Access to finance and foreign technology upgrading : Firm-level evidence from India

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Motivation : Import Patterns

- Globalization process is characterized by a significant increase in imports of foreign inputs .
- Foreign inputs considered are more efficient, more sophisticated or more advanced in terms of technology relative to domestic ones (Kashara and Lapham, 2007; Kugler and Verhoogen, 2010)
- Foreign technology/inputs enhance firm productivity (Kashara and Rodrigue, 2008, Halpern et al., 2009)
  $\Rightarrow$ Additional source of gains from trade as compared to Krugman (1980)

Motivation : Import barriers

- **Tariff reductions** can increase firm productivity through foreign technology (Amiti and Koenings, 2007, Goldberg et al., 2009)
- **Financial constraints** might also prevent imports of foreign inputs (high up-front cost, lack of cash-in-advance etc.)
  - In the absence of financial constraints, investment decision unrelated to the structure of financing (Modigliani-Miller theorem)
  - In the presence of financial constraints, firms with better financial health are less financially constrained (Hubbard, 1998).
  - Financial constraints expected to prevent investment decision

Motivation : Import barriers

Previous literature in finance focuses on:

1. **Investment / R&D-financial constraints linkage** (Bond et al. 1994, 2003; Blundell et al., 1992; Hall and Lerner, 2009)

2. The **finance-export linkage** in previous studies, with mixed results (Greenaway et al. 2007; Berman & Hericourt, 2010)

No evidence on the role of financial constraints on the adoption of foreign technology

Contribution

Is the decision to upgrade with foreign technology subject to financial constraints?

- **Theory:** choice of alternative technologies subject to efficiency gain and possibility to finance fixed cost
- **Empirical analysis** performed on Indian firm-level data over the period 1996-2006 (almost 10,000 manufacturing firms over the period)
  - Context of trade and financial reforms in India
  - Focus on **imports of capital goods** = foreign technology upgrading
  - Impact of **financial health** (liquidity or leverage) of the firm on the decision to import capital goods/start importing capital goods

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Main findings

- Model predicts that some firms will not import foreign technology, although this would be profitable in absence of financial constraints
- **Strong impact of financial health on import decision and import volume of capital goods**
- **Alternative robustness checks** to address the possible endogeneity bias & reverse causality issue between financial health and foreign technology adoption:
  1. Alternative measures of foreign technology : foreign royalties and know how fees paid by the firm
  2. Alternative subsamples: exporters, foreign firms, state-owned firms dropped
  3. Firms having not imported capital goods in preceding years
  4. IV estimations using lagged financial health of the firm
  5. IV estimations using cross-industry heterogeneity (Rajan and Zingales, 1998)

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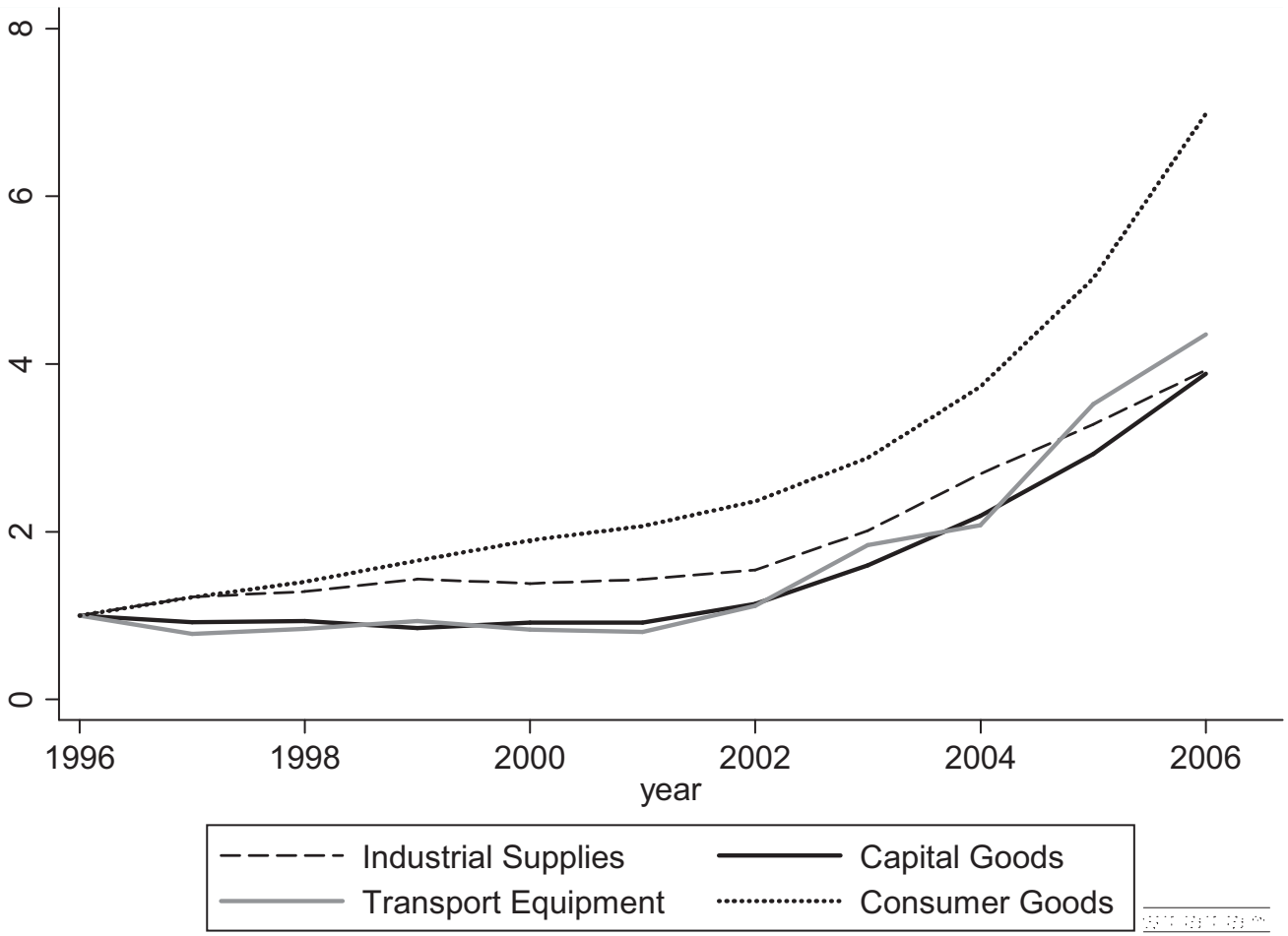
Descriptive evidence from India

Figure: Evolution of imports in India by BEC goods category (index = 1 in base year 1996)



Imports of capital goods

Descriptive statistics (Prowess, mean values 1996-2006)

	Non importers	Importers (all goods)	Importers (capital goods)	All firms
Number of firms	3388	5728	3648	9116
Sales	29,04	356,11	619,02	233,00
Wage bill	1,59	10,99	18,31	7,53
Capital used	16,83	107,11	175,95	76,26
Liquidity	0,44	0,51	0,49	0,48
Leverage	0,48	0,39	0,35	0,42

Liquidity = current asset / total liabilites ; Leverage = borrowings / total assets

Primary evidence

Are importers of capital goods ex ante less leveraged / more liquid?

Primary evidence based on estimation of "import premia" equations

$$Fin.Health(i, t-1) = \beta Starter(i, t) + FE(t) + \epsilon(i, t)$$

$$Fin.Health(i, t-1) = \beta Starter(i, t) + FE(s) + FE(t) + \epsilon(i, t)$$

$$Fin.Health(i, t-1) = \beta Starter(i, t) + FE(i) + FE(t) + \epsilon(i, t)$$

- "Starters" compared to "non importers", "Stoppers" and "Continuers" excluded
- OLS estimations

Descriptive evidence from India

	Import premia					
	(1)	(2)	(3)	(4)	(5)	(6)
Dep. variable	Leverage(i)(t-1)			Liquidity(i)(t-1)		
Treatment group	Imports(i)(t-1)=0; Imports(i)(t)=1					
Control group	Imports(i)(t-1)=0; Imports(i)(t)=0					
Excluded groups	Continuers and stoppers					
Starter(i)(t)	-0.083***	-0.083***	-0.083***	0.026***	0.025***	0.028***
	(0.006)	(0.006)	(0.007)	(0.003)	(0.003)	(0.003)
Year FE	yes	yes	yes	yes	yes	yes
Industry FE	no	yes	no	no	yes	no
Firm FE	no	no	yes	no	no	yes
Observations	35,563	35,563	35,563	35,566	35,566	35,566
R-squared	0.0005	0.0008	0.987	0.0020	0.0682	0.823
Number of id	8245	8245	8245	8245	8245	8245

The model

Model of import decision of capital goods:

- Monopolistic Competition;
- Two sources of firm heterogeneity :
  1. Differences in productivity levels φ
  2. Exogenous wealth A can serve as collateral

- Domestic and imported technology in the form of capital goods;
- Imported technology increases efficiency of the firm;
- Variable costs on imported capital goods;
- Importing capital goods requires payment of fixed cost but increases efficiency of the firm

Set-up of the model: production

$$Y_i = \varphi \gamma_i \left(\frac{k_i}{\eta}\right)^{\eta} \left(\frac{l}{1-\eta}\right)^{1-\eta} \tag{1}$$

if $i = d$ $\quad \gamma = 1$ and $k_d = z$

if $i = f$ $\quad \gamma > 1$ and $k_f = \left(\frac{z}{\alpha}\right)^{\alpha} \left(\frac{m}{1-\alpha}\right)^{1-\alpha}$

Assumption: Using foreign inputs increases efficiency ($\gamma > 1$).

Production & import decision with no credit imperfection

Use of domestic technology not subject to financial constraints:

$$\frac{r_d\left(\varphi_d^*\right)}{\phi} = F$$

Use of foreign technology not subject to financial constraints:

$$\frac{r_f\left(\varphi_f^*\right)}{\phi} = F_T$$

with $F_T > F$

$\Rightarrow$ Importing foreign technology requires $\varphi > \varphi_f^*$

Financial constraints and import decision

Firms can use their collateral to obtain external finance.

1. **Expected domestic sales** associated with the use of the domestic technology
   $\Rightarrow$ More productive firms get more cash-in-advance

2. **The exogenous wealth** A can be used as a collateral to borrow additional liquidity and pay the fixed cost of import
   $\Rightarrow$ Firms initially wealthier also get more cash (as in Aghion, Banerjee and Piketty, 1999)

Financial constraints and import decision

Decision to import foreign inputs in the presence of financial constraints:

- The decision to import foreign inputs is conditioned by the financing constraint:

$$\pi_d(\varphi) + \lambda A \geq F_T \tag{2}$$

- $\overline{\varphi}(A)$ is the lowest productivity level below which firms with an exogenous collateral A are not able import, given A.

Productivity cutoff & testable prediction

The imports of foreign inputs requires that $\varphi > \overline{\varphi}(A)$

$$\overline{\varphi}(A) = \left(\frac{F_T + F - \lambda A}{F} \right)^{\frac{1}{\phi - 1}} \varphi_d^* > \varphi_f^*$$

Proposition 1: states that there exists a subset of firms, identified by a productivity range, that are liquidity constrained

Testable prediction: *In the presence of financial constraints, wealthier firms are more likely to upgrade with foreign technology*

Data

Survey of manufacturing Firm level data of India:

- The Indian firm-level dataset is compiled from the Prowess database by the Centre for Monitoring the Indian Economy (CMIE).
- Balance sheet data of listed companies comprising more than 70% of the economic activity in the organized industrial sector of India.
- Almost 10,000 firms over the period 1996-2006 in manufacturing sectors: sales, capital employed, wage bill, age, ownership status, and financial statements

Import decision

Decision to import capital goods

$$Importer_{(is)(t)} = \beta_0 + \beta_1 Finance_{(i)(t\text{-}1)} + \beta_2 Z_{(i)(t\text{-}1)} + \beta_3 X_{(s)(t)} + \upsilon_t + \mu_i + \nu_{it}$$

- Conditional fixed effect estimator
- **Liquidity ratio** = current assets / total liabilities
- **Leverage ratio** = borrowings / total assets
- **Firm-level controls:** wage bill and capital intensity;
- **Industry-level controls:** output tariffs, Herfindhal index and import propensity in NIC 2-digit industries;
- Year fixed effects for aggregate conditions and macroeconomic shocks.

Access to finance and import of capital goods decision

Dependent variable	Dummy equal one if firm(i) imports capital goods in t							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Leverage ratio(i)(t-1)	-0.217***	-0.457***	-0.529***					-0.470***
	(0.057)	(0.030)	(0.053)					(0.079)
Leverage ratio(i)(t-2)				-0.453***				
				(0.079)				
Liquidity ratio (i)(t-1)					0.490***	0.283***		0.283***
					(0.067)	(0.070)		(0.066)
Liquidity ratio(i)(t-2)							0.231***	
							(0.062)	
Log wage-bill(i)(t-1)		0.114***	0.155***	0.155***		0.106***	0.097***	0.145***
		(0.014)	(0.018)	(0.019)		(0.027)	(0.027)	(0.021)
Capital intensity(i)(t-1)		0.017**	0.025**	0.003		0.032***	0.017*	0.039***
		(0.008)	(0.011)	(0.012)		(0.011)	(0.009)	(0.012)
Output tariff(s)(t-1)			-0.124	-0.187		-0.112	-0.130	-0.117
			(0.185)	(0.199)		(0.147)	(0.142)	(0.185)
Herfindhal index(s)(t-1)			0.009	0.011		0.006	0.007	0.008
			(0.008)	(0.008)		(0.005)	(0.005)	(0.007)
Import propensity(s)			0.112***	0.117***		0.082***	0.078***	0.106***
			(0.035)	(0.029)		(0.019)	(0.018)	(0.026)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	21109	17521	15042	13474	21114	15046	13482	15042
pseudo R^2	0.0712	0.0673	0.0575	0.0535	0.0560	0.0472	0.0464	0.0596

Interpretation of baseline results

Quantification

- A one s.d. reduction of leverage (-32%), increases import probability of capital goods by 15%
- A one s.d. increase of liquidity (+17%), increases import probability of capital goods by 5%

Intensive margin: Similar result although not independent from import decision

Additional questions

- Is the effect of financial health independent of the effect of tariffs on capital goods imports?
- Can we observe similar effect for imports of intermediates?

Financial constraints vs trade liberalization

Dependent variable	Dummy equal one if firm(i) imports of capital goods					
	(1)	(2)	(3)	(4)	(5)	(6)
Tariffs capital goods	-0.626***	-0.671***	-0.264*	-0.501***	-0.084*	-0.176
	(0.115)	(0.134)	(0.144)	(0.099)	(0.049)	(0.108)
Leverage(i)(t-1)		-0.555***	-0.564***			-0.368***
		(0.038)	(0.069)			(0.078)
Liquidity ratio (i)(t-1)				0.353***	0.156***	0.269***
				(0.021)	(0.026)	(0.043)
Log wage-bill(i)(t-1)		0.091***	0.083***	0.065***	0.026***	0.060***
		(0.014)	(0.014)	(0.009)	(0.006)	(0.013)
Capital intensity(i)(t-1)		0.013	0.015	0.028***	0.013***	0.025***
		(0.010)	(0.010)	(0.007)	(0.004)	(0.008)
Herfindhal index(s)(t-1)			-0.007		-0.002	-0.005
			(0.007)		(0.002)	(0.005)
Import propensity(s)			0.128***		0.041***	0.090***
			(0.016)		(0.005)	(0.011)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	20165	15061	15061	15065	15065	15061
pseudo R^2	0.00173	0.0308	0.0346	0.0181	0.0223	0.0385

Decision to import intermediates conditional to have never imported capital goods

Dependent variable	Dummy equal one if firm(i) imports intermediates in t				
	(1)	(2)	(3)	(4)	(5)
	Full sample		Never imported capital goods		
Leverage(i)(t-1)	-0.088*		-0.041		-0.016
	(0.052)		(0.044)		(0.027)
Liquidity ratio (i)(t-1)		0.111**		0.063	0.101
		(0.050)		(0.044)	(0.071)
Log wage bill (i)(t-1)	0.208***	0.111**	0.094	0.036	0.059
	(0.065)	(0.049)	(0.058)	(0.026)	(0.044)
Capital intensity(i)(t-1)	0.104***	0.059**	0.044*	0.018	0.030
	(0.031)	(0.025)	(0.026)	(0.013)	(0.021)
Output Tariff(s)(t-1)	0.073	0.035	0.277**	0.108*	0.180*
	(0.142)	(0.075)	(0.125)	(0.058)	(0.098)
Herfindhal index(s)(t-1)	0.004	0.002	0.001	0.000	0.000
	(0.005)	(0.003)	(0.004)	(0.002)	(0.003)
Import propensity (s)(t)	0.058***	0.030**	0.044**	0.016*	0.027*
	(0.021)	(0.013)	(0.020)	(0.009)	(0.015)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	11216	11216	5458	5458	5458
pseudo R^2	0.0925	0.0941	0.0800	0.0850	0.0853

Endogeneity issues

General concern about relation between investment decision and financial health of the firm in the litterature

We address the issue of endogeneity with a series of robustness tests:

- Alternative measurement of foreign technology adoption & investment decision
- Alternative subsamples according to export status or type of ownership
- Direction of causality with starters only or IV estimations

Alternative technology measures: Royalties and Know How

Dependent variable	Dummy=1 if firm pays royalties abroad				Dummy=1 if firm pays any royalty			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Leverage(i)(t-1)	-0.203***	-0.140***			-0.124***	-0.079**		
	(0.024)	(0.053)			(0.022)	(0.040)		
Liquidity ratio (i)(t-1)			0.166***	0.150*			0.234***	0.112*
			(0.062)	(0.091)			(0.044)	(0.068)
Wage-bill(i)(t-1)		0.084***		0.100***		0.079***		0.084***
		(0.028)		(0.025)		(0.016)		(0.014)
Capital intensity(i)(t-1)		0.023*		0.034**		-0.003		0.003
		(0.012)		(0.015)		(0.010)		(0.011)
Output Tariff(s)(t-1)		-0.481***		-0.617***		-0.353**		-0.380**
		(0.151)		(0.187)		(0.155)		(0.171)
Herfindhal index(s)(t-1)		0.007		0.008		0.001		0.001
		(0.008)		(0.009)		(0.008)		(0.008)
Import propensity industry		0.007		0.013		-0.000		0.001
		(0.034)		(0.041)		(0.031)		(0.033)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	10170	7561	10176	7566	14574	10473	14580	10478
pseudo R^2	0.0604	0.0537	0.0544	0.0525	0.00972	0.0107	0.00937	0.0105

Alternative samples

Dependent variable	Dummy equal one if firm(i) imports capital goods in t					
	Domestic firms sample		Non exporting firms sample		Subsample of firms without state firms	
	(1)	(2)	(3)	(4)	(5)	(6)
Leverage(i)(t-1)	-0.576***		-0.243**		-0.519***	
	(0.058)		(0.121)		(0.056)	
Liquidity ratio (i)(t-1)		0.260***		0.402***		0.252***
		(0.072)		(0.142)		(0.064)
Log wage-bill(i)(t-1)	0.148***	0.085***	0.063*	0.087***	0.151***	0.097***
	(0.018)	(0.026)	(0.036)	(0.030)	(0.019)	(0.025)
Capital intensity(i)(t-1)	0.022*	0.025**	0.009	0.028	0.024**	0.029***
	(0.012)	(0.010)	(0.015)	(0.021)	(0.011)	(0.010)
Output tariff(s)(t-1)	-0.007	-0.025	-0.139	-0.295	-0.122	-0.105
	(0.193)	(0.117)	(0.236)	(0.386)	(0.181)	(0.137)
Herfindhal index(s)(t-1)	0.012	0.006	0.015	0.018	0.010	0.006
	(0.008)	(0.005)	(0.014)	(0.016)	(0.008)	(0.005)
Import propensity(s)	0.120***	0.076***	0.028	0.035	0.114***	0.078***
	(0.034)	(0.019)	(0.061)	(0.071)	(0.037)	(0.018)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	13789	13793	3279	3279	14765	14769
Pseudo R^2	0.0589	0.0471	0.0466	0.0434	0.0571	0.0466

Decision to start importing capital goods

Dependent variable	dummy==1 if firm imports capital goods$_{it}$= 1				
	Firms that do not import capital goods in the previous four years				
	(1)	(2)	(3)	(4)	(5)
Leverage ratio(i)(t-1)	-0.216***	-0.302***			-0.165**
	(0.057)	(0.100)			(0.073)
Liquidity ratio (i)(t-1)			0.486***	0.051**	0.103***
			(0.068)	(0.021)	(0.039)
Log wage-bill(i)(t-1)		0.129***		0.028**	0.074***
		(0.036)		(0.012)	(0.028)
Capital intensity(i)(t-1)		0.081***		0.020**	0.051***
		(0.021)		(0.008)	(0.018)
Output tariff(s)(t-1)		-0.124		-0.030	-0.070
		(0.127)		(0.030)	(0.078)
Herfindhal index(s)(t-1)		0.005		0.001	0.003
		(0.005)		(0.001)	(0.003)
Import propensity(s)		0.055***		0.013***	0.032***
		(0.012)		(0.004)	(0.009)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	18532	12856	18537	12860	12856
Pseudo R^2	0.0763	0.0699	0.0596	0.0605	0.0722

IV estimations using lags

Dependent variable	Extensive margin		Intensive margin	
Estimator	OLS	2SLS	OLS	2SLS
	(1)	(2)	(3)	(4)
Leverage(i)(t-1)	-0.122***	-0.170***	-2.606***	-4.697***
	(0.021)	(0.029)	(0.248)	(0.466)
Liquidity ratio (i)(t-1)	0.135***	0.303***	2.059***	2.888***
	(0.034)	(0.058)	(0.276)	(0.574)
Capital intensity(i)(t-1)	0.032***	0.022*	0.361***	-0.003
	(0.006)	(0.013)	(0.072)	(0.173)
Import propensity industry	0.057***	0.057***	0.306**	0.286**
	(0.015)	(0.015)	(0.122)	(0.123)
Log wage-bill(i)(t-1)	0.051***	0.038***	0.473***	0.288***
	(0.008)	(0.010)	(0.072)	(0.104)
Output tariff (s)(t-1)	-0.009	-0.004	-2.446***	-2.543***
	(0.104)	(0.091)	(0.686)	(0.692)
Herfindhal index(s)(t-1)	-0.002	-0.002	-0.036	-0.033
	(0.003)	(0.003)	(0.024)	(0.024)
Firm fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Observations	23837	23158	7640	7640
R^2	0.022	0.019	0.083	0.057
Hansen statistic		5.656		2.396

IV using external dependence across industries

Dependent variable	Extensive Margin		Intensive Margin	
	(1)	(2)	(3)	(4)
Leverage(i)(t-1)	-0.050**		-2.211***	
	(0.025)		(0.411)	
Leverage(i)(t-1)× Ext. Dep.(s)	-0.146*		-0.190	
	(0.076)		(0.957)	
Liquidity ratio (i)(t-1)		0.055		2.192***
		(0.038)		(0.425)
Liquidity ratio (i)(t-1) × Ext. Dep. (s)		0.265***		-0.036
		(0.093)		(0.834)
Capital intensity(i)(t-1)	0.037***	0.045***	0.309***	0.353***
	(0.005)	(0.005)	(0.064)	(0.063)
Log wage-bill(i)(t-1)	0.058***	0.062***	0.425***	0.390***
	(0.006)	(0.006)	(0.067)	(0.065)
Herfindhal index(s)(t-1)	0.001	0.001	-0.003	-0.005
	(0.003)	(0.003)	(0.021)	(0.021)
Output tariff (s)(t-1)	-0.041	-0.039	-1.264*	-1.239*
	(0.080)	(0.081)	(0.657)	(0.671)
Import propensity industry	0.040***	0.040***	0.218*	0.245**
	(0.013)	(0.013)	(0.119)	(0.119)
Firm fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Observations	31523	31523	10304	10304

Conclusions

- **Contribution:** financial constraints are an important determinant of foreign technology adoption in a developing economy
- **Underdeveloped credit markets** may not only prevent aggregate productivity gains through a lack of domestic innovation, but also by preventing the adoption of foreign technologies
- **Future work:** Financial reforms (financial development, presence of foreign banks etc.) vs trade policy reforms: are they complementary?

Conclusions

Thanks!