Labor Redundancy and Adjustment under Partial Reform

Evidence from Cuban State-Owned Enterprises

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Abstract

This paper studies labor redundancy in state-owned enterprises (SOEs) where employment decisions are shaped by government objectives and institutional rigidities rather than firm-level optimization. In such settings, excess employment may also affect the use of complementary inputs and the firm's response to changes in its operating environment. Using firm-level data for Cuban manufacturing SOEs during 2009–2013, I construct a measure of labor redundancy based on the gap between observed employment and estimated optimal employment. The results show that labor redundancy was pervasive and quantitatively large at the beginning of the period: in 2009, approximately 93% of SOEs exhibited positive redundancy, and observed employment was nearly four times higher than the estimated optimal level. Although this ratio declined to roughly 3:1 by 2013, redundancy remained substantial. This reduction coincided with the implementation of the *Actualización del Modelo Económico*, a reform process that relaxed some constraints within SOEs without transforming the foundations of the state enterprise system. The evidence suggests that moderate improvements in material input availability, productivity, and market-related conditions were associated with lower levels of labor redundancy, while financial conditions played a more limited role. Overall, the findings indicate that although partial reforms may mitigate some distortions associated with labor redundancy in transition economies such as Cuba, deeper structural reforms are likely required to remove the institutional sources that sustain inefficient employment allocation.

Keywords: labor redundancy; state-owned enterprises; misallocation; Cuba; transition economies; soft budget constraints

1 Introduction

Misallocation has become a central framework for explaining productivity differences across countries (Hsieh & Klenow, 2009; Restuccia & Rogerson, 2017). In this literature, misallocation refers to distortions that affect how inputs are allocated across heterogeneous producers, preventing resources from flowing toward their most productive uses. In market economies, these distortions are often understood as wedges affecting firms' marginal revenue products of labor or capital, arising from heterogeneous taxes, regulations, market power, or financial frictions.

In transition and state-dominated economies, however, distortions may also emerge through direct constraints on firms' input choices. One important example arises when governments impose employment targets on state-owned enterprises (SOEs) for political or social reasons, limiting their ability to adjust labor demand in response to market conditions. This type of intervention, commonly described as a "policy burden" (Liao et al., 2023; Lin & Tan, 1999; Lin et al., 1998; Lixing, 2008), pushes SOEs away from their profit-maximizing allocation.

This paper studies how SOEs accommodate such labor constraints. When employment is imposed above its optimal level, firms cannot eliminate the distortion directly and must instead adjust other dimensions of resource allocation. The central hypothesis of the paper is that labor redundancy is not an isolated labor-market distortion, but a source of broader within-firm distortions affecting the allocation of complementary inputs. Excess labor may compress the use of material inputs, affect wage-setting decisions, alter short-term financial management, and, under some institutional conditions, be partially absorbed through price adjustments or other external mechanisms.

To examine these mechanisms, I adopt a short-term partial equilibrium framework based on Dong and Putterman (2003), in which SOEs face both an exogenous employment

constraint and a binding liquidity constraint. Firms choose wages and material inputs conditional on imposed employment levels, generating distortions in the internal allocation of productive resources.

I apply this framework to state-owned manufacturing enterprises in Cuba during 2009–2013, spanning the period immediately before and after the initial implementation of the 2011 reform program known as the *Actualización del Modelo Económico.* Although these reforms gradually expanded the role of the private sector and increased SOE autonomy in selected areas, state-owned enterprises continued to operate under substantial institutional constraints affecting employment decisions, pricing, access to inputs, and financial conditions. This environment provides a useful setting for studying how SOEs adjust when labor cannot be freely reallocated and the costs of redundant employment must be absorbed through alternative adjustment mechanisms.

Using a panel dataset of manufacturing SOEs, I estimate an efficiency-wage augmented production function to recover the parameters needed to compute optimal employment. This allows me to construct a measure of labor redundancy based on the gap between observed and profit-maximizing employment levels.

The results indicate that labor redundancy was both widespread and quantitatively large at the beginning of the period. In 2009, approximately 93% of SOEs exhibited redundant employment, and observed employment levels were on average nearly four times higher than the model-implied optimum (roughly a 4:1 ratio). Although redundancy declined over time—falling to approximately 3:1 by 2013—the adjustment appears to have been driven less by direct employment reductions than by changes in firms' operating conditions. Improvements in input availability, productivity, and especially market-related conditions are strongly associated with lower levels of labor redundancy, whereas financial conditions play a more limited quantitative role.

These findings suggest that SOEs absorbed excess labor primarily through adjustments in production conditions and input use rather than through financial accommodation alone. More broadly, the paper contributes to the literature on misallocation by examining how direct labor constraints in state-owned enterprises can affect firms' internal allocation decisions. It also contributes to the literature on policy burdens in SOEs and provides new firm-level evidence on enterprise adjustment during Cuba's early reform period.

The remainder of the paper is structured as follows. Section 2 describes the Cuban institutional context. Section 3 presents the theoretical framework. Section 4 describes the empirical strategy and data. Section 5 presents the results. Section 6 discusses their interpretation, and Section 7 concludes.

2 Why Cuba? Institutional Background

This section outlines the main institutional features that make Cuba a useful setting for studying labor redundancy in state-owned enterprises during a period of partial economic reform.

For decades, the Cuban economy was organized around a centrally planned system dominated by state ownership and limited market allocation.[1] By 2009, state entities accounted for 82.4% of total employment (ONEI, 2023), while private activity remained confined to a narrow group of heavily regulated sectors. Within this system, SOEs operated with limited autonomy, as key decisions regarding employment, input allocation, wages, and prices were strongly influenced by central authorities. Employment levels therefore reflected not only productive conditions, but also broader political and social objectives.

This institutional structure generated persistent imbalances within the state sector. Cuban SOEs were characterized by low productivity, weak profitability, distorted relative

[1] Although limited reforms were introduced during the 1990s, these changes did not substantially alter the predominance of state ownership or the central role of administrative allocation mechanisms in the economy.

prices, and recurrent shortages of intermediate inputs and final goods, while employment levels often exceeded firms' productive requirements. The scale of excess employment was publicly acknowledged even before the broader reform process began. In 2010, official statements estimated redundant employment in the state sector at more than 500,000 workers—roughly 10% of the country's labor force at the time (Granma, 2010). This recognition gave rise to a program aimed at restructuring state employment, which preceded and later became incorporated into the broader reform process (see also Hernández, 2018). As shown in Figure 1, state employment peaked around 2009 and declined during the following years, consistent with efforts to reduce overemployment within the state sector.

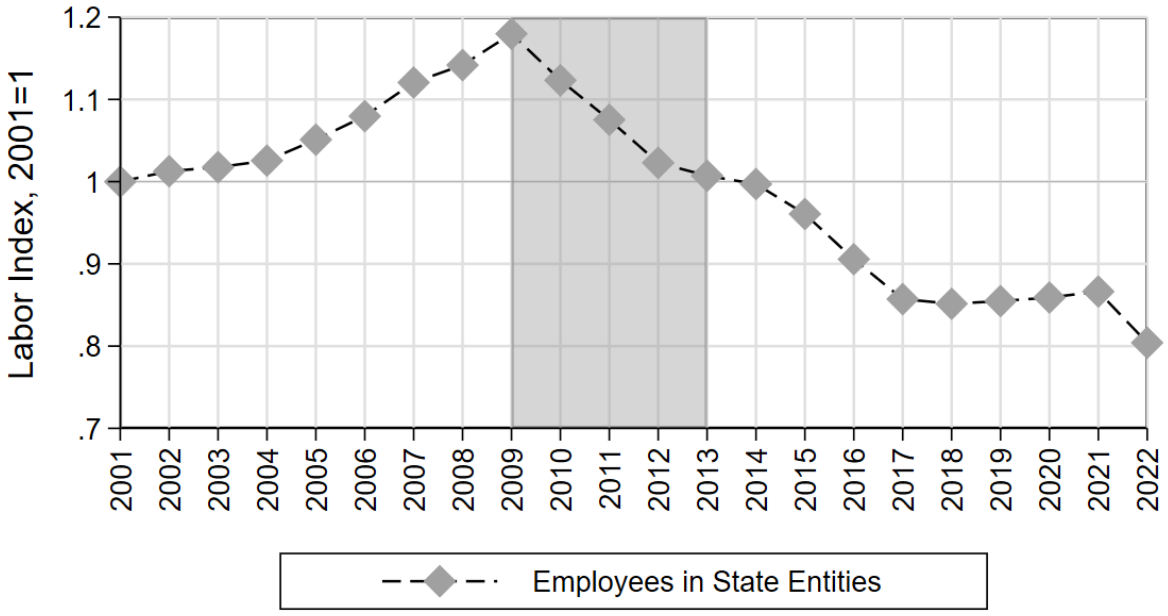

Figure 1: Employees in State-Owned Entities, Cuba 2001–2022
Source: Authors' calculations based on ONEI (2022).

In response to prolonged economic stagnation, the government launched in 2011 the reform program known as the *Actualización del Modelo Económico*, which sought to expand the role of the private sector and introduce limited changes in the functioning of state enterprises. Over the following years, restrictions on private activity were gradually relaxed, access to foreign investment broadened, and SOE autonomy expanded in selected areas, including some pricing and wage-setting decisions. The process also triggered a significant

restructuring and consolidation of the state sector. In manufacturing, for example, mergers and organizational restructuring contributed to a reduction of approximately one-third in the number of SOEs between 2009 and 2013 (ONEI, 2022).

Despite these changes, the reforms remained limited in scope and stopped well short of transforming SOEs into market-disciplined firms. Employment decisions continued to be shaped by government priorities, while access to key inputs such as imported raw materials and foreign exchange remained heavily regulated. Although some pricing authority was decentralized, firms still faced important restrictions in their ability to adjust prices and wages according to market conditions. Financial constraints also remained pervasive. Access to external finance was limited and mediated largely through state institutions, forcing SOEs to rely heavily on internal liquidity and short-term financial management. At the same time, soft-budget mechanisms such as subsidies and preferential financing persisted unevenly across firms, generating heterogeneity in financial conditions without fully eliminating liquidity pressures.

Taken together, these features created an environment in which SOEs operated under persistent employment rigidities while facing only partial relaxation of other institutional constraints during the early reform period. This setting provides a useful context for examining how labor redundancy evolved when firms gained limited room for adjustment without a fundamental transformation of the broader institutional structure.

3 Theoretical Framework

This section develops a simple framework linking imposed employment constraints to distortions in firms' input allocation. Following Dong and Putterman (2003), the model formalizes how labor redundancy may propagate across other dimensions of firm behavior. The framework combines two features particularly relevant in the Cuban context: externally

influenced employment levels and limited financial flexibility.

Firms operate in a short-run partial equilibrium setting in which capital is fixed, while labor, materials, and wages remain adjustable. Decisions unfold in two stages. First, employment is determined exogenously. Second, firms choose wages and material inputs conditional on imposed employment and subject to a liquidity constraint.

Demand is assumed to be isoelastic:

$$P = \sigma Y^{-\epsilon_P}, \tag{1}$$

where P denotes output prices, σ captures exogenous demand conditions, and ϵ_P is the inverse of the price elasticity of demand.

Production follows an efficiency-wage augmented Cobb–Douglas technology:

$$Y = AK^{\alpha_K}(EL)^{\alpha_L}M^{\alpha_M}, \tag{2}$$

where K, L, and M denote capital, labor, and materials. The parameter A represents Hicks-neutral productivity, while labor effort depends on the wage premium:

$$E = (W - W^0)^{\beta}, \tag{3}$$

where W is the wage paid by the firm, W^0 is an exogenous base wage, and $\beta < 1$ governs the elasticity of effort with respect to wages.

Constrained Adjustment

Firms face an exogenous employment constraint:

$$L \geq \bar{L}, \tag{4}$$

where $\bar{L}$ is externally imposed. Assuming the constraint binds, firms operate with employment fixed at $L = \bar{L}$.

Given imposed employment, firms maximize profits:

$$\pi = P(Y)Y - W\bar{L} - P_M M - rK, \tag{5}$$

subject to the liquidity constraint

$$W\bar{L} + P_M M = R, \tag{6}$$

where R denotes working capital available to finance variable costs.

The liquidity constraint implies that firms cannot freely adjust all inputs simultaneously. When employment exceeds its profit-maximizing level, labor absorbs resources that would otherwise finance complementary inputs. Labor redundancy therefore distorts not only employment itself, but also wages and material use.

Solving the second-stage problem yields:

$$W^* = \frac{1}{\gamma + 1}\frac{R}{\bar{L}} + \frac{\gamma}{\gamma + 1}W^0, \tag{7}$$

and

$$M^* = \frac{1}{P_M}\frac{\gamma}{\gamma + 1}(R - W^0\bar{L}), \tag{8}$$

where

$$\gamma = \frac{\alpha_M}{\beta\alpha_L}.$$

These expressions capture the central mechanism of the model: higher imposed employment reduces resources available per worker and crowds out material inputs, generating

distortions that propagate across production decisions.

Labor Redundancy

In the absence of employment constraints, optimal labor demand satisfies

$$(1 - \epsilon_P) P \frac{\partial Y}{\partial L} = W^*. \tag{9}$$

This condition defines the profit-maximizing level of employment, L^*. Labor redundancy is therefore defined as

$$LRR = \ln \bar{L} - \ln L^*. \tag{10}$$

Under the Cobb–Douglas specification, optimal employment can be expressed as

$$\ln L^* = \frac{1}{1 - \alpha_L} \Big[\ln \alpha_L + \ln P + \ln A + \beta \alpha_L \ln(W^* - W^0) + \alpha_M \ln M^* + \alpha_K \ln K - \ln W^* \Big] \tag{11}$$

Substituting Equation (11) into Equation (10) yields a structural representation in which labor redundancy depends on market conditions, productivity, wages, and complementary inputs:

$$LRR = \beta_0 + \beta_1 \ln \bar{L} + \beta_2 \ln P + \beta_3 \ln A + \beta_4 \ln E + \beta_5 \ln M + \beta_6 \ln K + \beta_7 \ln W. \tag{12}$$

Because liquidity conditions shape optimal wages and material inputs through Equations (7) and (8), the model also implies an indirect role for working capital. To capture this channel, I additionally consider the reduced-form specification:

$$LRR = \pi_0 + \pi_1 \ln \bar{L} + \pi_2 \ln P + \pi_3 \ln A + \pi_4 \ln M + \pi_5 \ln K + \pi_6 \ln W^0 + \pi_7 \ln R. \tag{13}$$

The effect of working capital on labor redundancy is theoretically ambiguous. Higher liquidity relaxes the financial constraint and increases both wages and material inputs, but these adjustments affect optimal employment through different channels. The net effect is therefore an empirical question.

The framework generates two main empirical implications. First, imposed employment constraints create a measurable divergence between observed and profit-maximizing labor demand. Second, because labor redundancy interacts with liquidity conditions and complementary inputs, firms may accommodate excess labor through multiple adjustment margins rather than through employment reduction alone.

4 Empirical Analysis and Data

Empirical Strategy

I implement a two-step empirical strategy that maps directly from the theoretical framework. First, I estimate an efficiency-wage augmented production function to recover the parameters required to compute optimal employment. Second, I use these estimates to construct a measure of labor redundancy and analyze its determinants, focusing on the main margins through which firms adjust to imposed employment levels.

Step 1: Production function estimation The starting point is the estimation of the production function in Equation (2). The main parameter of interest is the elasticity of output with respect to labor, α_L, which is required to compute the optimal level of employment, L^*.

Estimating production functions in this context raises standard concerns regarding unobserved productivity and simultaneity in input choices (Griliches & Mairesse, 1995; Levinsohn & Petrin, 2003). To address these issues, I consider both static and dynamic specifications. In particular, I estimate a dynamic panel model using the Blundell-Bond system GMM estimator (Blundell & Bond, 2000), which allows for endogenous input choices

and persistent productivity shocks. However, the results do not provide strong evidence of additional dynamics beyond firm fixed effects, and the estimates are broadly consistent with those obtained from static specifications. For this reason, and given concerns regarding instrument proliferation, I adopt a fixed effects specification as the baseline.

An additional challenge arises from the inclusion of efficiency wages, as wages may be correlated with unobserved productivity. To address this issue, I implement an instrumental variables strategy. Following the structure of the model, I use the base wage (W^0) and firm-level liquidity as instruments for wages. The identifying assumption is that these variables affect observed wages through institutional wage-setting rules and financial constraints, but do not directly influence contemporaneous productivity, conditional on firm fixed effects.

Step 2: Measuring labor redundancy Using the estimated parameters, I compute the optimal level of employment implied by the model and construct the labor redundancy rate as

$$LRR = \ln \bar{L} - \ln L^*.$$

This measure captures the deviation between observed and profit-maximizing employment, with positive values indicating excess labor relative to the model-implied benchmark.

Step 3: Determinants of labor redundancy In the second step, I analyze the determinants of labor redundancy using both a structural and a reduced-form specification. The structural specification relates the redundancy measure to its theoretical determinants, including productivity, input use, wages, and market conditions, as derived from Equation (12).

To assess the role of financial conditions, I estimate a reduced-form specification that incorporates working capital as a key margin of adjustment. Working capital captures firms' short-term liquidity conditions and their ability to reallocate resources across inputs. Since working capital may be jointly determined with labor redundancy, I implement an

instrumental variables strategy.

Specifically, I use two financial variables as instruments: (i) the net balance between accounts receivable and accounts payable (*Trade Credit*), and (ii) long-term financial leverage (*Leverage*). The identifying assumption is that these variables affect firms' liquidity conditions, and therefore their ability to adjust input use, but do not directly influence contemporaneous labor redundancy beyond this channel, conditional on firm fixed effects.

All specifications include firm and time fixed effects. In addition, the regressions are estimated in first differences to mitigate concerns related to common trends and non-stationarity.

Data

The empirical analysis uses a panel dataset of state-owned manufacturing firms in Cuba covering the period 2009–2013. The data are drawn from administrative records compiled by the National Office of Statistics and Information (ONEI), based on standardized reporting forms. The dataset includes detailed firm-level information on output, inputs, wages, and financial variables.

The production function is estimated using logarithmic values of gross output (Y), capital stock (K), employment ($\bar{L}$), materials (M), and wages (W). The base wage (W^0) is constructed as the ratio of the base wage bill to employment. Monetary variables are deflated using price indices with 2009 as the base year.

The optimal level of employment is computed using the estimated labor elasticity and observed firm-level data on output and wages. The resulting redundancy measure captures the gap between observed employment, influenced by institutional constraints, and the level implied by profit maximization.

Working capital (R) is defined as the difference between current assets and current liabilities, capturing firms' short-term liquidity conditions. The instrumental variables

include *Trade Credit*, defined as the difference between accounts receivable and accounts payable, and *Leverage*, measured as the ratio of long-term liabilities to total assets.

Additional variables are included to capture firm heterogeneity along key dimensions of the empirical analysis, including market conditions, productivity, and exposure to external markets.

Descriptive Statistics

Table 1 presents the main descriptive statistics for the sample. The dataset includes 751 state-owned manufacturing firms in 2009, representing approximately 88% of the total number of firms in the sector (ONEI, 2022). The number of firms declines over time, reflecting the restructuring process initiated after 2011, which involved mergers and closures of state-owned enterprises. Despite this attrition, the sample consistently covers a large share of the sector throughout the period.

A notable feature of the data is the increase in average firm size. While aggregate employment in manufacturing declines, the average number of workers per firm rises, indicating a consolidation process in which fewer but larger enterprises account for a growing share of activity.

Wages remain low but grow moderately over time, driven primarily by increases in the variable component. Labor productivity also rises, reflecting faster growth in value added relative to employment. Financial indicators show a general improvement: firms exhibit higher levels of working capital, suggesting an easing of short-term liquidity constraints, alongside changes in financial structure, including higher leverage and improved trade credit positions.

These patterns point to substantial heterogeneity and evolving firm conditions along both real and financial dimensions. In particular, the dispersion in liquidity and financial variables provides relevant variation for identifying the role of working capital in the

Variable	Stat.	2009	2010	2011	2012	2013
Panel A. Sample Structure						
SOEs	N	751	731	556	510	483
Coverage	%	88.8	92.1	90.7	91.1	88.0
Subsidized	%	18.5	16.0	18.3	20.0	21.3
Loss-making	%	17.3	16.4	9.7	9.6	7.5
Acquirers	%	–	–	6.5	8.2	9.7
Panel B. Production and Inputs						
Gross output (10,000 CUP)	Avg	1812	1749	2461	2835	2983
	SD	3242	3158	4293	4697	4982
	Miss	4	3	1	1	1
Employees (units)	Avg	522	506	606	617	632
	SD	734	732	980	900	905
	Miss	3	3	2	0	0
Capital stock (10,000 CUP)	Avg	582	573	788	872	851
	SD	1008	983	1724	1830	1836
	Miss	3	5	3	2	2
Materials (10,000 CUP)	Avg	1158	1212	1548	1778	2303
	SD	2532	2669	3366	3860	4829
	Miss	1	3	0	0	1
Panel C. Labor and Productivity						
Wages (CUP)	Avg	438	443	453	480	505
	SD	123	127	142	139	148
	Miss	4	3	2	0	1
Fixed-to-total wage ratio	Avg	0.68	0.68	0.65	0.63	0.60
	SD	0.193	0.187	0.182	0.171	0.161
	Miss	7	7	1	1	0
Labor productivity (10,000 CUP)	Avg	1.267	1.279	1.539	1.705	1.698
	SD	1.44	1.44	1.59	1.47	1.58
	Miss	7	6	3	1	3
Panel D. Performance, Market Conditions, and Finance						
Margin	Avg	0.020	0.020	0.079	0.085	0.084
	SD	0.329	0.391	0.277	0.211	0.475
	Miss	4	6	3	4	1
HHI	Avg	1888.5	1989.2	2251.8	2070.8	2169.8
	SD	2071.2	2095.8	2310.6	2339.6	2457.8
	Miss	0	0	0	0	0
ROA	Avg	0.051	0.066	0.090	0.078	0.093
	SD	0.163	0.169	0.161	0.140	0.149
	Miss	3	2	1	2	1
Subsidy-to-sales ratio	Avg	0.037	0.031	0.040	0.043	0.048
	SD	0.107	0.101	0.116	0.122	0.131
	Miss	6	7	3	2	1
Leverage	Avg	0.361	0.381	0.376	0.401	0.437
	SD	0.327	0.332	0.329	0.337	0.346
	Miss	2	0	2	2	1
Trade credit (10,000 CUP)	Avg	-17.28	-12.6	-35.29	-40.51	-58.58
	SD	455.84	440.73	662.29	501.73	760.99
	Miss	1	1	1	0	0
Working capital (10,000 CUP)	Avg	142.0	144.7	319.8	437.6	563.0
	SD	1032	1056	986	1109	1376
	Miss	0	0	0	0	0

Note: Margin is profit over revenue. ROA is profit over total assets. Leverage is long-term liabilities over total assets. Trade credit equals accounts receivable minus accounts payable; negative values indicate net supplier financing. Working capital equals current assets minus current liabilities.

Table 1: Descriptive Statistics, 2009–2013

empirical analysis.

5 Results

This section presents the main empirical results. I first estimate the production function and use the implied labor elasticity to construct the labor redundancy rate (LRR). I then examine the factors associated with changes in redundancy over time.

5.1 Measuring Labor Redundancy

Table 2 reports the estimates of the efficiency-wage augmented production function. Columns (1)–(2) report OLS estimates, Columns (3)–(4) fixed effects estimates, and Columns (5)–(6) instrumental variable estimates. The preferred specification is the IV estimator with controls in Column (6), which addresses the potential simultaneity between wages and unobserved productivity.

The estimated output elasticities are broadly stable across specifications. The elasticity with respect to capital is not statistically significant, a result consistent with previous evidence for Cuban manufacturing (Doimeadios & Sanchez, 2015; Gonzalez & Cribeiro, 2018). The IV estimates also suggest that the contribution of effort is smaller than in simpler specifications: the coefficient falls from about 0.151 in the OLS specification to 0.092 in the preferred IV specification. This supports the use of the instrumental variable strategy for wage-related effort.

The diagnostic tests provide additional support for the IV specification. The Hansen-J p-value is above conventional rejection thresholds, while the Kleibergen-Paap statistic suggests that weak instruments are not a major concern. I therefore use the preferred labor elasticity estimate from Column (6), equal to 0.660, to compute the model-implied level of optimal employment and construct the labor redundancy rate.

The resulting measures of marginal products, productivity, and labor redundancy are

Dependent Variable: Gross Output

	OLS		Fixed Effects		IV	
Variables	(1)	(2)	(3)	(4)	(5)	(6)
Labor	0.421***	0.428***	0.666***	0.679***	0.647***	0.660***
	(0.024)	(0.029)	(0.089)	(0.087)	(0.093)	(0.091)
Capital	-0.020	-0.022	-0.001	-0.002	-0.000	-0.002
	(0.015)	(0.016)	(0.020)	(0.020)	(0.020)	(0.020)
Materials	0.550***	0.547***	0.414***	0.404***	0.426***	0.415***
	(0.036)	(0.039)	(0.042)	(0.040)	(0.046)	(0.045)
Effort	0.151***	0.152***	0.128***	0.128***	0.092**	0.092**
	(0.024)	(0.024)	(0.012)	(0.012)	(0.038)	(0.038)
Absorbed Fixed Effects						
Firm	No	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes
Loss	Yes	Yes	Yes	Yes	Yes	Yes
Merged	Yes	Yes	Yes	Yes	Yes	Yes
Subsidized	Yes	Yes	Yes	Yes	Yes	Yes
Controls						
Export		-0.075		0.117		0.127
		(0.178)		(0.167)		(0.163)
Import		0.096		0.220***		0.213***
		(0.115)		(0.061)		(0.062)
Subsidy		0.156		-0.172		-0.184
		(0.150)		(0.122)		(0.128)
Excluded Instruments						
w^0					0.420***	0.418***
					(0.055)	(0.056)
r					-0.065***	-0.064***
					(0.021)	(0.020)
Hausman Test †			0.000	0.000		
Instruments					9	12
Hansen-J †					0.524	0.536
Cragg-Donald Statistic					235.2	232.4
Kleibergen-Paap Statistic					35.2	34.6
Observations	2982	2982	2949	2949	2949	2949
R-squared	0.943	0.943	0.976	0.976	0.518	0.522

Note: All variables are in logs. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Export represents the ratio of exports to sales, Import refers to the ratio of material expenses valued in USD to total material expenses valued in both USD and CUP at the official exchange rate, and Subsidy is the ratio of subsidies to sales. w^0 denotes the normalized fixed wage, and r represents the liquidity ratio.

Table 2: Regression of the Efficiency Wage-Augmented Production Function

reported in Appendix A. The evidence indicates that labor redundancy was both pervasive and quantitatively large at the beginning of the period. In 2009, approximately 93% of SOEs exhibited positive redundancy, and observed employment was, on average, nearly four times higher than the profit-maximizing benchmark. This suggests that overemployment was not confined to a small group of inefficient enterprises, but was a systemic feature of state-owned manufacturing.

Redundancy declined over time, although it remained substantial. By 2013, the ratio of observed to optimal employment had fallen to roughly 3:1. Descriptively, this decline coincided with rising productivity and greater use of material inputs, suggesting an improvement in operating conditions during the period.

The marginal product of materials provides further evidence on input constraints. It remained above unity throughout the period, rising from approximately 1.20 in 2009 to 1.52 in 2012, which suggests that SOEs continued to operate with insufficient levels of intermediate inputs. This pattern anticipates the regression results below, where changes in materials are strongly associated with reductions in labor redundancy.

5.2 Sources of Adjustment

Table 3 reports the estimates of the factors associated with changes in the labor redundancy rate. Columns (1)–(3) estimate the structural specification derived from Equation (12), while Columns (4)–(5) report reduced-form IV estimates based on Equation (13), instrumenting working capital with trade credit and leverage.

The results show a strong association between market conditions and labor redundancy. Across all specifications, the coefficient on firm market share is negative and statistically significant, ranging from -0.986 to -0.920. This indicates that improvements in market position are associated with reductions in the LRR.

Materials are also consistently related to lower redundancy. The coefficient on

Dependent Variable: ΔLabor Redundancy Rate

	Fixed Effects			Instrumental Variables	
	(1)	(2)	(3)	(4)	(5)
ΔFirm Market Share	-0.986**	-0.940**	-0.946**	-0.966**	-0.920**
	(0.401)	(0.399)	(0.396)	(0.401)	(0.400)
Δ Labor	0.356***	0.355***	0.274***	0.254***	0.253***
	(0.063)	(0.060)	(0.064)	(0.065)	(0.063)
ΔCapital	0.019	0.019	0.025*	0.032**	0.031**
	(0.015)	(0.015)	(0.014)	(0.014)	(0.014)
ΔMaterials	-0.317***	-0.309***	-0.269***	-0.275***	-0.267***
	(0.044)	(0.042)	(0.041)	(0.041)	(0.040)
ΔEffort	-0.009	-0.009	0.096***	0.070***	0.071***
	(0.015)	(0.015)	(0.022)	(0.021)	(0.021)
ΔLabor Productivity	-0.068***	-0.078***	-0.045***	-0.024	-0.034*
	(0.016)	(0.014)	(0.015)	(0.019)	(0.018)
ΔWage	0.566***	0.574***			
	(0.066)	(0.065)			
ΔFixed Wage			0.082***	0.061***	0.061***
			(0.016)	(0.022)	(0.022)
ΔWorking Capital			-0.006*	-0.030**	-0.026*
			(0.003)	(0.013)	(0.013)
Absorbed Fixed Effects					
Firm	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes
Loss	Yes	Yes	Yes	Yes	Yes
Merged	Yes	Yes	Yes	Yes	Yes
Subsidized	Yes	Yes	Yes	Yes	Yes
Controls					
Export		-0.683**	-0.604**		-0.574**
		(0.271)	(0.260)		(0.251)
Imports		0.069	0.071		0.034
		(0.076)	(0.079)		(0.081)
Subsidy		0.446**	0.475**		0.513**
		(0.207)	(0.204)		(0.197)
Excluded Instruments					
ΔTrade Credit				0.048***	0.046***
				(0.014)	(0.014)
ΔLeverage				1.191***	1.185***
				(0.324)	(0.321)
Total Number of Instruments				12	15
Hansen-J †				0.801	0.851
Cragg-Donald Wald F statistic				70.4	67.96
Kleibergen-Paap rk Wald F statistic				14.5	12.99
Observations	1996	1996	1996	1991	1991
R-squared	0.483	0.498	0.447	0.283	0.306

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All variables are in logarithms. X represents the export-to-sales ratio, U represents the ratio of expenses in USD to total expenses, and S represents the subsidy-to-sales ratio. w^0 is the normalized fixed wage, and r is the current ratio. † denotes that the p-value of the statistic is reported. Uncentered R-squared reported in IV estimates. The differences in the number of observations are due to the exclusion of singletons in the estimation process.

Table 3: Labor Redundancy Regressions: Structural and Reduced Form Models

materials is negative, statistically significant, and stable across specifications, ranging from -0.317 to -0.267. This result is consistent with the descriptive evidence on the high marginal product of materials and points to the importance of intermediate input availability in explaining changes in measured redundancy.

Labor productivity is negatively associated with redundancy in the fixed effects specifications, with coefficients ranging from -0.078 to -0.045, although the effect becomes weaker in the IV specifications. This suggests that productivity improvements contributed to the reduction in redundancy, but less robustly than materials or market conditions.

In contrast, changes in employment are positively associated with the LRR across all specifications. The coefficient ranges from 0.356 in the baseline fixed effects model to 0.253 in the preferred IV specification. This is consistent with the construction of the measure: higher imposed employment mechanically widens the gap between observed and optimal labor demand.

Wage-related variables also enter with positive coefficients. In the structural specifications, the coefficient on wages is approximately 0.57, while the coefficient on the fixed wage in the reduced-form models is around 0.06. These signs are consistent with the theoretical framework, in which higher labor costs reduce optimal labor demand and increase measured redundancy.

The reduced-form estimates indicate that working capital is negatively associated with labor redundancy. The coefficient is small in the fixed effects specification (-0.006) but larger in the IV estimates, ranging from -0.030 to -0.026. The first-stage instruments are statistically significant, and the Hansen-J p-values do not reject the overidentifying restrictions. These results suggest that liquidity conditions mattered, although their quantitative role appears smaller than that of materials and market-related variables.

Finally, the controls point to meaningful heterogeneity across SOEs. Export-oriented

enterprises exhibit lower redundancy, with coefficients between -0.683 and -0.574, while subsidized SOEs show higher redundancy, with coefficients between 0.446 and 0.513. This pattern is consistent with differences in competitive exposure and financial accommodation across enterprises.

Overall, the evidence indicates that the decline in labor redundancy was most strongly associated with improvements in market position, material input use, and productivity, while financial conditions played a statistically significant but quantitatively more limited role.

6 Discussion

The results suggest that labor redundancy in Cuban SOEs was shaped not only by imposed employment levels, but also by the broader operating conditions under which firms functioned. The decline in measured redundancy during 2009–2013 coincided with improvements in material input availability, productivity, and market conditions, indicating that changes in firms' productive environment affected the gap between observed and optimal employment.

One important result concerns the role of intermediate inputs. The consistently negative association between materials and labor redundancy, together with the persistently high marginal product of materials, suggests that many SOEs operated under chronic input shortages during the period studied. Under these conditions, excess labor was associated not only with overemployment itself, but also with lower effective utilization of complementary productive inputs.

The results also point to a more limited role for financial conditions. Although improvements in working capital are associated with reductions in labor redundancy, their quantitative effect is smaller than that of materials and market-related variables. At the same time, the positive association between subsidies and redundancy is consistent with the

presence of heterogeneous soft-budget mechanisms across firms, which may have allowed some SOEs to sustain inefficient employment structures for longer periods.

The findings further suggest that the reforms implemented after 2011 altered some of the conditions under which SOEs operated without fundamentally transforming the institutional structure of the state sector. Greater autonomy in selected pricing and operational decisions, together with improved access to inputs in some activities, may have contributed to reducing measured redundancy even in the absence of fully flexible labor adjustment. However, these changes stopped well short of the deeper restructuring processes observed in transition experiences such as China or Vietnam, where reforms more substantially altered ownership structures, strengthened market discipline, and expanded firms' autonomy over production and employment decisions, even if important distortions and forms of labor redundancy also persisted in parts of the state sector. In the Cuban case, the evidence suggests that the reforms alleviated some operational rigidities and improved firms' operating conditions, but did not remove the institutional foundations that sustained labor redundancy inside the state sector. This may help explain why the observed improvements remained partial and why substantial inefficiencies persisted despite the reform process.

More broadly, the paper highlights the importance of studying misallocation in contexts where firms face direct institutional constraints on input adjustment. In such environments, distortions associated with labor allocation may extend beyond employment itself and shape the use of complementary inputs and firms' operating performance more generally.

7 Conclusions

This paper examines how state-owned enterprises adjust when employment levels cannot be freely determined. Using firm-level data for Cuban manufacturing SOEs during

2009–2013, the analysis documents a high prevalence of labor redundancy at the beginning of the period, followed by a significant but incomplete decline over time.

The results suggest that this reduction in measured redundancy was associated less with direct employment cuts than with changes in firms' operating conditions. Improvements in material input availability, productivity, and market conditions were consistently associated with lower levels of labor redundancy, while financial conditions played a more limited quantitative role.

The findings also indicate that labor redundancy affected more than employment levels alone. The persistently high marginal product of materials and the strong association between input availability and redundancy suggest that imposed employment levels were linked to broader inefficiencies in the use of complementary productive inputs inside SOEs.

More broadly, the paper highlights the importance of studying misallocation in settings where firms face direct institutional constraints on input adjustment. In such environments, labor distortions may shape firms' productive organization even when employment itself adjusts only partially.

The Cuban case further suggests that partial reforms can alleviate some operational rigidities without fundamentally transforming the institutional conditions that sustain inefficient employment structures. Although the reforms implemented after 2011 appear to have improved some operating conditions inside SOEs, substantial labor redundancy persisted throughout the period. This is consistent with the idea that limited reforms may soften the effects of institutional distortions without eliminating their underlying sources.

Overall, the paper contributes to the literature on misallocation and state-owned enterprises by providing evidence that labor redundancy in state-dominated economies may be closely linked to the broader organization of production and input use inside firms.

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A Marginal Products and Labor Redundancy

	LRR	MPM	MPL	Wages	LnTFP	% of SOEs with RL	Excess, 1000s (sum)	L, 1000s (sum)	t-test	# of SOEs
2009 (Base year)	1.388***	1.202***	2.050***	5.274***	1.767***	0.928***	259.7	389.0	0.000	739
2010	-0.042**	-0.089*	-0.028	0.066**	-0.095***	0.002	236.2	366.8	0.000	716
2011	-0.173***	0.292**	0.391***	0.191***	0.092***	-0.016***	189.5	334.6	0.000	547
2012	-0.211***	0.322***	0.614***	0.489***	0.211***	-0.018**	170.3	313.9	0.000	503
2013	-0.248***	-0.014	0.646***	0.764***	0.070*	-0.020*	155.9	304.7	0.000	479

Notes: Table entries (columns 1 to 6) correspond to regressions with annual dummies, controlling for firm, industry, losses, mergers, and subsidies fixed effects. The 2009 base-year coefficient represents the annual average, followed by the cumulative yearly deviation from that average. Standard errors (not reported) are robust. Excess is the sum of the absolute difference between L and L^*. The t-test refers to a paired t-test where $H_0 : \text{mean}(L - L^*) = 0$, with p-values reported. *** p<0.01, ** p<0.05, * p<0.1.

Table 4: Average Marginal Products, TFP, Wages, and Labor Redundancy Rate