Private debt, public debt, and capital misallocation

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Overview

Motivation

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- More recent research focuses on how debt accumulation impacts on productivity and allocative efficiency (Borio et al. (2015); Anderson & Raissi (2018); Cecchetti & Kharroubi (2018))

Motivation

- In a recent paper, Aghion et al. (2019) develop a simple theoretical model to show that there is an inverted-U relationship between credit access and aggregate productivity growth that is generated by two counteracting effects: (i) a positive investment effect of credit access on incumbent firms' productivity growth working through facilitation of innovation, and (ii) a negative reallocation effect of credit access working through the exit rate of incumbent firms and its influence on the entry cost for new—potentially more efficient—innovators.

Motivation

- One of the key factors in understanding aggregate productivity differences across countries is input misallocation (Restuccia & Rogerson (2008); Hsieh & Klenow (2009); Bartelsman et al. (2013); Restuccia & Rogerson (2013); Hopenhayn (2014); Restuccia (2019))

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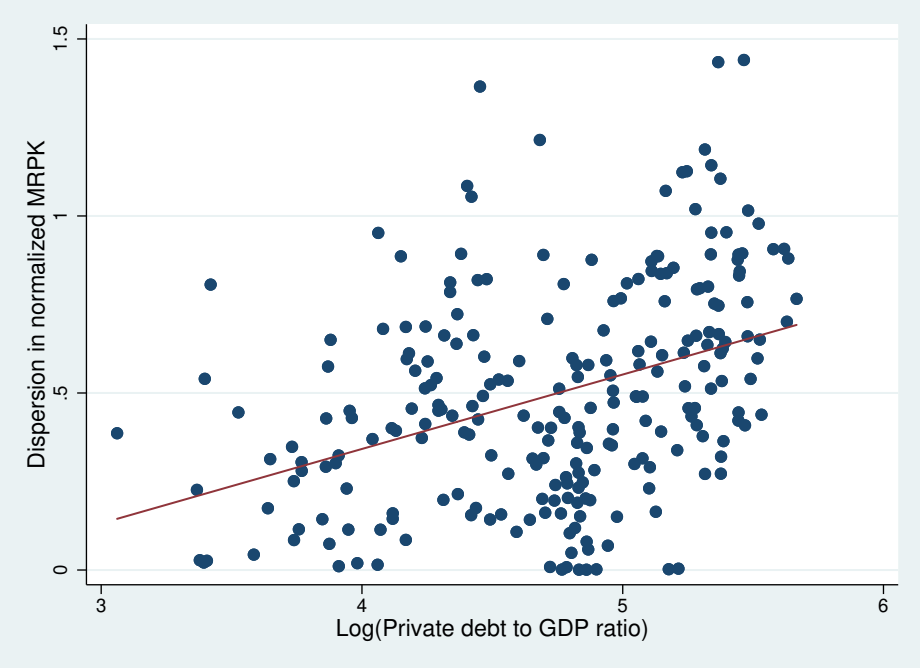
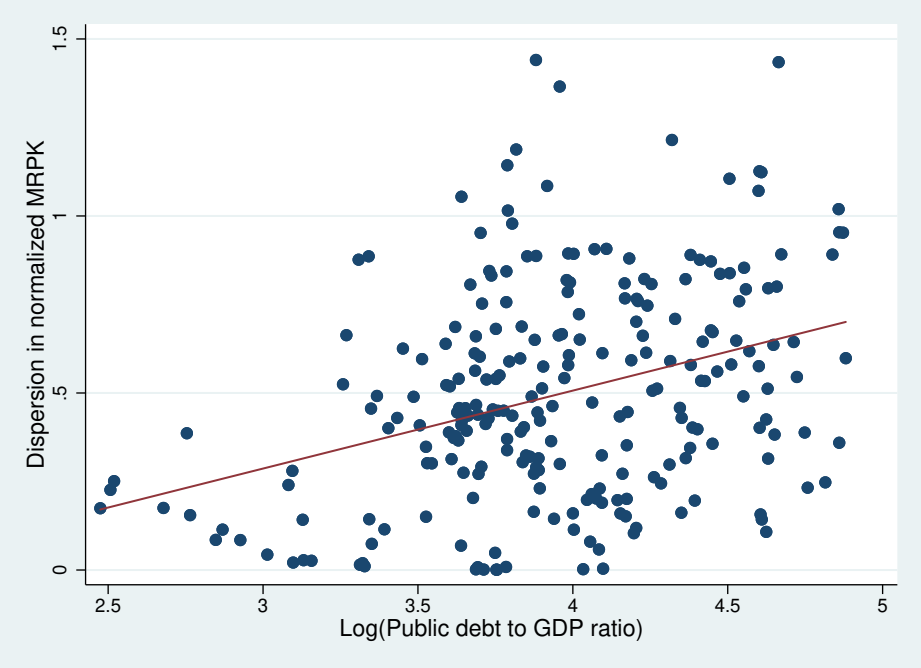
- What if private and public debt build-up is partly responsible for generating misallocation, and hence these productivity differences?

Motivation



(a) Private debt and capital misallocation



(b) Public debt and capital misallocation

Figure 1: Scatterplots of debt-to-GDP ratios and capital misallocation

State of the Literature

- Earlier studies found positive effects of finance on growth (King & Levine (1993); Rajan & Zingales (1998); Levine et al. (2000); Beck et al. (2000))

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- Later studies found a nonlinear relationship between private sector debt and growth (Shen & Lee (2006); Law & Singh (2014); Arcand et al. (2015))
- The relationship between public debt and growth has also been found to be inverse U-shaped or nonlinear (Reinhart & Rogoff (2010); Cecchetti et al. (2011); Checherita-Westphal & Rother (2012); Baum et al. (2013); Woo & Kumar (2015); Karadam (2018); Yang & Su (2018))

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- Another strand of literature has focused on the joint dynamics of private and public debt, and found primarily private debt surges to precede crises or to pose a bigger threat to financial stability (Reinhart & Rogoff (2009); Reinhart & Rogoff (2011); Jordà et al. (2015))

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- More recent research focuses on how debt accumulation impacts on productivity or input reallocations (Borio et al. (2015); Anderson & Raissi (2018); Cecchetti & Kharroubi (2018))

Research Question

- How do private debt and public debt at the aggregate level influence capital misallocation within different industries?

Data Sources

- IMF's Global Debt Database: **private debt** (loans and debt securities) and **public debt** (general government debt liabilities) as a share of GDP

- 6th Vintage of the CompNet database: Hsieh-Klenow measure of **capital misallocation** at the 1-digit NACE Rev.2 sector level, detrended and normalized by the industry standard deviation (at the 2-digit level) as per Kehrig (2015)

Appendix

Data Sources

- Control variables: Chinn & Ito (2006) **capital account openness** index, long-term **interest rates** (OECD), general **government** final consumption **expenditure** (World Bank), **taxes** on income, profits and capital gains (ICTD Government Revenue Dataset), **trade** (sum of exports and imports as % of GDP, World Bank), **inflation** (IMF's World Economic Outlook), and an index of **institutional quality** measured as the sum of political risk rating indicators such as bureaucracy quality, investment profile, rule of law, and control of corruption (ICRG Researchers Dataset)

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- Sector-specific variables: **external finance dependence** as per Rajan & Zingales (1998) (Franco (2018)); sectoral **technological intensity** (Eurostat); indicator of **credit constraints** (mean and dispersion), De Loecker & Warzynski (2012) **markups**, and the **skewness of TFP distribution** (CompNet, 6th Vintage)

Methodology

- We use a diff-in-diff-type econometric specification similar to Rajan & Zingales (1998) and Larrain & Stumpner (2017):

$$\begin{aligned} Capital\_Misallocation_{cjt} = \beta_0 &+ \beta_1(ln[PrivateDebt]_{ct-1} \times Z_j) \\ &+ \beta_2(ln[PublicDebt]_{ct-1} \times Z_j) \\ &+ \gamma(X_{ct} \times Z_j) + \delta_c + \delta_j + \delta_{cj} + \epsilon_{cjt} \end{aligned} \tag{1}$$

where c is country, j is macro-sector, t is year, X_{ct} denotes country-level controls, and Z_j denotes sector-specific (time-invariant) indicators

Methodology

- We employ the within-effects estimation method
- For robustness check, we use the difference and system GMM

Results

Table 1: Debt to GDP ratios and capital misallocation: fixed effects regressions (interaction with financial dependence)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ln(PrivDebt)×*FinDep*	0.739***	0.901***	0.856***	0.747***	0.731***	0.608**	0.739***	0.668**	0.955***	0.955***
	(0.232)	(0.229)	(0.211)	(0.206)	(0.246)	(0.243)	(0.230)	(0.295)	(0.170)	(0.235)
ln(PubDebt)×*FinDep*	0.391**	0.294	0.327	0.385**	0.285	0.300	0.401**	0.303*	0.023	0.023
	(0.171)	(0.185)	(0.250)	(0.169)	(0.212)	(0.189)	(0.163)	(0.172)	(0.305)	(0.283)
KA-Openness×*FinDep*		-0.878**							-1.061**	-1.061**
		(0.380)							(0.490)	(0.355)
LT-IntRate×*FinDep*			-0.038						-0.058**	-0.058**
			(0.026)						(0.025)	(0.017)
ln(GovtCons)×*FinDep*				-0.130					0.128	0.128
				(0.732)					(0.974)	(1.195)
ln(TaxesIncProf)×*FinDep*					-0.273				-0.074	-0.074
					(0.490)				(0.452)	(0.266)
ln(Trade)×*FinDep*						0.573			-0.122	-0.122
						(0.375)			(0.654)	(0.506)
Inflation×*FinDep*							0.003		0.010	0.010
							(0.027)		(0.037)	(0.028)
InstQuality×*FinDep*								-0.031	-0.037	-0.037
								(0.053)	(0.052)	(0.035)
Standard Errors	Clustered (country)	Clustered (country)	Clustered (country)	Clustered (country)	Clustered (country)	Clustered (country)	Clustered (country)	Clustered (country)	Clustered (country)	HAC (Driscoll-Kraay)
Observations	1,806	1,806	1,600	1,806	1,782	1,806	1,806	1,806	1,600	1,600
R-squared	0.172	0.176	0.190	0.172	0.180	0.173	0.173	0.172	0.196	0.196

Results

Table 2: Debt to GDP ratios and capital misallocation: fixed effects regressions (interaction with technological intensity)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ln(PrivDebt)× *TechIntens*	0.566**	0.639**	0.711***	0.587***	0.533**	0.360**	0.563**	0.553**	0.674***	0.674***
	(0.204)	(0.245)	(0.181)	(0.194)	(0.202)	(0.171)	(0.197)	(0.213)	(0.196)	(0.168)
ln(PubDebt)× *TechIntens*	0.354*	0.311	0.251	0.339*	0.177	0.213	0.254	0.339	0.008	0.008
	(0.192)	(0.218)	(0.208)	(0.183)	(0.191)	(0.210)	(0.188)	(0.228)	(0.286)	(0.172)
KA-Openness× *TechIntens*		-0.390							-0.877**	-0.877***
		(0.247)							(0.305)	(0.221)
LT-IntRate× *TechIntens*			-0.025						0.004	0.004
			(0.018)						(0.018)	(0.017)
ln(GovtCons)× *TechIntens*				-0.347					0.559	0.559
				(0.526)					(0.557)	(0.582)
ln(TaxesIncProf)× *TechIntens*					-0.465				0.136	0.136
					(0.343)				(0.388)	(0.180)
ln(Trade)× *TechIntens*						0.891*			1.008	1.008**
						(0.424)			(0.605)	(0.352)
Inflation× *TechIntens*							-0.030*		-0.043*	-0.043***
							(0.027)		(0.037)	(0.028)
InstQuality× *TechIntens*								-0.005	0.026	0.026*
								(0.038)	(0.035)	(0.015)
Standard Errors	Clustered (country)	Clustered (country)	Clustered (country)	Clustered (country)	Clustered (country)	Clustered (country)	Clustered (country)	Clustered (country)	Clustered (country)	HAC (Driscoll-Kraay)
Observations	1,806	1,806	1,600	1,806	1,782	1,806	1,806	1,806	1,600	1,600
R-squared	0.164	0.165	0.178	0.164	0.171	0.167	0.166	0.164	0.184	0.184

Results

Table 3: Debt to GDP ratios and capital misallocation: fixed effects regressions (interaction with credit constraints)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ln(PrivDebt)×*CredConstr*	3.364***	3.310***	3.901***	3.405***	3.478***	2.625***	3.588***	3.428***	3.540***	3.540***
	(0.709)	(0.733)	(0.687)	(0.705)	(0.709)	(0.780)	(0.680)	(0.674)	(0.858)	(0.970)
ln(PubDebt)×*CredConstr*	1.386***	1.148*	0.814	1.343***	1.316**	0.685	1.041*	1.477**	0.369	0.369
	(0.368)	(0.611)	(0.465)	(0.354)	(0.515)	(0.533)	(0.515)	(0.666)	(1.959)	(0.995)
KA-Openness×*CredConstr*		-1.830							-2.047	-2.047
		(1.822)							(5.732)	(3.064)
LT-IntRate×*CredConstr*			-0.220**						-0.179	-0.179**
			(0.086)						(0.133)	(0.076)
ln(GovtCons)×*CredConstr*				-0.800					1.082	1.082
				(1.901)					(3.051)	(3.679)
ln(TaxesIncProf)×*CredConstr*					0.232				0.945	0.945
					(1.183)				(1.727)	(0.827)
ln(Trade)×*CredConstr*						3.346*			1.878	1.878
						(1.850)			(2.746)	(1.708)
Inflation×*CredConstr*							-0.097		-0.028	-0.028
							(0.105)		(0.147)	(0.116)
InstQuality×*CredConstr*								0.029	0.021	0.021
								(0.133)	(0.231)	(0.128)
Standard Errors	Clustered (country)	Clustered (country)	Clustered (country)	Clustered (country)	Clustered (country)	Clustered (country)	Clustered (country)	Clustered (country)	Clustered (country)	HAC (Driscoll-Kraay)
Observations	1,482	1,482	1,326	1,482	1,473	1,482	1,482	1,482	1,326	1,326
R-squared	0.178	0.179	0.197	0.179	0.178	0.181	0.179	0.179	0.198	0.198

Results

Table 4: Private debt to GDP ratios and capital misallocation: fixed effects regressions

Interacting variable	Financial	Dependence	Financial	Dependence	Technol.	Intensity	Technol.	Intensity	Credit	Constraints	Credit	Constraints
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
ln(CorporateDebt)	0.957***	0.957***			0.709***	0.709***			3.429***	3.429***		
×*Interaction*	(0.258)	(0.303)			(0.221)	(0.185)			(0.924)	(1.200)		
ln(HouseholdDebt)			0.325***	0.325***			0.216***	0.216**			1.205**	1.205***
×*Interaction*			(0.091)	(0.128)			(0.070)	(0.078)			(0.450)	(0.387)
KA-Openness	-0.805*	-0.805***	-1.090	-1.090***	-0.701***	-0.701***	-0.867**	-0.867***	-2.721	-2.721	-1.187	-1.187
×*Interaction*	(0.405)	(0.196)	(0.625)	(0.215)	(0.215)	(0.117)	(0.302)	(0.188)	(3.581)	(2.843)	(3.317)	(2.549)
LT-IntRate	-0.059**	-0.059***	-0.058**	-0.058***	0.004	0.004	0.004	0.004	-0.200	-0.200**	-0.175	-0.175**
×*Interaction*	(0.026)	(0.020)	(0.026)	(0.020)	(0.018)	(0.021)	(0.017)	(0.020)	(0.133)	(0.086)	(0.127)	(0.081)
ln(GovtCons)	0.172	0.172	0.911	0.911	0.555	0.555	1.126*	1.126*	0.889	0.889	3.897	3.897
×*Interaction*	(0.928)	(1.195)	(0.983)	(1.054)	(0.600)	(0.575)	(0.567)	(0.509)	(2.702)	(3.823)	(3.375)	(3.308)
ln(TaxesIncProf)	-0.325	-0.325	-0.188	-0.188	-0.028	-0.028	0.038	0.038	-0.039	-0.039	0.341	0.341
×*Interaction*	(0.482)	(0.215)	(0.464)	(0.233)	(0.384)	(0.135)	(0.369)	(0.145)	(2.327)	(0.840)	(1.825)	(1.047)
ln(Trade)	0.241	0.241	-0.001	-0.001	1.250**	1.250***	1.123*	1.123***	2.827	2.827	2.705	2.705
×*Interaction*	(0.619)	(0.518)	(0.617)	(0.528)	(0.511)	(0.314)	(0.622)	(0.310)	(2.735)	(1.809)	(2.917)	(1.817)
Inflation	0.014	0.014	0.019	0.019	-0.041	-0.041***	-0.036	-0.036***	0.003	0.003	-0.012	-0.012
×*Interaction*	(0.039)	(0.027)	(0.037)	(0.025)	(0.026)	(0.009)	(0.021)	(0.012)	(0.155)	(0.125)	(0.159)	(0.127)
InstQuality	-0.032	-0.032*	-0.065	-0.065***	0.032	0.032**	0.007	0.007	-0.004	-0.004	-0.091	-0.091
×*Interaction*	(0.053)	(0.018)	(0.052)	(0.021)	(0.037)	(0.014)	(0.038)	(0.018)	(0.156)	(0.086)	(0.161)	(0.060)
Standard Errors	Clustered (country)	Driscoll-Kraay	Clustered (country)	Driscoll-Kraay	Clustered (country)	Driscoll-Kraay	Clustered (country)	Driscoll-Kraay	Clustered (country)	Driscoll-Kraay	Clustered (country)	Driscoll-Kraay
Observations	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,326	1,326	1,326	1,326
R-squared	0.195	0.195	0.193	0.193	0.183	0.183	0.182	0.182	0.195	0.195	0.195	0.195

Robustness checks

Table 5: Debt to GDP ratios and capital misallocation: One-step GMM regressions

Interacting variable	Financial	Dependence	Financial	Dependence	Technol.	Intensity	Technol.	Intensity	Credit	Constraints	Credit	Constraints
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Estimation	Diff-GMM	Diff-GMM	Sys-GMM	Sys-GMM	Diff-GMM	Diff-GMM	Sys-GMM	Sys-GMM	Diff-GMM	Diff-GMM	Sys-GMM	Sys-GMM
ln(PrivDebt)	0.813**	0.678**	0.875***	0.782***	0.789***	0.772**	0.754***	0.720***	2.995***	2.909**	2.771***	2.686***
×*Interaction*	(0.289)	(0.317)	(0.150)	(0.134)	(0.254)	(0.281)	(0.183)	(0.174)	(0.981)	(1.125)	(0.412)	(0.372)
ln(PubDebt)	-0.184	-0.228	-0.336*	-0.361*	-0.082	-0.090	-0.324	-0.412	-0.796	-0.639	-0.615	-0.702
×*Interaction*	(0.369)	(0.379)	(0.189)	(0.186)	(0.319)	(0.333)	(0.201)	(0.240)	(1.774)	(1.875)	(0.666)	(0.643)
KA-Openness	-1.263**	-1.208*	-1.642***	-1.616***	-1.211**	-1.167**	-1.502***	-1.586***	-6.306	-7.161	-6.587**	-8.274**
×*Interaction*	(0.463)	(0.618)	(0.444)	(0.447)	(0.450)	(0.431)	(0.389)	(0.431)	(5.530)	(5.522)	(2.462)	(2.893)
LT-IntRate	-0.050	-0.051	-0.075**	-0.073	0.016	0.018	-0.018	-0.018	-0.162	-0.137	-0.298*	-0.265
×*Interaction*	(0.044)	(0.052)	(0.033)	(0.047)	(0.029)	(0.027)	(0.013)	(0.018)	(0.161)	(0.174)	(0.146)	(0.151)
ln(GovtCons)	0.625	0.971	-0.006	0.285	0.842	0.853	-0.448	-0.251	2.807	4.159	-0.323	0.642
×*Interaction*	(1.266)	(1.424)	(0.613)	(0.674)	(0.780)	(0.807)	(0.340)	(0.370)	(5.126)	(5.756)	(3.262)	(3.574)
ln(TaxesIncProf)	0.072	0.028	0.048	0.036	0.353	0.388	0.052	0.106	2.022	2.224	1.123	1.396
×*Interaction*	(0.456)	(0.554)	(0.371)	(0.415)	(0.363)	(0.405)	(0.261)	(0.279)	(1.450)	(1.935)	(1.321)	(1.401)
ln(Trade)	0.665	0.781	0.157	0.170	1.168	1.133	0.304*	0.361*	4.717*	4.217	-0.175	-0.281
×*Interaction*	(1.006)	(0.934)	(0.257)	(0.254)	(0.935)	(0.893)	(0.162)	(0.186)	(2.578)	(2.441)	(1.072)	(1.050)
Inflation	0.032	0.035	0.025	0.024	-0.054*	-0.057	-0.045*	-0.052**	-0.017	-0.003	0.077	0.093
×*Interaction*	(0.035)	(0.043)	(0.038)	(0.047)	(0.028)	(0.035)	(0.022)	(0.024)	(0.147)	(0.145)	(0.149)	(0.153)
InstQuality	-0.072	-0.090	-0.087***	-0.109***	0.019	0.009	-0.047*	-0.065**	0.017	-0.027	-0.199	-0.251
×*Interaction*	(0.053)	(0.062)	(0.022)	(0.025)	(0.037)	(0.046)	(0.024)	(0.027)	(0.225)	(0.225)	(0.125)	(0.149)
Observations	1,469	1,469	1,600	1,600	1,469	1,469	1,600	1,600	1,213	1,213	1,326	1,326
Instrument count	120	81	130	91	119	81	129	91	115	81	125	91
AR(1) test p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AR(2) test p-value	0.239	0.241	0.250	0.249	0.267	0.267	0.236	0.238	0.387	0.368	0.378	0.358
Hansen test p-value	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Robustness checks

Table 6: Debt to GDP ratios and capital misallocation: interaction with alternative sectoral indicators

Interacting variable	St.Dev. of	Cred. Constr.	St.Dev. of	Cred. Constr.	DL&W (2012)	Markups	DL&W (2012)	Markups	Skewness	of TFP	Skewness	of TFP
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Estimation	FE	FE	Diff-GMM	Sys-GMM	FE	FE	Diff-GMM	Sys-GMM	FE	FE	Diff-GMM	Sys-GMM
ln(PrivDebt)	1.587***	1.587***	1.403**	1.422***	0.278***	0.278***	0.266**	0.220***	0.066***	0.066***	0.052**	0.065***
×*Interaction*	(0.459)	(0.439)	(0.556)	(0.202)	(0.090)	(0.055)	(0.111)	(0.056)	(0.018)	(0.009)	(0.023)	(0.019)
ln(PubDebt)	0.097	0.097	-0.486	-0.295	0.119	0.119**	0.050	0.028	-0.010	-0.010	-0.016	-0.005
×*Interaction*	(0.887)	(0.524)	(0.812)	(0.329)	(0.069)	(0.046)	(0.059)	(0.046)	(0.023)	(0.010)	(0.024)	(0.019)
KA-Openness	-1.634	-1.634	-3.728	-3.225**	-0.363**	-0.363***	-0.370	-0.188	-0.126**	-0.126***	-0.101*	-0.109**
×*Interaction*	(2.436)	(1.644)	(2.534)	(1.076)	(0.140)	(0.097)	(0.220)	(0.192)	(0.046)	(0.023)	(0.056)	(0.044)
LT-IntRate	-0.071	-0.071**	-0.067	-0.138*	0.009	0.009	0.002	-0.006	-0.001	-0.001	-0.003	-0.006***
×*Interaction*	(0.053)	(0.032)	(0.073)	(0.066)	(0.007)	(0.006)	(0.008)	(0.005)	(0.002)	(0.002)	(0.002)	(0.002)
ln(GovtCons)	1.010	1.010	2.266	0.450	-0.257	-0.257	-0.563	-0.459**	-0.015	-0.015	-0.018	-0.067**
×*Interaction*	(1.807)	(1.784)	(2.717)	(1.232)	(0.230)	(0.241)	(0.331)	(0.177)	(0.078)	(0.053)	(0.074)	(0.026)
ln(TaxesIncProf)	0.115	0.115	0.481	-0.031	-0.007	-0.007	-0.049	-0.042	-0.021	-0.021	-0.035	-0.023
×*Interaction*	(0.896)	(0.456)	(0.762)	(0.680)	(0.082)	(0.073)	(0.070)	(0.046)	(0.023)	(0.013)	(0.021)	(0.016)
ln(Trade)	1.163	1.163	2.278	-0.293	0.291	0.291**	0.195	0.118	0.055*	0.055***	0.074*	0.014
×*Interaction*	(1.247)	(0.828)	(1.862)	(0.493)	(0.199)	(0.120)	(0.268)	(0.069)	(0.027)	(0.018)	(0.041)	(0.016)
Inflation	-0.020	-0.020	-0.015	0.025	-0.022**	-0.022***	-0.020	-0.015*	-0.003	-0.003**	-0.001	0.001
×*Interaction*	(0.076)	(0.044)	(0.081)	(0.083)	(0.010)	(0.006)	(0.012)	(0.008)	(0.002)	(0.001)	(0.002)	(0.002)
InstQuality	0.016	0.016	0.002	-0.093*	0.013	0.013**	0.006	0.002	0.002	0.002*	0.002	0.001
×*Interaction*	(0.102)	(0.051)	(0.093)	(0.049)	(0.013)	(0.006)	(0.012)	(0.008)	(0.002)	(0.001)	(0.002)	(0.001)
Standard Errors	Clustered (country)	Driscoll-Kraay	Clustered (country)	Clustered (country)	Clustered (country)	Driscoll-Kraay	Clustered (country)	Clustered (country)	Clustered (country)	Driscoll-Kraay	Clustered (country)	Clustered (country)
Observations	1,326	1,326	1,213	1,326	1,402	1,402	1,290	1,402	1,600	1,600	1,469	1,600

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- At the same time, another active strand of research has shown that misallocation of capital and labor across firms is responsible for a significant part of the differences in total factor productivity across countries.
- These developments have led us to ask the question about the possible role of debt build-up in generating these productivity differences.

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- We employ CompNet database for the Hsieh-Klenow measure of the sectoral capital misallocation, and we exploit the within-country variation across industries in such indicators as external finance dependence, technological intensity, credit constraints and the level of competition.

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- We employ CompNet database for the Hsieh-Klenow measure of the sectoral capital misallocation, and we exploit the within-country variation across industries in such indicators as external finance dependence, technological intensity, credit constraints and the level of competition.
- Our results show that private debt accumulation significantly increases capital misallocation, particularly in industries with high financial dependence, high R&D intensity, a larger share of credit-constrained firms and a lower level of competition among firms.

Conclusion

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Conclusion

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- When considering the two components of private debt, we find that corporate debt has a much larger amplifying effect on capital misallocation as compared to household debt, although the coefficients of both corporate debt and household debt are significant.
- On the other hand, we fail to find any significant effect of public debt on capital misallocation within industries in our sample.

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Appendix

- To measure capital misallocation, we adopt the framework developed by Hsieh & Klenow (2009). They consider an economy consisting of S sectors characterized by monopolistic competition. Each sector's output is a CES aggregate of M_s differentiated products:

$$Y_s = \left(\sum_{i=1}^{M_s} Y_{si}^{(\sigma-1)/\sigma} \right)^{\sigma/(\sigma-1)}$$

- Each firm's production function is given by a Cobb-Douglas technology of the following form:

$$Y_{si} = A_{si} K_{si}^{\alpha_s} L_{si}^{\alpha_{1-s}}$$

Appendix

- Hsieh & Klenow (2009) define distortions that simultaneously affect both capital and labor—thus increasing the marginal products of these inputs by the same proportion—as an output distortion, denoted by τ_Y, and those that raise the marginal product of capital relative to labor as the capital distortion, denoted by τ_K

- Then, firms maximize profits given by:

$$\pi_{si} = (1 - \tau_{Ysi})P_{si}Y_{si} - wL_{si} - (1 + \tau_{Ksi})RK_{si}$$

Appendix

- From the FOCs, and given the definition of marginal product of capital (MPK), we obtain the following result for marginal revenue product of capital:

$$MRPK_{si} \equiv MR_{si} \times MPK_{si} = \alpha_s \frac{\sigma - 1}{\sigma} \frac{P_{si} Y_{si}}{K_{si}} = R \frac{1 + \tau_{K_{si}}}{1 - \tau_{Y_{si}}}$$

  where $MR_{si} \equiv \frac{\sigma - 1}{\sigma} P_{si}$

- The dispersion of $MRPK_{si}$ reflects capital misallocation due to firm-specific output and capital distortions

Appendix

- We use the measure of capital misallocation at the macro-sector level, cleaned of industry-specific common developments as proposed by Kehrig (2015):

$$Capital\_Misallocation_t \equiv Median_t \left[STDEV_{st} \left(\frac{MRPK_{sit} - \overline{MRPK}_s}{\sigma_s} \right) \right]$$

where $MRPK_{sit}$ denotes the deviation of $MRPK_{it}$ around the 2-digit industry's long-run growth trend, $\overline{MRPK}_s$ stands for the long-run average level of $MRPK_{sit}$, and σ_s denotes the long-run standard deviation of $MRPK_{sit}$.

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