (2005) report equivalent levels of control

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[10]See 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.

amounting to 42.4 percent of employment and 39.1 percent of revenues for the 22 most dominant oligarchs in Russia. While we do not observe similar levels of concentration in the hands of a few select individuals, there is considerable skew in the ownership distribution. The top percentile of ultimate owners controls more than a fifth of all pre-privatization employment and more than a third of initial revenues. However, this effect may be the consequence of a similarly skewed firm size distribution shaping our volume-based ownership concentration measures.[11]

TABLE 4. Post-Privatization Ultimate Ownership Concentration in East Germany by Employment and Revenue Controlled

Ultimate Owners	Initial Employment Controlled	Initial Employment Controlled (percent)	Initial Revenue Controlled (DM)	Initial Revenue Controlled (percent)
Top 10	46,000	4.56	8,917,000	9.52
Top 20	80,000	7.89	13,987,000	14.93
Top 100	236,000	23.12	34,533,000	36.88
Top 200	345,000	33.76	46,285,000	49.43
Total	1,023,000	100.00	93,626,000	100.00

Note: Table 4 reports measures of concentration among ultimate post-privatization owners of firms privatized by the Treuhand. Concentration is measured by the amount of pre-privatization employment and revenues controlled by the most dominant ultimate owners post-privatization. We use an extended data set to compute ultimate owners and allow firms with missing information to enter the sample to avoid missing latent ownership links, provided that ownership information is available for these firms.
Sources: BvS Firm Register, Treuhand Firm Surveys, and MUP Firm Register.

That privatization in East Germany did not result in the formation of a class of oligarchs may in part be due to the institutional framework overseeing the privatization process and its emphasis on precluding former GDR-insiders from turning their political capital into firm control. Similarly, the fact that privatization mainly

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[11]Essentially, we are ordering ultimate owners by the volume of employment and revenue they control through their portfolio of privatized firms. The majority of ultimate owners only hold ownership rights to a single firm, meaning that the overall shape of the distribution of ultimate owner control will, at least in part, be driven by the underlying variation in the product of firm size and ownership shares. Within East Germany, we observe the full extent of ultimate ownership. For owners outside of East Germany we only observe first level direct ownership. As such, latent ownership concentration outside of East Germany may exceed the levels we observe in our analyses. We report results on ownership concentration by ultimate owner percentiles in Table A.18 in the Appendix.

occurred through direct sales to investors may have provided the Treuhand with additional levels of oversight and control regarding post-privatization ownership. In direct sales negotiations, the Treuhand frequently obliged buyers to make employment and investment pledges. The existence of such obligations may have reduced the new owners' ability to quickly sell on privatized firms to third parties and thereby may have prevented additional increases in ownership concentration through secondary markets. The fact that the most productive firms were more likely to be sold to investors from outside East Germany may also have reduced East Germans' chances for amassing ownership rights.

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 and West German ownership. In particular, we study how majority firm ownership varies depending on firm-level productivity. As before, we focus on pre-privatization indicators of labor productivity as indicators 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 5. Here, we regress binary indicators of majority ownership from East Germany, West Germany, and outside Germany on measures of initial firm productivity and several controls. The results emphasize the heterogeneity in ownership outcomes across the productivity distribution. We find statistically meaningful correlations for both East and West German ownership. East German majority ownership significantly decreases in firm productivity, while West German majority ownership displays a significant and positive relationship with productivity measures. Generally,

FIGURE 7. Majority Ultimate Ownership by Initial Productivity (Privatized Firms)
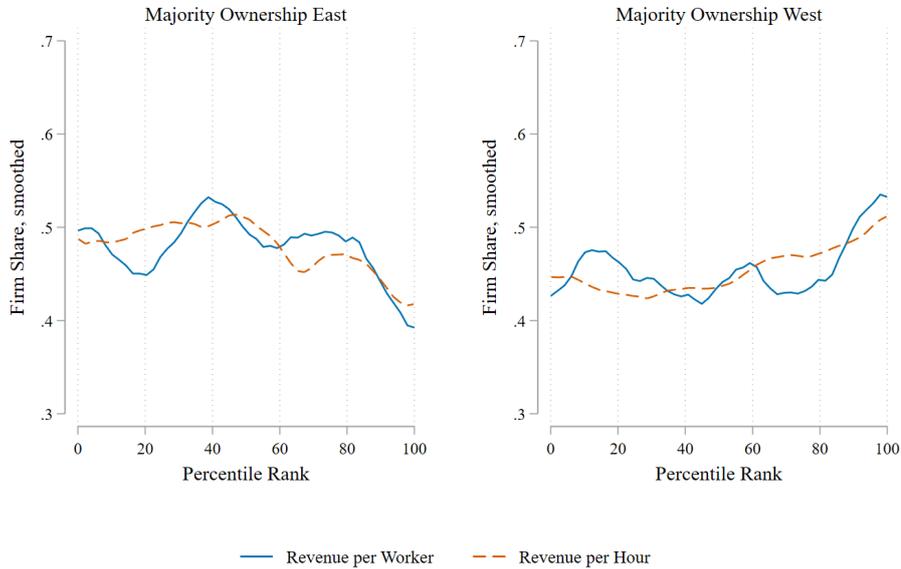
Note: Share of privatized firms with a majority of ultimate owners based in West (East) Germany in 1995. Rank coefficients calculated using Hazen's rule. Smoothing procedure uses an Epanechnikov kernel function of degree zero. Firms with international majority ownership are not depicted (6.7% of privatized firms).
N = 2,566.
Sources: BvS Firm Register, Treuhand Firm Surveys, and MUP Firm Register.

a unit increase in log productivity is associated with an increase of 2.1 to 3.5 percentage points in West German majority ownership.

We test the robustness of our findings by employing a number of alternative specifications, documented in Tables A.10 to A.15 of the Appendix. Table A.20 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 pre-privatization productivity. When limiting the sample of firms to the manufacturing sector and using district or Treuhand local-branches instead of state-level fixed-effects, our results become less significant when measuring productivity as revenue per worker.

TABLE 5. Majority Ultimate Ownership by Initial Productivity for Privatized Firms

	East Ownership		West Ownership		Int'l Ownership	
	(1)	(2)	(3)	(4)	(5)	(6)
Revenue per Worker	-0.028**		0.021*		0.007	
	(0.012)		(0.012)		(0.006)	
Revenue per Hour		-0.041***		0.035***		0.006
		(0.012)		(0.013)		(0.007)
Number of Owners	0.015***	0.015***	-0.013***	-0.013***	-0.002**	-0.002**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)
Mean Y	0.480	0.480	0.452	0.452	0.067	0.067
Observations	2,566	2,566	2,566	2,566	2,566	2,566
R-squared	0.067	0.069	0.053	0.054	0.027	0.026

Note: Table 5 reports results from regressing indicators for West German, International, and East German majority ultimate firm ownership on log initial (pre-privatization) productivity with survey-time FE, industry FE (3-digit), and state FE. 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.

In summary, we observe that West Germans own a substantial share of formerly state-owned firms in East Germany, especially larger and initially more productive firms. Several factors could explain why the Treuhand may have favored selling firms to West German investors. First, the degree to which potential investors have access to financial capital may vary substantially between Eastern Germany, Western Germany, and other countries. Unlike East German investors, West German and international investors were likely able to build on existing connections to financial institutions. It is also likely that they were able to use existing property as collateral. Therefore, they had advantages in accessing capital to invest in the larger and more attractive Treuhand firms. Second, West German investors may have had access to better market knowledge. Thus, they may have been able to better gauge the productivity of firms and predict which may have more value going forward. Third, West German investors may have had better political connections, enabling them to gain access to the most productive firms on offer. Ex-ante familiarity with post-reunification institutions in the mold of their West German predecessors may have put West German investors at an advantage vis-a-vis East German investors who

were learning to build networks in an unfamiliar political system. While we cannot differentiate between these factors, data limitations notably imply that this picture of the ownership distribution likely constitutes a lower bound for the degree of West German and international firm ownership in East Germany following the Treuhand program.

4.5. Privatization Outcomes and Initial Firm Productivity. In this section, we investigate short- and long-term firm survival to assess how initial productivity and post-privatization ownership relate to firm success. As privatization schemes intend state-owned firms to become a thriving part of the private sector, firm survival is an important condition for firm performance and privatization success. For large-scale privatization programs, survival is an additional key policy concern when trying to maintain sufficient levels of economic activity in the regions where privatizations take place. Accordingly, the main ambitions of the Treuhand included ensuring the provision of employment opportunities and enabling the East German economy to catch up with the West. The success of privatized firms was crucial for these objectives as firm closures would be associated with substantial increases in regional unemployment and might curtail further economic activity.

Survival is also closely linked to ownership. In the previous section, we find that West German ownership of privatized firms increases with firms' productivity. Previous surveys on privatizations in transition economies find a positive relationship between foreign ownership and firm performance (Megginson and Netter, 2001; Estrin, Hanousek, Kočenda, and Svejnar, 2009). For a number of reasons, there is no a priori consensus on whether we should find a similar relationship between ownership and survival in the Treuhand case. On average, West German investors had considerably more experience managing firms in a competitive market-based economy than their East German counterparts. As such, they may have been better suited to run a market-oriented firm profitably, resulting in higher survival rates. Privatization literature has discussed the importance of such human capital advantages for privatization

success (Barberis, Boycko, Shleifer, and Tsukanova, 1996). On the other hand, we have already shown that more efficient firms had an increased chance of ending up in West German ownership. Assuming that past efficiency can reasonably predict future efficiency, these firms may have been of higher quality to begin with. Thus, we would expect that these firms were also inherently more likely to survive. Therefore, superior performance of firms owned by West German investors may reflect selection effects. That said, the ability to select the right firms for acquisition might be a key part of the West German managers' skill and experience set. In addition, anecdotal evidence suggests that West German owners, and in particular corporate owners, attempted to use the privatization scheme to rid themselves of potential competitors. Preemption of competitive pressures can serve as an incentive to acquire future rivals with the intention of discontinuing their operations (Cunningham, Ederer, and Ma, 2021). If this behavior was pervasive in East Germany, we could in fact expect Western ownership to be negatively associated with firm survival. As an additional measure of post-privatization firm success, we also study how firms' employment stock has developed relative to the initial situation at the Treuhand's inception. Relative to a competitive market setting, it is likely that East German firms prior to reunification were overstaffed. We would therefore expect that, on average, post-privatization employment fell below initial pre-privatization levels. However, a priori it is not clear whether this decline is likely to be constant across the productivity distribution or whether firms with higher initial productivity levels might maintain a larger share of their initial employment.

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 pre-privatization level, also plotted against productivity percentile ranks. Both series are measured five, ten, 15 and 20 years after the end of the privatization program. While there are notable level shifts in survival rates affecting the entire productivity distribution, we observe a similar trend

FIGURE 8. Firm Success by Initial Productivity (Privatized Firms)
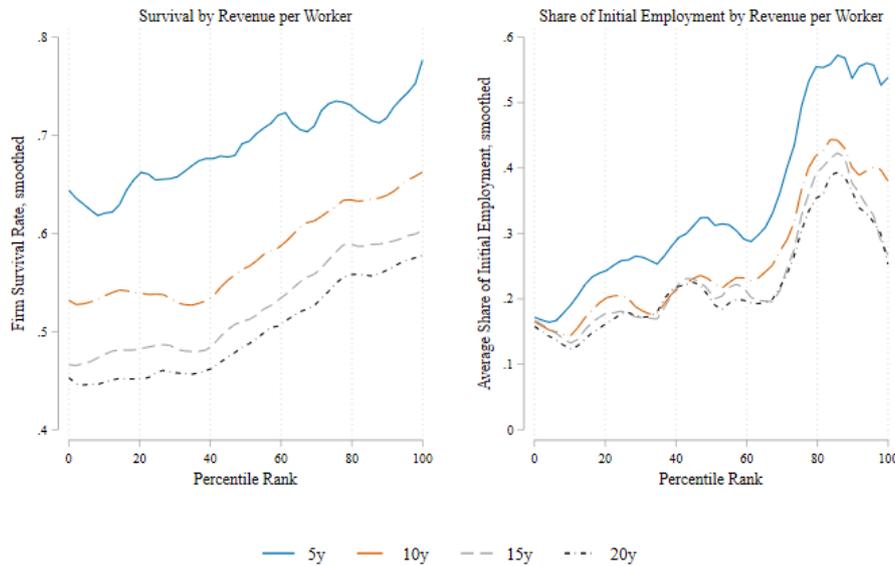
Note: Left: Survival rates calculated as the percentage of firms still active 5, 10, 15, and 20 years after the dissolution of the Treuhandanstalt. Right: Current employment as share of initial employment, measured 5, 10, 15 and 20 years after the dissolution of the Treuhandanstalt. Non-survivors employment 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.

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 in the set of privatized firms on aggregate. 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 B.1 in Appendix B, 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 comparable trend across the productivity distribution. Relative to 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 further highlights the overall scale of the employment reduction in privatized firms with all but the initially most productive firms showing staff reductions of more than 50 percent.

We focus on the relationship between ownership and survival in Table 6. 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. Table A.16 in the appendix confirms these results for using revenue per hour as our measure of productivity.

In Table 7, we further analyze the relationship between initial firm productivity, post-privatization ownership and firms' long-term rate of current to initial employment. 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 A.17 in the appendix repeats these analyses and confirms our results using revenue per hour as measure of productivity.

TABLE 6. Majority Ultimate Ownership, Initial Revenue per Worker and Firm Survival

	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 6 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. *** $p < 0.01$ ** $p < 0.05$ * $p < 0.1$

Contributing to the positive correlation between West German majority ownership and subsequent firm survival may be that West German investors are more likely to be corporate investors rather than natural persons. Figure 9 documents that the share of natural person owners is considerably higher amongst post-privatization majority owners from East Germany. Being integrated into existing corporations rather than being owned by natural persons may have considerable advantages for privatized firms. For instance, the firms will 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, 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. We also find that the shares owned by West German and International investors are on average larger than the shares held by East German proprietors. If these larger shares result in greater degrees of control over the firms they owned, the

TABLE 7. Majority Ultimate Ownership, Initial Revenue per Worker and Firms' Long-Term Employment Rates

	5y Employment	10y Employment	15y Employment	20y Employment
	(1)	(2)	(3)	(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 7 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

reduced effort of coordinating with other owners may further favor West German and International owners.

These findings entail several implications. The positive correlation between West German ownership and survival seemingly contradicts the popular narrative suggesting that West German owners brought about large-scale closure of potentially viable firms. Generally, this finding is consistent with prior observations in the privatization literature documenting the benefits of foreign ownership (Estrin, Hanousek, Kočenda, and Svejnar, 2009). 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.

FIGURE 9. Post-Privatization Majority Owners by Type

Note: Share of corporate investors and natural person investors among majority shareholders depending on whether a firm is owned from East or West Germany post-privatization. Left-hand panel: investor types among majority owners from West Germany post-privatization. Right-hand panel: investor types among majority owners from East Germany post-privatization. Ownership is measured as first-level direct ownership rather than ultimate ownership. N = 2,566.
Sources: BvS Firm Register, Treuhand Firm Surveys, and MUP Firm Register.

Therefore, it is possible that the superior survival rates of West German owners are to some extent explained by West German investors' preferential access 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. When interpreting our estimates, it needs to be considered 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, deregistration from the trade register only takes effect after a firm has ceased to operate.

5. Benchmarking the Treuhand's Performance with Simulated Counterfactuals

Finally, 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 was facing 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 encompassing 80 percent of observations and holdout the remaining observations as a test data set to evaluate performance against. After having settled on a model specification, 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 D. 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 metric 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.[12] 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 decision-making 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. Going forward, we use this percentage as our measure of how constrained the Treuhand was in its privatization priorities. Implicitly, adopting this constraint in the construction of counterfactual privatization scenarios 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 lacking interest among investors, but the result of the privatization agency not being able to dedicate the necessary resources to achieve successful privatization.[13]

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

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[12]We 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.

[13]While 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 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.

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.

TABLE 8. Benchmarks: 10 Year Survival & Employment

Firms Selected for Privatization	Actual Allocation		Simulated Counterfactual		
	Firm Survival Share	Survivors' Initial Employment	Firm Survival Share	Survivors' Initial Employment	Share of Best Firms Selected
Actual Treuhand Selection	0.668	933,076	0.713	1,001,769	0.699
Scenario 1: Worst Candidates			0.555	753,536	0.479
Scenario 2: Productivity Sorting (Rev./Worker)			0.717	896,681	0.692
Scenario 3: Productivity Sorting (Rev./Hour)			0.720	1,056,530	0.675
Scenario 4: Best Candidates			0.967	1,323,104	1.000

Note: Table 8 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 8 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. Most strikingly, the results in Table 8 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 8 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 10 and 11, we augment our analysis by repeating this exercise separately for 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

FIGURE 10. Benchmarks: Ten Year Survival by Treuhand Entity
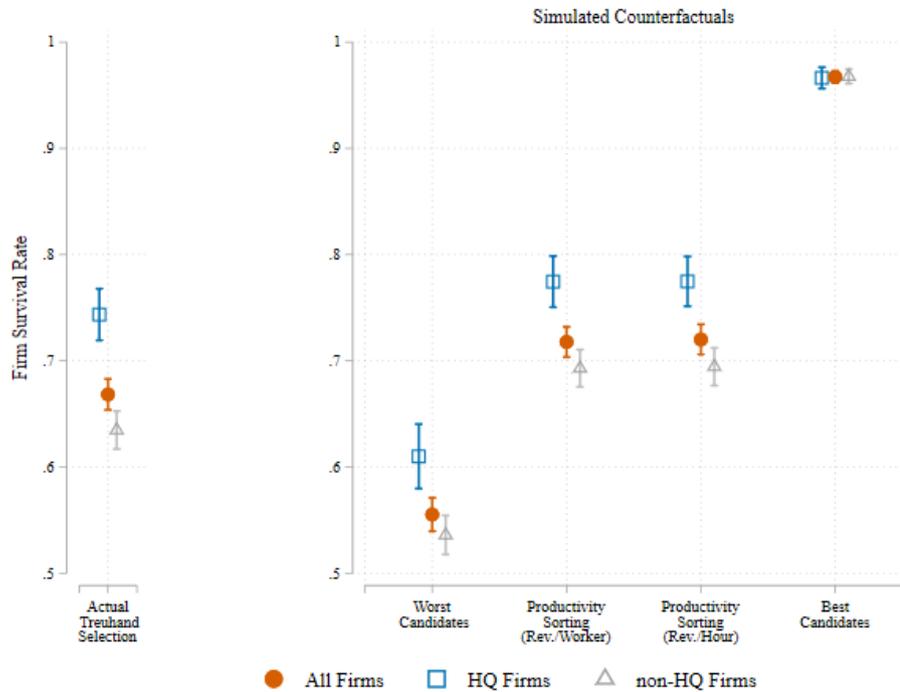
Note: Mean 10 year survival rates for factual (left hand panel) and counterfactual (right hand panel) privatization scenarios. Survival rates are calculated as averages over the selected set of firms using a composite indicator that combines actual survival for firms that were privatized by the Treuhand with predicted survival for firms that were liquidated by the Treuhand. Figure 10 includes 95% confidence intervals for average survival in each scenario.
Sources: BvS Firm Register, Treuhand Firm Surveys, and MUP Firm Register.

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 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 11. Benchmarks: Initial Employment of Survivors by Treuhand Entity
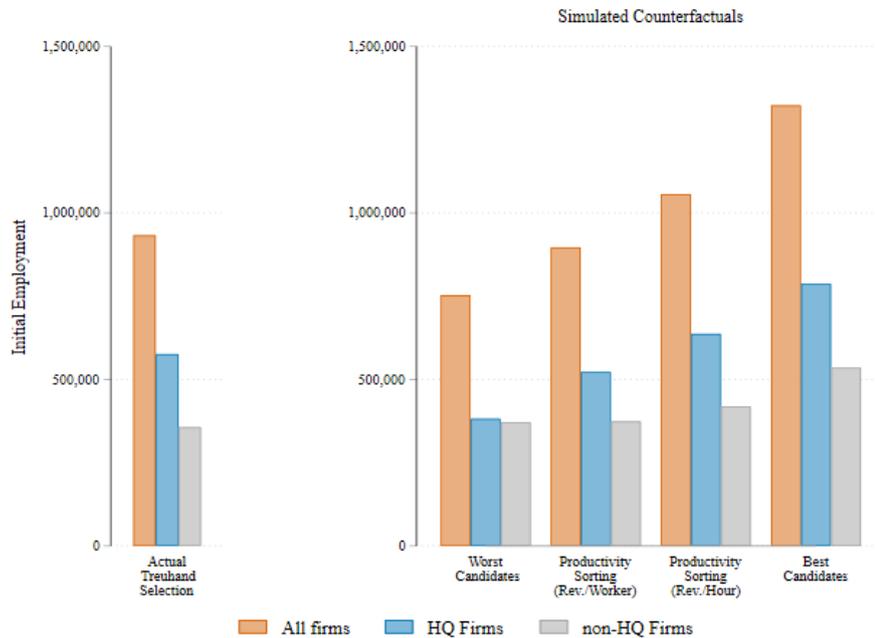
Note: Sum of initial employment for 10 year survivor firms in factual (left hand panel) and counterfactual (right hand panel) privatization scenarios. Initial employment is added up for all firms that in Table 8 and Figure 10 are designated as survivors in the respective privatization scenario.
Sources: BvS Firm Register, Treuhand Firm Surveys, and MUP Firm Register.

The results depicted in Figure 10 do indeed confirm 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, part of this difference may also result from higher firm 'quality' in the headquarters' portfolio. Comparing privatization performance based on initial employment differences between actual and simulated survivors in Figure 11 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, though, 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. This interpretation also carries broader implications for the inherent privatization task of picking *winners* rather than saving *losers*: a privatization program's ability to do so may be strongly influenced by its resource constraints.

6. Conclusion

This paper provides the first comprehensive analysis of East Germany's mass privatizations, arguably the most radical privatization program in history and described as the "fire sale of the century" (Eisenhammer, 1995). By combining administrative data with firm surveys and archival data, we are able to trace East German firms 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 test whether the Treuhand acted in line with its legal mandate to privatize competitive and to liquidate non-viable firms. 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 according to 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, contributing to the debate whether democracy causes economic growth (Acemoglu, Naidu, Restrepo, and Robinson, 2019), our results show the state-led liquidations during the transition led to a reduction in output, but raised average labor productivity in the short run. Moreover, firms selected by the Treuhand were on average able to survive for a longer period of time 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. In contrast to other privatization programs, East Germany did not see the emergence of a class of oligarchs. Based on low levels of East German ownership and ownership concentration, it seems unlikely that former East German regime insiders benefited directly from gaining control over privatized firms. This result was also favored by the Treuhand's requirement to consider additional bid characteristics beyond a pure cash price.

Yet, public discontent about privatization in East Germany still looms large even thirty 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). Despite some merits of privatization through direct sales, public support might be higher if more East German citizens had been given the opportunity to acquire firm assets themselves. 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 honest and transparent communication, coupled with thorough evaluation, could have spared misguided expectations and subsequent disappointments. Our results highlight that the Treuhand has left an important legacy by transforming the East German economy.

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Appendix
(For Online Publication)

Appendix A. Supplementary Graphs and Tables

Supplementary Graphs

FIGURE A.1. Potential and Actual Monitoring by the Ministry of Finance
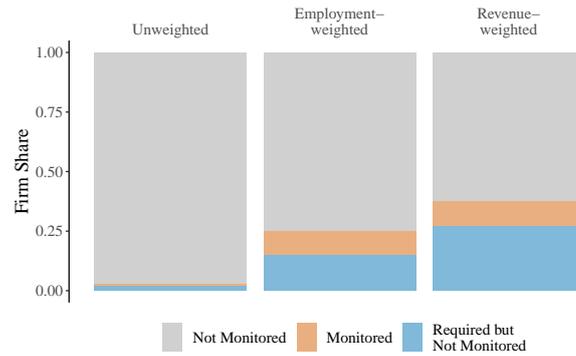
Notes.– A Treuhand decision was to be monitored by the Minstery of Finance if the underlying firm size measured by employment, revenue, and balance sheet total surpassed specific thresholds. Using a list of decision under active monitoring by the Ministry from a parliamentary inquiry in 1994 in combination with employment and revenue figures from Söstra, we can identify a subset of firms which were monitored and unmonitored conditional on being subject to monitoring (Deutscher Bundestag, 1994). However, as we lack balance sheet information we cannot identify the need for monitoring perfectly as foreseen by the threshold rules.
Source.– Deutscher Bundestag (1994), BvS Firm Register, and THA Firm Surveys.

FIGURE A.2. Firms' Labor Productivity and Rating Scores
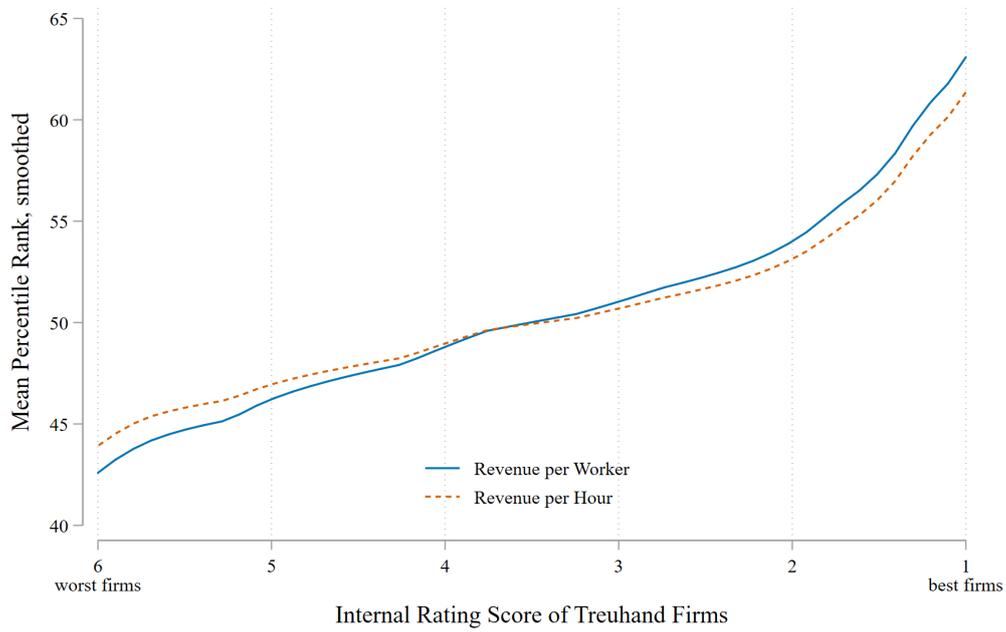
Note: Figure shows mean productivity percentiles by internal firm rating scores for two labor productivity indicators. Rank coefficients calculated using Hazen's rule. Smoothing procedure uses an Epanechnikov kernel function of degree zero. The sample contains firms that were rated between July 1990 and June 1991. $N = 588$.
Sources: BvS Firm Register, THA Firm Surveys, and THA Firm Ratings.

FIGURE A.3. Investor Inquiries for Treuhand Firms
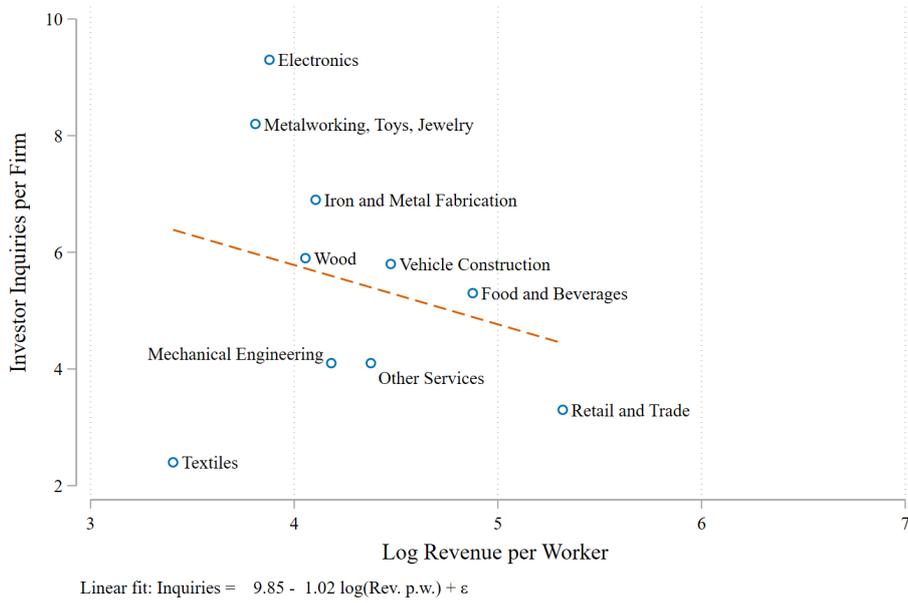
(A) Labor Productivity (Revenue per Worker) and Investor Inquiries
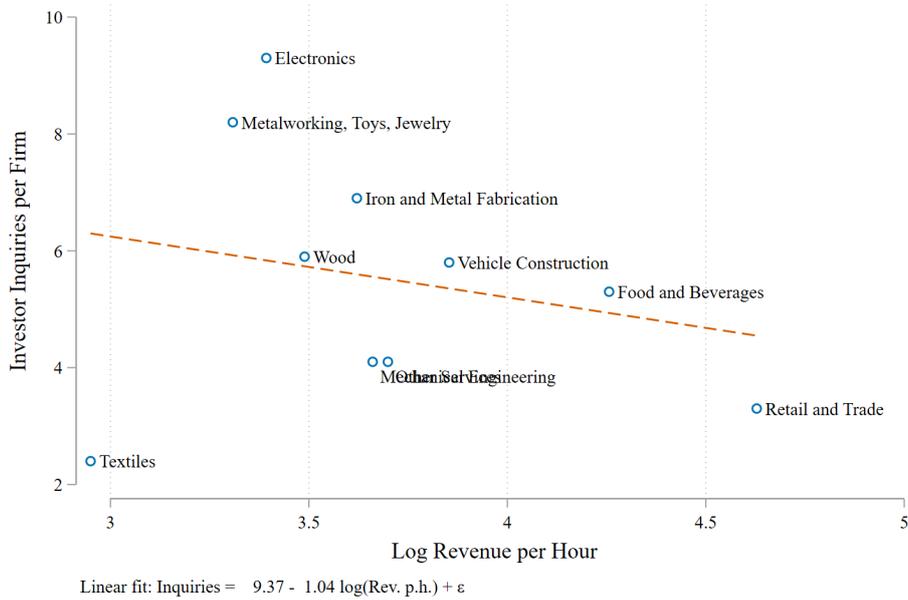
(B) Labor Productivity (Revenue per Hour) and Investor Inquiries
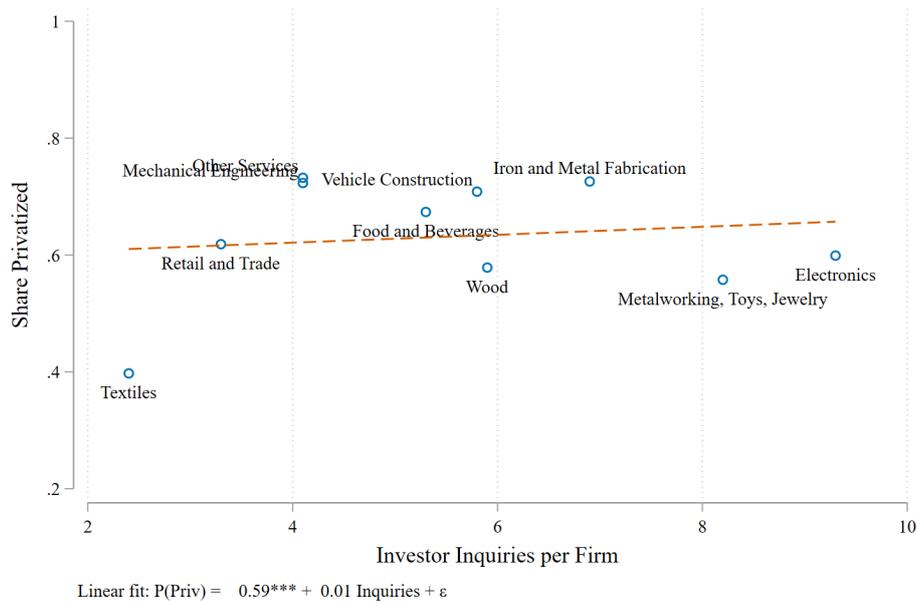
(C) Investor Inquiries and Privatization
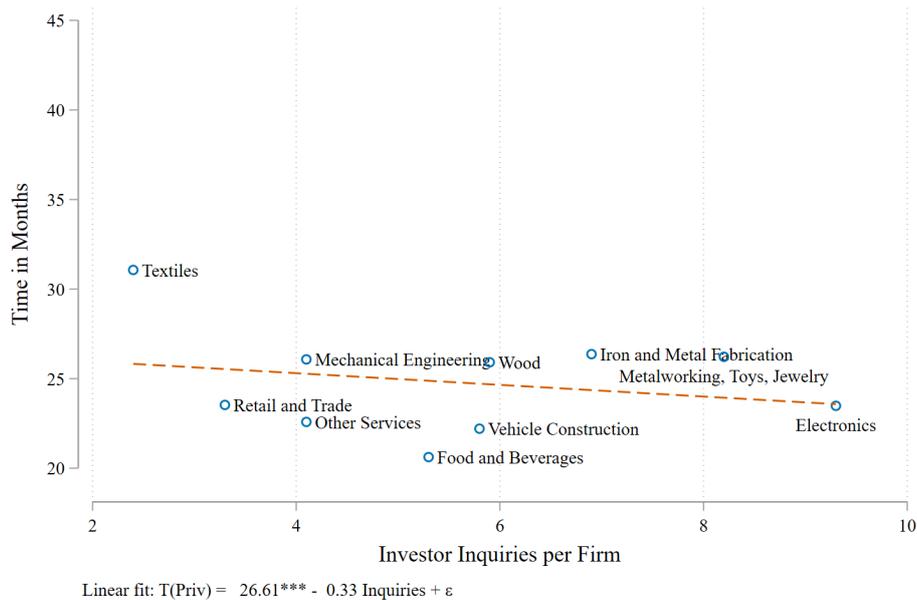
(D) Investor Inquiries and Time to Privatization

Note: Figures present the association between investor demand and various components of privatization policies. Investor demand represents the average number of requests from interested parties for company information by industry addressed to the Treuhandanstalt. Analyses are conducted at the industry-level as investor demand information only available at the aggregated level.
Sources: BvS Firm Register, THA Firm Surveys, Investor Inquiries from Siegmund (2001).

Supplementary Tables

TABLE A.1. Descriptive Statistics

	Mean	Std. Dev	Min	Max	Count	Source
Privatization Outcomes						
Privatization (0/1)	0.68	0.47	0.00	1.00	6190	BvS
Time to Privatization (months)	26.36	14.45	0.00	53.00	4076	THA Surveys
Log Price	11.09	5.43	0.00	19.75	1779	THA Contracts
Log Employment Pledge	3.89	1.64	0.00	8.78	1779	THA Contracts
Log Investment Pledge	12.90	5.19	0.00	20.09	1779	THA Contracts
Majority Ownership East (0/1)	0.48	0.50	0.00	1.00	2566	MUP
Majority Ownership West (0/1)	0.45	0.50	0.00	1.00	2566	MUP
Majority Ownership Int'l (0/1)	0.07	0.25	0.00	1.00	2566	MUP
5 Year Post-THA Survival (0/1)	0.69	0.46	0.00	1.00	2566	MUP
10 Year Post-THA Survival (0/1)	0.57	0.49	0.00	1.00	2566	MUP
15 Year Post-THA Survival (0/1)	0.52	0.50	0.00	1.00	2566	MUP
20 Year Post-THA Survival (0/1)	0.49	0.50	0.00	1.00	2566	MUP
Firm Characteristics						
Firm Rating Score (1=best, 6=worst), rounded	3.76	1.16	1.00	6.00	588	THA Ratings
Firm Rating Score (1=best, 6=worst)	3.67	1.16	1.00	6.00	588	THA Ratings
Log Revenue per Worker (in DM/pers)	4.30	1.05	0.44	7.95	6190	THA Surveys
Log Revenue per Hour Worked (in DM/hour)	3.76	0.97	0.13	7.22	6190	THA Surveys
Log Gross Value Added p.a. (in 1000 DM)	7.89	1.80	1.89	12.52	3297	THA Surveys
Employees (#)	377.94	720.50	0.00	5308.00	6190	THA Surveys
Revenue (in 1000 DM)	27582.30	111050.47	0.00	3824609.50	6190	THA Surveys
Manufacturing (0/1)	0.65	0.48	0.00	1.00	6190	THA Surveys

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

TABLE A.2. Regression Results: Privatization - Alternative Specifications

	Outcome Variable: Privatization Indicator					
	(1)	(2)	(3)	(4)	(5)	(6)
Log Revenue per Worker	0.077***	0.095***		0.073***	0.076***	0.079***
	(0.007)	(0.009)		(0.007)	(0.007)	(0.007)
Log Gross Value Added			0.053***			
			(0.004)			
Mean Y	0.68	0.68	0.82	0.67	0.68	0.68
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. + Serv.	Manuf.	Manuf. + Serv.	Manuf. + Serv.	Manuf. + Serv.	Manuf. + Serv.
Observations	6,190	4,033	3,282	5,837	6,189	6,206

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. Each column presents an OLS regression with industry FE (3-digit), state FE, and survey-time FE. 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 A.3. Regression Results: Time to Privatization - Alternative Specifications

	Outcome Variable: Months under THA ownership since July 1990					
	(1)	(2)	(3)	(4)	(5)	(6)
Log Revenue per Worker	-1.144***	-1.586***		-1.324***	-1.272***	-1.093***
	(0.267)	(0.359)		(0.285)	(0.276)	(0.282)
Log Gross Value Added			-1.046***			
			(0.189)			
Mean Y	26.36	24.92	26.49	26.32	26.36	26.37
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. + Serv.	Manuf.	Manuf. + Serv.	Manuf. + Serv.	Manuf. + Serv.	Manuf. + Serv.
Observations	4,076	2,685	2,631	3,805	4,075	4,082

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. 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. Robust standard errors given in parentheses.

Sources.– BvS Firm Register and THA Firm Surveys.

TABLE A.4. Regression Results: Privatization, Time to Privatization and Productivity at the VEB-level

	(1) Privatization Probability	(2)	(3) Months to Privatization	(4)
Log Revenue per Worker	0.068*** (0.008)		-1.684*** (0.343)	
Log Revenue per Hour		0.064*** (0.009)		-2.035*** (0.348)
Mean Y	0.67	0.67	1.00	1.00
R-squared	0.114	0.110	0.294	0.297
Observations	4,496	4,496	2,947	2,947

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 A.5. Regression Results: Privatization Outcomes, Firm Ratings, and Productivity

	Outcome Variable			
	P(Priv) (1)	P(Priv) (2)	P(Priv) (3)	P(Priv) (4)
I(Rating >= 1)	0.186** (0.094)			
I(Rating >= 2)		0.159*** (0.053)		
I(Rating >= 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

Notes.– Each column regresses the probabilty 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 treshold with firms that received grade below the treshold. 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 A.6. Regression Results: Sales Prices in Privatization Contracts - Alternative Specifications

| | Outcome Variable: Log Price | | | | | |
	(1)	(2)	(3)	(4)	(5)	(6)
Log Revenue per Worker	0.407***	0.437***		0.399***	0.434***	0.461***
	(0.108)	(0.114)		(0.111)	(0.118)	(0.135)
Log Gross Value Added			0.711***			
			(0.076)			
Mean Y	13.18	13.17	13.15	13.14	13.18	13.18
Firm Size	✓					
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. + Serv.	Manuf.	Manuf. + Serv.	Manuf. + Serv.	Manuf. + Serv.	Manuf. + Serv.
N(Y>0)	1,066	1,059	698	1,030	1,066	1,067
N	1267	1259	824	1229	1267	1269

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. As missing values are indistinguishable from 0's in Hau's contract data, the columns report average marginal effects from left-0-truncated regression models. Positive values are log-transformed. The outcome variable is sales price. Positive values are log-transformed. Robust standard errors given in parentheses. The number of untruncated observations is reported and the number of observations before truncation.

Sources.– THA Contract Data and THA Firm Surveys.

TABLE A.7. Regression Results: Employment Pledge in Privatization Contracts
- Alternative Specifications

| | Outcome Variable: Log Employment Pledge | | | | | |
	(1)	(2)	(3)	(4)	(5)	(6)
Log Revenue per Worker	0.181***	0.191***		0.157***	0.211***	0.253***
	(0.042)	(0.051)		(0.043)	(0.046)	(0.061)
Log Gross Value Added			0.577***			
			(0.039)			
Mean Y	4.24	4.24	4.29	4.23	4.24	4.24
Firm Size	✓					
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. + Serv.	Manuf.	Manuf. + Serv.	Manuf. + Serv.	Manuf. + Serv.	Manuf. + Serv.
N(Y>0)	1,184	1,176	761	1,152	1,184	1,185
N	1267	1259	824	1229	1267	1269

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. As missing values are indistinguishable from 0's in Hau's contract data, the columns report average marginal effects from left-0-truncated regression models. Positive values are log-transformed. The outcome variable is employment guarantees. Positive values are log-transformed. Robust standard errors given in parentheses. The number of untruncated observations is reported and the number of observations before truncation.

Sources.– THA Contract Data and THA Firm Surveys.

Table A.8. Regression Results: Investment Pledge in Privatization Contracts -
Alternative Specifications

| | Outcome Variable: Log Investment Pledge | | | | | |
	(1)	(2)	(3)	(4)	(5)	(6)
Log Revenue per Worker	0.203***	0.219***		0.164***	0.223***	0.220***
	(0.056)	(0.067)		(0.058)	(0.061)	(0.064)
Log Gross Value Added			0.647***			
			(0.051)			
Mean Y	14.81	14.80	14.89	14.78	14.81	14.81
Firm Size	✓					
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. + Serv.	Manuf.	Manuf. + Serv.	Manuf. + Serv.	Manuf. + Serv.	Manuf. + Serv.
N(Y>0)	1,131	1,124	728	1,100	1,131	1,132
N	1267	1259	824	1229	1267	1269

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. As missing values are indistinguishable from 0's in Hau's contract data, the columns report average marginal effects from left-0-truncated regression models. Positive values are log-transformed. The outcome variable is investment guarantees. Positive values are log-transformed. Robust standard errors given in parentheses. The number of untruncated observations is reported and the number of observations before truncation.

Sources.– THA Contract Data and THA Firm Surveys.

TABLE A.9. Regression Results: Privatization Contracts - Ownership

	Log Price		Log Employment Pledge		Log Investment Pledge	
	(1)	(2)	(3)	(4)	(5)	(6)
Log Rev. per Worker	0.405***		0.157***		0.176***	
	(0.108)		(0.047)		(0.061)	
Log Rev. per Hour Worked		0.445***		0.170***		0.216***
		(0.108)		(0.045)		(0.062)
Majority West Ownership	1.092***	1.080***	0.643***	0.637***	1.038***	1.031***
	(0.164)	(0.164)	(0.063)	(0.063)	(0.088)	(0.088)
Majority Int'l Ownership	0.968**	0.967**	0.937***	0.937***	1.376***	1.373***
	(0.396)	(0.397)	(0.137)	(0.138)	(0.181)	(0.182)
State Dummies	✓	✓	✓	✓	✓	✓
Industry Dummies	✓	✓	✓	✓	✓	✓
Survey Dummies	✓	✓	✓	✓	✓	✓
Mean Y	13.18	13.18	10.99	10.99	11.06	11.06
N(y>0)	1,066	1,066	1,184	1,184	1,131	1,131
N	1267	1267	1267	1267	1267	1267

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. As missing values are indistinguishable from 0's in Hau's contract data, the columns report average marginal effects from left-0-truncated regression models. Positive values are log-transformed. The outcome variable is investment guarantees. Positive values are log-transformed. Robust standard errors given in parentheses. The number of untruncated observations is reported and the number of observations before truncation.
Sources.– THA Contract Data and THA Firm Surveys.

TABLE A.10. Regression Results: Majority Ownership East Germany by Initial Revenue per Worker - Alternative Specifications

	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	✓					
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. + Serv.	Manuf.	Manuf. + Serv.	Manuf. + Serv.	Manuf. + Serv.	Manuf. + 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 A.11. Regression Results: Majority Ownership West 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**	0.019		0.014	0.017	0.028**
	(0.012)	(0.015)		(0.012)	(0.012)	(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	✓					
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. + Serv.	Manuf.	Manuf. + Serv.	Manuf. + Serv.	Manuf. + Serv.	Manuf. + 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 A.12. Regression Results: Majority Ownership International by Initial
Revenue per Worker - Alternative Specifications

| | Outcome Variable: Majority Ownership Int'l (1/0) | | | | | |
	(1)	(2)	(3)	(4)	(5)	(6)
Log Revenue per Worker	0.009	0.008		0.002	0.005	0.011
	(0.006)	(0.007)		(0.006)	(0.006)	(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	✓					
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. + Serv.	Manuf.	Manuf. + Serv.	Manuf. + Serv.	Manuf. + Serv.	Manuf. + 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 A.13. Regression Results: Majority Ownership East Germany by Initial Revenue per Hour - 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	✓					
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. + Serv.	Manuf.	Manuf. + Serv.	Manuf. + Serv.	Manuf. + Serv.	Manuf. + 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 A.14. Regression Results: Majority Ownership West Germany by Initial
Revenue per Hour - Alternative Specifications

| | 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	✓					
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. + Serv.	Manuf.	Manuf. + Serv.	Manuf. + Serv.	Manuf. + Serv.	Manuf. + 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 A.15. Regression Results: Majority Ownership International 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	0.010		-0.000	0.004	0.009
	(0.007)	(0.009)		(0.007)	(0.007)	(0.008)
Log Gross Value Added			0.011**			
			(0.004)			
Mean Y	0.07	0.07	0.07	0.06	0.07	0.07
Firm Size	✓					
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. + Serv.	Manuf.	Manuf. + Serv.	Manuf. + Serv.	Manuf. + Serv.	Manuf. + 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 A.16. Regression Results: Majority Ownership, Initial Revenue per Hour and Firm Survival

	5y Survival	10y Survival	15y Survival	20y Survival
	(1)	(2)	(3)	(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 A.16 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 A.17. Regression Results: Majority Ownership, Initial Revenue per Hour
and Firms' Long-Term Employment Rates

	5y Employment Share	10y Employment Share	15y Employment Share	20y Employment Share
	(1)	(2)	(3)	(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 A.16 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 A.18. Post-Privatization Ultimate Ownership Concentration in East Germany by Employment and Revenue Controlled - Relative Shares of Owners

Ultimate Owners	Initial Employment Controlled	Initial Employment Controlled (percent)	Initial Revenue Controlled (DM)	Initial Revenue Controlled (percent)
Top 1%	219,000	21.39	32,221,000	34.41
Top 5%	501,000	48.98	59,209,000	63.23
Top 10%	662,000	64.66	70,540,000	75.34
Top 50%	980,000	95.80	91,036,000	97.23
Total	1,023,000	100.00	93,626,000	100.00

Note: Table A.18 reports measures of concentration among ultimate post-privatization owners of firms privatized by the Treuhand. Concentration is measured by the amount of pre-privatization employment and revenues controlled by the most dominant ultimate owners post-privatization. We use an extended data set to compute ultimate owners and allow firms with missing information to enter the sample to avoid missing latent ownership links, provided that ownership information is available for these firms.
Sources: BvS Firm Register, Treuhand Firm Surveys, and MUP Firm Register.

Table A.19. Majority Post-Privatization Ownership

Table A.20. Regression Results: Majority Post-Privatization Ultimate Owner-ship – Multinomial Logit

|	Majority Ultimate Ownership			
	(1) West	(2) International	(3) West	(4) 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 A.20 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

Appendix B. 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 B.1.

FIGURE B.1. Survival Relative to West German Benchmark by Revenue per Worker
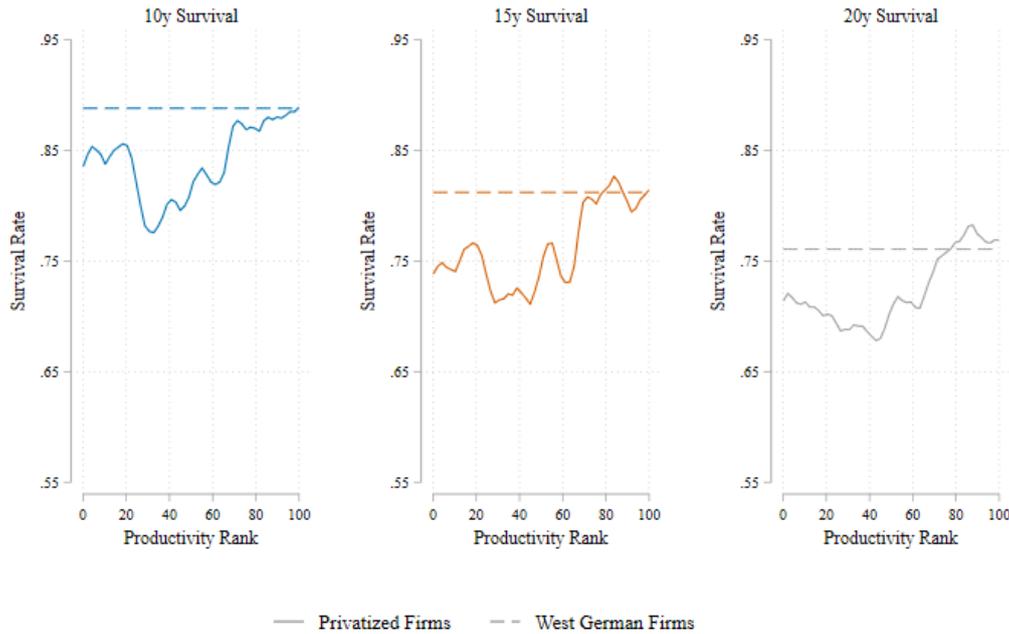
Note: Figure shows mean survival rates by revenue per worker rank for firms from East Germany. Survival rates calculated as the percentage of firms still active 10, 15, and 20 years after the dissolution of the Treuhandanstalt - conditional on having survived at least 5 years after privatization. West 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.

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.

Appendix C. Data Appendix

Extending the information summarized in Section 3, the following paragraphs provide further details on the individual data segment used in this study.

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.[14] 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 C.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.

To gauge whether the survey data is equivalent to administrative data, we assess the similarity between survey information as submitted firm respondants and corresponding information from the THA Contract Data. Although the THA Contract

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[14]Leitlinien für eine Zusammenarbeit zwischen der Treuhandanstalt und der Bundesanstalt für Arbeit, 11 April 1991

Data only covers a subset of firms being privatized and basic firm characteristics outside the contractual outcomes are often missing entries, there is still subbstantial overlap where we can observe the same items for the same firms in the same year. In particular, we are interested in the main components of our labor productivity indicators, namely revenues and employment. We can compare these items for 1991 and 1992 based on correlation coefficients. Table C.1 summarizes the indicates, indicating that revenues and employment as recorded by both sources are very consistent with correlation coefficents well above 0.9. Perfect correlations may not be attainable if underlying reference dates or rounding practices differ across sources.

TABLE C.1. Correlation Between Treuhand Firm Surveys and Treuhand Contract Data

Item, year	Pearson	Spearman	N
Revenues, 1991	0.963	0.927	851
Revenues, 1992	0.927	0.939	50
Employment, 1991	0.933	0.964	1938
Employment, 1992	0.749	0.879	332

Notes.– Table presents correlation coefficients between Treuhand Firm Surveys and Treuhand Contract Data for cases where we have overlapping data from the same firms in the same year.
Sources.– THA Firm Surveys and THA Contract Data.

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 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 C.2, 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.

TABLE C.2. Treuhand Firm Surveys: Collection Years of Earliest Available Productivity Items

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	

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.

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.

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 Contract Data. The Treuhand contract data was made accessible to us by Harald Hau from the Swiss Finance Institute at the University of Geneva (Hau, 1998). The correspondance between the BvS (department A1) and him that is accompanying the data dates back to 18 November 1998. The data contains information on 2,148 privatized firms from 17 "major" manufacturing industries sold prior to December 1993 and originally stems from the Treuhand's contract-controlling divisions. The sectors included are Chemicals, Plastics, Ceramics, Light Metal, Steel, Machinery, Cars, Electrical, Optical, Consumer, Wood, Paper, Leather, Textile, Food, Construction, and Construction supply. The dataset contains key information on 2,613 privatization contracts. Due to the original formatting of the data, we cannot distinguish missing values from 0s. We therefore only make use of three continuous variables which are the sales price, and employment and investment guarantees. The share of observations equal to zero in sales price is 0.01, in employment pledge 0.12 and 0.19 in investment pledge. Multiple contracts exist for 20 firms, which we interpret as privatizations where multiple parties buy separate stakes in the Treuhand company. We summarize our variables of interest at the level of the Treuhand firm. Matching of the contracts with the BvS Firm Register is achieved by using the Treuhand internal identifiers. The matched sample comprises of 1778 privatized manufacturing firms.

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 identifiy the ultimate owners we build a directed network with adjacency matrix $\mathbf{A}$ 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 adjanceny matrix $\mathbf{A}$ of the directed ownership network:

(1) Delete iteratively all nodes in $\mathbf{A}$ 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 $\mathbf{A} + \mathbf{A}^2 + \mathbf{A}^3 + ... = (I - \mathbf{A})^{-1}$. 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 C.1. Treuhand Firm Surveys Questionnaire, April 1991

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 D. 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

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 D.1 and D.2, respectively, as well as by investigating the area under the receiver-operating characteristic curve in Figure D.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.

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

	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	0.9668		Accuracy	0.8118	

Note: Table D.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.

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

|	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	0.96	0.97	Recall	0.82	0.72
Accuracy	0.9655		Accuracy	0.7703	

Note: Table D.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 D.3. Hyperparameter Choice for Machine Learning Algorithms

Random Forest		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 for Additional Split	2	Solver	LBFGS
Max. Features for Random Selection	log(M)	L2 Regularization Parameter	0.00001
Min. Purity Gain for Additional Split	1e-7	Initial Learning Rate	0.00001
Tree Pruning Parameter	1e-9	Learning Rate Schedule	Adaptive

Note: Table D.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 D.1. Predictive Performance: Receiver-Operating Characteristic
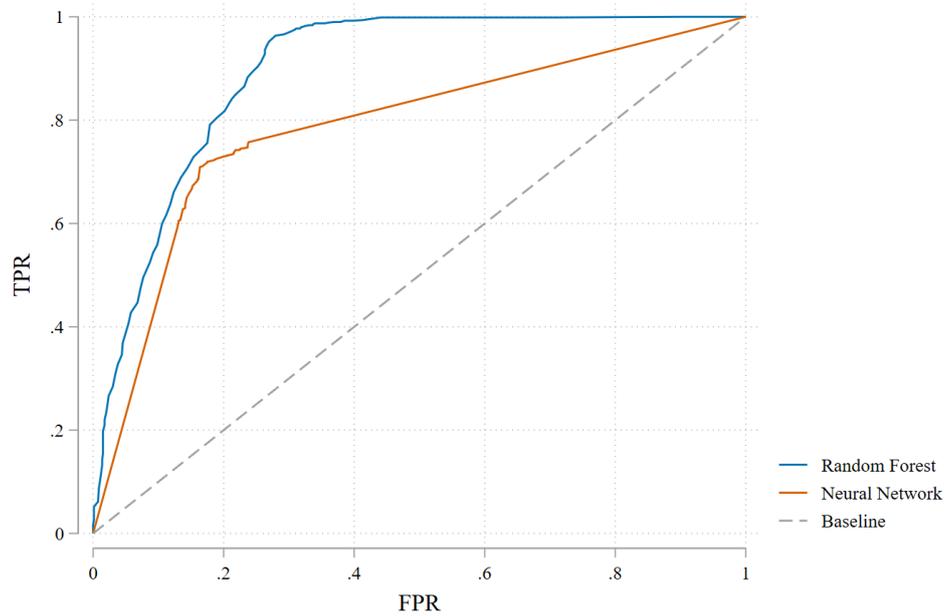
Note: Receiver-operating curve based on the trained random forest and neural network binary classification algorithm. The receiver-operating curve displays the achieved combinations of true positive rate (survivors classified as survivors) and false positive rates (non-survivors classified as survivors) 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.