Supplementary Web Appendix to
"Growth and Risk at the Industry Level:
the Real Effects of Financial Liberalization"

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A Propensity Score Matching

In order to overcome the selection on observables problem in the difference-in-differences model (1), we implement a propensity score matching procedure (hereafter PSM) to identify a control country for each treated one.

The basic idea of propensity score matching is to simulate a randomized experiment. We want to pair together countries with similar characteristics. To do so, we use a vector of covariates X, and assume that conditional on the vector X, the expected value of the variable of interest (in our case, output growth or output volatility) in the absence of financial liberalization would be the same for the treated and the control countries that have been paired together. If this assumption holds, it is legitimate to see the control country as an identical twin of the treated country if the latter *had not received treatment*. Thus, the difference between the treated and control countries will be an appropriate estimate of the effect of financial liberalization – the treatment effect.

The relevant set of covariates, X, should include variables that are co-determinants of the financial liberalization treatment and of the outcome variables of interest. Since the treatment happens at the country-level, we consider a set country-level variables for X. An obvious difficulty in performing a matching based on X is the multi-dimensionality of the information set. As shown by Rosenbaum and Rubin (1983), it is possible to match instead on the probability of liberalization conditional on the vector X, which is a scalar quantity. We therefore define the *propensity score* as the conditional probability of receiving the liberalization treatment for country c in year t given X:

$$p_{ct}(X) = Pr(z_{ct} = 1|X),$$

where $z_{ct} = 1$ if country c is fully liberalized at time t and $z_{ct} = 0$ otherwise. The basic econometric results supporting the PSM approach are derived in Rosenbaum and Rubin (1983). In particular, Theorem 1 in Rosenbaum and Rubin (1983) states that, under some conditions, exposure to the treatment and the observed covariates are conditionally inde-

pendent given the propensity score ($z \perp X|p(X)$). [28]

The propensity matching procedure follows three steps. In the first step, we use a logit model to estimate the probabilities of financial liberalization, that we call the propensity scores, for a sample of countries and years. Next, following Dehejia and Wahba (2002), we group observations into intervals with similar propensity score – referred to as propensity score strata – and test whether the means of each right-hand side variable do not differ between treated and non-treated units within each stratum.[29] In the third step, we construct the relevant control group for each treated country using a proximity measure based on propensity scores.

In our case, the first step involves estimating the following logit model:

$$E(TREATED_{ct}|X_i) = \frac{\exp(AX_{ct})}{1 - \exp(AX_{ct})},$$

where $TREATED_{ct}$ is the indicator for whether or not the country is liberalized and X_{ct} a vector of covariates. In the baseline specification X_{ct} includes the log of PPP-adjusted per capita income ($INCOME_{ct}$), the volatility of the per capita GDP growth over the previous 5 years ($VOLATILITY_{ct}$), the trade openness ($OPEN_{ct}$), defined as imports plus exports as a share of GDP, life expectancy ($LIFE\_EXP_{ct}$), the number of years the current government has been in office (YRS_OFFC_{ct}) and an index of voice and accountability ($VOICE_c$).[30]

The logit specification borrows from a small literature on the determinants of financial liberalization and, in particular, from Abiad and Mody (2005). It includes economic, political, and institutional variables. Note that the objective of the logit estimation is not to predict financial liberalization but to obtain a distribution of propensity scores that allows to match treated and control countries. For this reason, we favor a parsimonious specification that includes variables that are significant determinants of financial liberalization and, at the same time, passes the Dehejia and Wahba (2002) test of equality of means within strata referred to above. In the final specification, more than 85 percent of tests fail to reject equality of means within strata. We also experimented with a wide variety of other

[28] PSM methods were first used in international economics by Persson (2001) and Glick, Guo and Hutchinson (2006).

[29] This is a test of the *balancing hypothesis* which needs to be verified for the Rosenbaum and Rubin (1983) theorem to be valid.

[30] The first three variables come from the Penn World Tables. Life expectancy comes from the U.N. Population Database. The sources for YRS_OFFC_{ct} and $VOICE_c$ are the World Bank's Database of Political Institutions (Beck et al., 2001) and the Governance Matters Database of Kaufmann, Kraay, and Mastruzzi (2005), respectively.

country variables, capturing the level of development, human capital, various aspects of institutions, the incidence of financial and currency crises, and the composition of trade and output. In addition, we included measures of global growth opportunities developed by Bekaert, Harvey, Lundblad, and Siegel (2007) to control for the possible simultaneity between the decision to financially liberalize and a change in the country's growth potential. Many of these variables turned out to be insignificant.

The results of the logit estimation are reported in Appendix Table A4. Having estimated this logit model, the last step consists of exploiting the propensity scores to construct control groups. For each liberalization episode, we calculate the probability of liberalization during the five years immediately preceding the actual liberalization. We then compare these probabilities to those of all the other potential control countries, defined as all the countries that did not liberalize during the 20-year window around the episode in question. Letting C be the set of all countries, we define the *proximity* between the liberalized country $c \in C$ and another country d as the average of the square of the difference between p_{dt} and p_{ct} for the five-year period prior to financial liberalization:

$$proximity_{dc} = \frac{1}{5} \sum_{t=t_c-4}^{t_c} (p_{dt} - p_{ct})^2 , \tag{A.1}$$

where t_c is the year country c liberalized.[31] We use the *first neighbor* matching method and define the control group of the liberalized country c as:

$$CG_c = \underset{\substack{d \in C \\ |t_c - t_d| \geq 10}}{\text{argmin}} \{proximity_{dc}\} ,$$

where the additional restriction of a 10 years' difference between liberalization dates of c and d is required to prevent countries that liberalized around the same time as c from being included in its control group. The list of control countries for each liberalization episode is presented in Appendix Table A2. In addition to the tests of equality of means within each stratum, we perform the following check suggested by Glick, Guo and Hutchinson (2006): a two-sample test of equality of means between the sample of treated and control countries for each independent variable measured at the time of financial liberalization. In all cases but one, the variables in our specification satisfy this test. Once the control group has been constructed, it is used in the estimation of equation (1) described in Section 3.

[31] Missing data may lead to missing years in the p_{ct} set. When this happens, we adapt the equation (A.1) to be an average over the propensity scores available.

References

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[4] Dehejia, Rajeev, and Sadek Wahba, 2002, "Propensity Score Matching Methods for Non-Experimental Causal Studies," *Review of Economics and Statistics*, 84, 151-161.

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Appendix Table A4: PSM Logit Regression

	(1)
Dep. Var.: TREATED	
Log(Per capita income)	3.829***
	[0.642]
Growth volatility over past 5 years	46.590***
	[12.425]
Trade/GDP	-0.026***
	[0.005]
Current government's years in office	0.248***
	[0.037]
Voice and accountability	-0.054
	[0.427]
Log(Life expectancy)	63.586***
	[7.470]
Constant	-308.625***
	[33.063]
Observations	575
Estimation Technique	Logit

Notes: Robust standard errors in brackets; * significant at 10%; ** significant at 5%; *** significant at 1%. *TREATED* takes on the value of 1 when the country is liberalized, zero otherwise. *Log(Per capita income)* is the log of PPP-adjusted per capita income from Penn World Tables. *Trade/GDP* is exports plus imports as a share of GDP; *Log(Life Expectancy)* is the log of the life expectancy; *Current government's years in office* is how many years the active government has been in office; *Voice and accountability* is an index sources from the World Bank's Governance Matters Database; *Growth Volatility* is the volatility of the GDP growth rate over the preceding 5 years. Variable definitions and sources are described in detail in the text.

Appendix Table A5: Measures of External Dependence and Liquidity Needs

ISIC code	Industrial sector	External dependence	Liquidity needs
311	Food products	0.14	0.11
313	Beverages	0.08	0.09
314	Tobacco	-0.45	0.24
321	Textile	0.19	0.16
322	Apparel	0.03	0.20
323	Leather	-0.14	0.27
324	Footwear	-0.08	0.22
331	Wood products	0.28	0.13
332	Furniture	0.24	0.16
341	Paper and products	0.17	0.11
342	Printing and publishing	0.2	0.08
351	Industrial chemicals	0.25	0.13
352	Other chemicals	0.75	0.15
353	Petroleum refineries	0.04	0.06
354	Petroleum and coal products	0.33	0.15
355	Rubber products	0.23	0.14
356	Plastic products	1.14	0.14
361	Pottery	-0.15	0.17
362	Glass	0.53	0.16
369	Nonmetal products	0.06	0.15
371	Iron and steel	0.09	0.16
372	Nonferrous metal	0.01	0.15
381	Metal products	0.24	0.18
382	Machinery	0.6	0.21
383	Electric machinery	0.95	0.21
384	Transportation equipment	0.36	0.15
385	Professional goods	0.96	0.22
390	Other industries	0.47	0.21

Source: Klingebiel, Kroszner, and Laeven (2007) and Raddatz (2006). External dependence is defined as capital expenditure minus cash flow, divided by capital expenditure. Liquidity needs are defined as inventories/sales. Both measures are constructed based on US firm-level data.

Appendix Table A6: Financial Liberalization, Growth, and Volatility Using De Jure Indices, 10-year Panel Estimates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Dep. Var.: Growth Rate of Output				**Dep. Var.: Volatility of the Growth Rate of Output**			
KS Index	0.015**	0.015*	0.017*	0.017*	0.031***	0.031***	0.027**	0.027**
	[0.007]	[0.007]	[0.009]	[0.009]	[0.011]	[0.011]	[0.013]	[0.013]
Log(Initial Output/Worker)	-0.018**	-0.013	-0.046***	-0.040**	-0.017**	-0.015**	-0.006	-0.005
	[0.008]	[0.008]	[0.014]	[0.015]	[0.007]	[0.007]	[0.014]	[0.017]
Initial Share	-0.204***	-0.211***	-0.724***	-0.971***	-0.05	-0.02	-0.207***	-0.071
	[0.065]	[0.068]	[0.147]	[0.179]	[0.050]	[0.046]	[0.076]	[0.097]
Exports/Output	0.231**	0.225**	0.142	0.133	-0.016	-0.217	0.938**	0.08
	[0.092]	[0.104]	[0.148]	[0.170]	[0.224]	[0.199]	[0.409]	[0.591]
Imports/Output	-0.278**	-0.238*	-0.073	-0.013	-0.254***	-0.265***	-0.212	-0.367
	[0.125]	[0.128]	[0.159]	[0.175]	[0.068]	[0.065]	[0.241]	[0.278]
Private Credit	-0.008	-0.009	-0.004	-0.011	0.157	0.06	0.076	-0.054
	[0.048]	[0.048]	[0.055]	[0.057]	[0.299]	[0.292]	[0.228]	[0.215]
Private Credit*Extern.Fin	0.018	0.022	0.084**	0.105**	0.27	0.262	0.485	0.527*
	[0.022]	[0.022]	[0.039]	[0.047]	[0.294]	[0.271]	[0.304]	[0.314]
Country FE	yes	yes	no	no	yes	yes	no	no
Sector FE	yes	no	no	no	yes	no	no	no
Time FE	yes	no	yes	no	yes	no	yes	no
Country*Sector FE	no	no	yes	yes	no	no	yes	yes
Sector*Time FE	no	yes	no	yes	no	yes	no	yes
Country*Time FE	no	no	no	no	no	no	no	no
Observations	1692	1692	1692	1692	1691	1691	1691	1691
R-squared	0.39	0.43	0.64	0.68	0.45	0.48	0.67	0.69

Notes: Standard errors clustered at country-time level in brackets; * significant at 10%; ** significant at 5%; *** significant at 1%. The sample is a panel of three decades, 1970-79, 1980-89 and 1990-99; all of the variables are 10-year averages unless otherwise indicated. The dependent variable is the growth rate of output in columns (1)-(4), and the volatility of the growth rate of output in columns (5)-(8). *KS Index* is the initial value of the Kaminsky-Schmukler index of financial liberalization. *Log(Output/Worker)* is the log of output per worker in a sector. *Initial Share* is the beginning-of-period share of output in a sector in total manufacturing output. *Exports/Output* and *Imports/Output* are the exports and the imports in the sector divided by the total output in the sector. *Private Credit* is the private credit by banks and other financial institutions as a share of GDP. *Extern.Fin.* is the sector-level measure of reliance on external finance. All specifications are estimated using OLS, and including the fixed effects specified in the table.

Appendix Table A7: Difference-in-Differences Results Based on Industry Characteristics, Channels

	(1)	(2)	(3)	(4)
	Num.of Establish.	Employment	Capital accumulation	Total factor productivity
Extern.Fin*treated	-0.007	0.018**	0.012*	0.002
	[0.009]	[0.007]	[0.007]	[0.008]
Exports/Output	0.008	0.007	0.008**	-0.002
	[0.008]	[0.005]	[0.004]	[0.003]
Imports/Output	-0.002**	-0.002	0.004**	-0.004***
	[0.001]	[0.002]	[0.002]	[0.001]
Initial Share	-0.015	-0.022	0.058	-0.058
	[0.046]	[0.059]	[0.053]	[0.045]
Private Credit*Extern.Fin	0.012	0.008	0.019	-0.014
	[0.016]	[0.015]	[0.014]	[0.017]
Country*Time FE	yes	yes	yes	yes
Sector FE	yes	yes	yes	yes
Observations	706	878	779	776
R-squared	0.43	0.57	0.69	0.32

Notes: Robust standard errors in brackets; * significant at 10%; ** significant at 5%; *** significant at 1%. The dependent variable is the average growth rate of the number of establishments, total employment, and labor productivity (value added per worker) during the 10 years immediately before or immediately after an episode of financial liberalization. *Treated* takes on the value of 1 if a liberalization event took place, and zero otherwise. *Private Credit* is the private credit by banks and other financial institutions as a share of GDP. *Extern.Fin.* is the sector-level measure of reliance on external finance. *Liq. Needs* is the sector-level measure of liquidity needs. *Initial Share* is the beginning-of-period share of output in a sector in total manufacturing output. *Exports/Output* and *Imports/Output* are the exports and the imports in the sector divided by the total output in the sector. All specifications are estimated using OLS, and including country*time and sector fixed effects. Variable definitions and sources are described in detail in the text.

Appendix Table A8: De Facto Financial Liberalization and Growth, 10-year Panel Estimates, Channels

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Number of Establishments		Employment		Capital Accumulation		Total Factor Productivity	
FINOPEN	0.217*		0.234**		0.229***		0.035	
	[0.128]		[0.095]		[0.074]		[0.060]	
Extern.Fin*FINOPEN		0.113*		0.188***		0.136**		0.004
		[0.061]		[0.050]		[0.054]		[0.049]
Log(Initial Output/Worker)	0.014	0.006	0.008	0.007**	0.000	0.006*	-0.029***	-0.019***
	[0.017]	[0.004]	[0.009]	[0.004]	[0.007]	[0.003]	[0.010]	[0.004]
Initial Share	-0.465**	-0.014	-0.803***	-0.088***	-0.083	-0.013	-0.284***	0.009
	[0.198]	[0.029]	[0.105]	[0.024]	[0.085]	[0.026]	[0.088]	[0.027]
Exports/Output	0.858**	-0.006	-0.182	-0.021	-0.071	0.065	-0.127	-0.09
	[0.425]	[0.154]	[0.220]	[0.112]	[0.092]	[0.071]	[0.254]	[0.122]
Imports/Output	-0.039	0.058*	0.048	0.031	0.01	-0.001	0.001	-0.017
	[0.027]	[0.035]	[0.030]	[0.027]	[0.023]	[0.009]	[0.035]	[0.019]
Private Credit	0.018		-0.008		0.064*		-0.027	
	[0.164]		[0.039]		[0.035]		[0.028]	
Private Credit*Extern.Fin	-0.022	0.015	0.084*	0.020*	0.022	0.033***	0.038	-0.008
	[0.087]	[0.015]	[0.046]	[0.012]	[0.032]	[0.011]	[0.053]	[0.014]
Country*Sector FE	yes	no	yes	no	yes	no	yes	no
Sector*Time FE	yes	yes	yes	yes	yes	yes	yes	yes
Country*Time FE	no	yes	no	yes	no	yes	no	yes
Observations	2254	2254	3779	3779	3032	3032	3027	3027
R-squared	0.64	0.40	0.60	0.44	0.66	0.50	0.54	0.25

Notes: Robust standard errors in brackets; standard errors are clustered at country*time level in columns (1), (3), (5), and (7); * significant at 10%; ** significant at 5%; *** significant at 1%. The sample is a panel of three decades, 1970-79, 1980-89 and 1990-99; all of the variables are 10-year averages unless otherwise indicated. The dependent variable is the growth rate of the number of establishments, total employment, capital stock, or TFP, in a sector. *FINOPEN* is gross capital flows, defined as the absolute value of total inflows plus the absolute value of total outflows. *Log(Initial Output/Worker)* is the log of beginning-of-period output per worker in a sector. *Initial Share* is the beginning-of-period share of output in a sector in total manufacturing output. *Exports/Output* and *Imports/Output* are the exports and the imports in the sector divided by the total output in the sector. *Private Credit* is the private credit by banks and other financial institutions as a share of GDP. *Extern.Fin.* is the sector-level measure of reliance on external finance. All specifications are estimated using OLS, and including the fixed effects specified in the table. Variable definitions and sources are described in detail in the text.