Trade Liberalization and Investment in Foreign Capital Goods: Evidence from India

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International Trade, Investment and Productivity

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- We analyze this specific mechanism by estimating the impact of trade liberalization in India on firms' investment in imported capital goods.

- Along similar lines, Kandilov and Leblebicioglu (2012) show that trade liberalization increased the overall investment rate for Mexican firms.

- Focusing on the complementarities between imported intermediate inputs and imported capital, Bas and Berthou (2017) show that reductions in tariffs on intermediate inputs increased the probability of importing capital goods for Indian firms.

Our contribution

▶ We estimate the effects of trade liberalization on firm level investment in foreign capital goods.

▶ We distinguish between tariffs on *capital goods*, *intermediate inputs* and *final goods*, which allows us to identify three mechanisms through which trade liberalization can affect investment decisions:

1. Reduction in tariffs on *capital goods*: by lowering the relative price of imported capital goods and thereby increasing the demand for them

2. Reduction in tariffs on *intermediate inputs*: by lowering the cost of using imported intermediate inputs and thereby increasing the marginal profitability of capital

3. Reduction in tariffs on *final goods*: by exposing the firm to foreign competition and thereby lowering the marginal profitability of capital

▶ We provide direct evidence showing that the largest gains from trade liberalization in terms of capital accumulation occurs through the reduction in the price of foreign capital.

Formulating the Investment Decisions

▶ Consider the investment problem of a monopolistically competitive firm that uses domestic and imported capital goods, as well as domestic and foreign intermediate inputs in production (L_{it}, L_{it}^*), and sells its output at home.

▶ At the beginning of period t, the firm chooses the optimal level of variable inputs (L_{it}, L_{it}^*), the output price (P_{it}), and how much to invest in domestic and imported capital goods ($I_{D,it}$, $I_{M,it}$).

▶ Imported and domestic capital goods are imperfect substitutes, that are combined with a CES technology to produce one unit of composite investment.

▶ Imported capital goods and imported intermediate inputs are subject to industry-specific tariffs.

▶ New capital resulting from investment in period t, K_{it}, becomes productive in period $t+1$ due to a one period time-to-build lag.

- The firm chooses investment, I_{it}, in period t in order to maximize the net present value of profits:

$$V_{it}(K_{it-1}) = \max \left\{ \hat{\Pi}_{it} - G\left(K_{it}, I_{it}\right) - I_{it} + \beta V_{it+1}(K_{it}) \right\}$$

subject to $K_{it} = (1-\delta)K_{it-1} + I_{it}$

  - $G\left(K_{it}, I_{it}\right)$: convex adjustment costs
  - $\hat{\Pi}_{it}$: maximum profit obtained by choosing the optimal level of variable inputs and the output price

- Optimal investment decision yields the usual Euler equation:

$$1 + \frac{\partial G\left(K_{it-1}, I_{it}\right)}{\partial I_{it}} = \beta E_t \left[\frac{\partial \Pi_{it+1}}{\partial K_{it}} - \frac{\partial G\left(K_{it}, I_{it+1}\right)}{\partial K_{it}} + (1-\delta)\left(1 + \frac{\partial G\left(K_{it}, I_{it+1}\right)}{\partial I_{it+1}}\right) \right]$$

Tariffs on capital goods and investment decisions

▶ Investment comprises purchases of domestic and imported capital goods that are combined with a CES technology:

$$I_{it} = \left[(1 - \mu_i)^{\frac{1}{\omega}} I_{Dit}^{\frac{\omega-1}{\omega}} + \mu_i^{\frac{1}{\omega}} I_{Mit}^{\frac{\omega-1}{\omega}} \right]^{\frac{\omega}{\omega-1}}$$

▶ Normalizing the price of the total investment basket to 1, and denoting the relative price of imported capital goods with $\left(\tau_{\mathbf{t}}^{\mathbf{K}} P_{Mt} \right)$, we obtain the demand for imported capital goods:

$$I_{Mit} = \mu_i \left(\tau_{\mathbf{t}}^{\mathbf{K}} P_{Mt} \right)^{-\omega} I_{it}$$

▶ Trade liberalization: $\tau_{\mathbf{t}}^{\mathbf{K}} \downarrow \Rightarrow \downarrow$ in the relative price of imported capital $\Rightarrow \uparrow I_{Mt}$

Marginal profitability of capital and intermediate input tariffs

▶ The firm maximizes expected profits:

$$\Pi_t = \max_{p_{it}, L_{it}, L_{it}^*} E_{t-1} \left\{ p_{it} x_{it} - w_t L_t - \left(\tau_t^I w_t^* \right) L_t^* \right\}$$

subject to: $x_{it} = F(K_{it-1}, L_{it}, L_{it}^*)$

where the demand firm faces is $x_{it} = \left(\frac{p_{it}}{P_t} \right)^{-\theta} X_t$.

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▶ Marginal profitability of capital is given by

$$\frac{\partial \Pi_{it}}{\partial K_{it-1}} = \left[\frac{1}{K_{it-1}} \left(\frac{x_{it} p_{it}}{\psi_i} - w_t L_{it} - \left(\tau_t^I w_t^* \right) L_{it}^* \right) \mid \Omega_{t-} \right]$$

where $\psi_i = \frac{\theta}{\theta - 1}$ is the firm's mark-up.

▶ Trade liberalization: $\tau_t^I \downarrow \Rightarrow \downarrow$ in the marginal cost of imported intermediate goods$\Rightarrow \uparrow$ marginal profitability of capital$\Rightarrow I_i t \uparrow$ (increase in both I_M and I_D).

Marginal profitability of capital and output tariffs

- Changes in output tariffs affect marginal profitability of capital and thereby investment through changes in foreign competitors' prices, which in turn affect firm's sales.

- Demand for firm i's product: $x_{it} = \left(\frac{p_{it}}{P_t}\right)^{-\theta} X_t$, where

$$P_t = \left[\int_0^a p_t(z)^{1-\theta} \, dz + \int_a^1 \left(\tau_t^O p_t^*(z)\right)^{1-\theta} \, dz\right]^{\frac{1}{1-\theta}}$$

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▶ We can show that $\frac{\partial(x_{it} p_{it})}{\partial \tau_t^O} = \theta \frac{x_{it} p_{it}}{P_t} \frac{\partial P_t}{\partial \tau_t^O} = \theta \frac{x_{it} p_{it}}{\tau_t^O} (1-a) \left(\frac{P_{Ft}}{P_t}\right)^{1-\theta} > 0$.

▶ Trade liberalization: $\tau_t^O \downarrow \Rightarrow \downarrow$ effective price individuals pay on foreign varieties $\Rightarrow \downarrow$ demand for firm i's product $\Rightarrow \downarrow$ marginal profitability of capital and I_{it} (reduction in both I_M and I_D)

Investigation equation

- Combining the investment Euler equation, the expression for the marginal profitability of capital, and the demand for investment in imported capital goods, and assuming quadratic adjustment costs, we obtain a non-linear equation in variables of interest.

- We linearize the Euler equation using a first-order Taylor approximation around the steady-state, which yields the following investment equation:

$$\frac{I_{M,it}}{K_{it-1}} = E_t \left[\phi_0 + \phi_1 \frac{I_{M,it+1}}{K_{it}} + \phi_2 \frac{S_{it+1}}{K_{it}} - \phi_3 \frac{Z_{it+1}}{K_{it}} - \phi_4 \frac{Z_{it+1}^*}{K_{it}} + \phi_5 \left(\tau_{t+1}^K P_{M,t+1} \right) - \phi_6 \left(\tau_t^K P_{M,t} \right) \right]$$

$I_{M,it}$: investment in imported capital goods

P_{Mt}: relative price of imported capital goods

S_{it}: sales

Z_{it}: variable input costs

Empirical Investment Equation and Its Estimation

- As our empirical investment equation, we use:

$$
\begin{aligned}
\frac{I_{M,ijt}}{K_{ijt-1}} &= \alpha_1 \frac{I_{M,ijt-1}}{K_{ijt-2}} + \alpha_2 \frac{S_{ijt}}{K_{ijt-1}} + \alpha_3 \frac{S_{ijt-1}}{K_{ijt-2}} + \alpha_4 \frac{C_{ijt}}{K_{ijt-1}} + \alpha_5 \frac{C_{ijt-1}}{K_{ijt-2}} \\
&+ \alpha_6 \tau_{jt}^{KT} + \alpha_7 \tau_{jt}^{IT} + \alpha_8 \tau_{jt}^{OT} + \upsilon_i + \eta_t + \varepsilon_{ijt}
\end{aligned}
$$

  where $I_{M,ijt}$ stands for investment in imported capital goods.

- The baseline specification includes lagged investment, current and lagged sales (S_{ij}), current and lagged cash-flow (C_{ij}) as determinants of investment, as well as the tariff measures (capital, intermediate input and output) for industry j.

- We estimate the dynamic investment equation using the System GMM (Arellano and Bover (1995) and Bond and Blundell (1998)) which allows us to control for unobservable firm effects and the endogeneity of lagged investment, sales, and cash flows.

- We analyze the heterogeneity in investment behavior by allowing the reaction to changes in the tariffs to vary based on average firm mark-up, imports of intermediate goods, scope for differentiation, and initial firm size.

Firm-level Data

- Our data for the Indian manufacturing firms comes from Prowess, collected by the Center for Monitoring of the Indian Economy.

- The data-set includes information on sales, costs, value of fixed assets (capital), as well as imports of capital goods and intermediate inputs.

- We use imports of capital goods as our measure of investment in foreign capital goods.

- In order to mitigate endogeneity concerns and following Topalova and Khandelwal (2011), we confine our study to early part of trade liberalization episode until 1997.

- Consequently, we use information on 2,512 unique firms for the 1990-1997 period.

Policy Variables

- In our analysis, we employ tariff measures for final goods, intermediate inputs, and capital goods for five digit NIC (2008) industries.

- We obtain the data on final goods tariffs from Topalova and Khandelwal (2011).

- We construct the intermediate input and capital goods tariffs by using the output tariffs and the the input-output matrix:

$$\tau_{lt}^{j} = \sum_{s} \omega_{sl}^{j} \tau_{st}$$

τ_{lt}^{j}: capital good tariffs/intermediate input tariffs of industry l, in period t

ω_{sl}^{j}: value share of industry s in output of industry l; $\sum_{s} w_{sl}^{j} = 1$ for each $j = \{capital\ goods,\ intermediate\ inputs\}$

τ_{st}: output tariff of industry s in period t
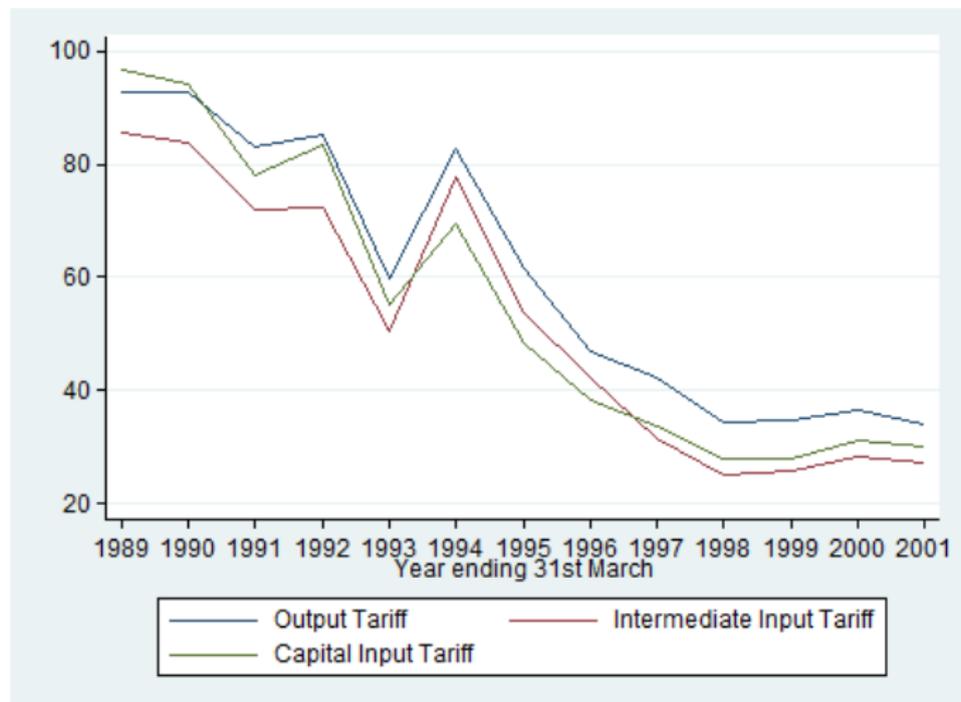
Average Tariff Rates, %

Table: Main Effects of Trade Liberalization on Investment in Imported Capital Goods

Dependent Variable: $\frac{I_{Mijt}}{K_{ijt-1}}$	(1)	(2)	(3)	(4)	(5)	(6)
Output tariff $\left(\frac{\tau_{jt}^{O}}{100}\right)$	0.010	0.015	0.017	0.014	0.016*	0.017*
	(0.010)	(0.012)	(0.011)	(0.011)	(0.008)	(0.009)
Input tariff $\left(\frac{\tau_{jt}^{I}}{100}\right)$		-0.017	-0.015	-0.017	-0.016	-0.022
		(0.015)	(0.012)	(0.014)	(0.010)	(0.015)
Capital goods tariff $\left(\frac{\tau_{jt}^{K}}{100}\right)$			-0.032***	-0.028**	-0.030***	-0.034**
			(0.012)	(0.012)	(0.008)	(0.014)
License				-0.011*	-0.011*	-0.013**
				(0.006)	(0.006)	(0.006)
FDI				-0.013	-0.012	-0.011
				(0.009)	(0.010)	(0.009)
Firm-specific variables	yes	yes	yes	yes	yes	yes
Regional time trends	no	no	no	no	yes	yes
Number of observations	9,486	9,486	9,486	9,486	9,486	9,486

Main Effects of Trade Liberalization

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- These impacts are not statistically significant for investment in domestic capital goods. Also, the results are insignificant if we consider the combined input and capital goods tariffs.

Table: Alternative Specifications

Dependent Variable:	(1) $\frac{I_{ijt}}{K_{ijt-1}}$	(2) $\frac{I_{Dijt}}{K_{ijt-1}}$	(3) $\frac{I_{Mijt}}{K_{ijt-1}}$
Output tariff $\left(\frac{\tau_{jt}^{O}}{100}\right)$	0.047	0.027	0.014
	(0.058)	(0.062)	(0.009)
Input tariff $\left(\frac{\tau_{jt}^{I}}{100}\right)$	0.125	0.143	
	(0.093)	(0.090)	
Capital goods tariff $\left(\frac{\tau_{jt}^{K}}{100}\right)$	-0.065	-0.053	
	(0.118)	(0.105)	
Combined input and capital goods tariff			-0.024
			(0.020)
Firm-specific variables	yes	yes	yes
Number of observations	9,486	9,486	9,486

Overall Impact of Trade Liberalization

- Using the changes in the average tariff measures between 1990-1997, we calculate the overall impact of the tarde liberalization episode in India.
  - 61 pp decline in *capital goods tariffs* $\Rightarrow$ 57.58 percent *increase* in the average investment rate of foreign capital goods (an increase of 2.1 pp in $\frac{I_M}{K}$)
  - 56 pp decline in *output tariffs* $\Rightarrow$ 26.43 percent *decline* in the average investment rate of foreign capital goods (a reduction of 1 pp in $\frac{I_M}{K}$)
  - 51 pp decline in *input tariffs* $\Rightarrow$ 31.16 percent *increase* in the average investment rate of foreign capital goods (an increase of 1.1 pp in $\frac{I_M}{K}$)

- As a result, trade liberalization led to a 62.31 percent increase in the investment rate, which means the average investment rate of foreign capital $\left(\frac{I_M}{K}\right)$ increased by 2.2 pp.

- Between 1990-1996, average investment in foreign capital goods grew by 5.8 percentage points in India. Our results imply that 38 percent of this increase can be attributed to trade liberalization.

- The impact varies by the industry.

Table: Tariff Changes and Impacts By Industry

Industry	Output Tariff			Input Tariff			Capital Tariff		
	1990	1997	impact	1990	1997	impact	1990	1997	impact
Coke and Petroleum Prod.	80	30	-47	56	19	44	123	32	170
Beverages	155	127	-26	83	37	56	100	32	130
Food Products	85	35	-60	73	31	66	93	31	149
Non-Metallic Mineral Prod.	89	47	-37	76	34	48	105	34	127
Pharmaceuticals	99	40	-44	93	35	55	100	33	99
Wood Products	65	32	-21	72	24	39	96	33	79
Fabricated metal Products	100	32	-35	80	30	34	106	32	77
Chemicals and Chemical Prod.	112	39	-34	92	34	35	106	32	70
Basic Metals	94	29	-36	74	28	32	98	32	72
Machinery and Equipment	74	29	-26	87	32	41	77	31	52
Electrical Equipment	83	43	-17	92	33	33	86	35	45
Rubber and Plastic Prod.	108	45	-19	118	35	32	109	33	45
Paper Products	81	24	-27	65	21	27	91	32	56
Leather Products	82	37	-14	86	25	24	92	36	35
Other Transport Equipment	74	43	-11	90	33	27	82	43	29
Tobacco Products	100	50	-20	84	35	25	76	30	37
Wearing Apparel	100	50	-15	93	46	18	78	31	28
Textiles	94	50	-11	88	44	15	84	30	28
Computer, Electronic Prod.	111	32	-18	92	34	17	99	39	27
Motor Vehicles, Trailers	97	45	-5	92	33	7	95	42	10
Furniture	103	48	-4	94	32	6	88	32	8
Recorded Media	58	20	-1	68	20	2	90	34	3

▶ The impact of intermediate input tariffs should be larger for firms that rely on imported intermediate inputs. Similarly, to the extent that imported intermediate goods and capital goods (imported or domestic) are complements, the impact of capital goods tariffs should be larger for these firms.

▶ Additionally, firms that export likely have higher investment profiles, and therefore might be responding more to reductions in tariffs.

▶ To test for these predictions, we estimate the baseline model for the importer, exporter, and non-exporter sub-samples.

Table: Intermediate good importers and Exporters

Dependent Variable: $\frac{I_{Mijt}}{K_{ijt-1}}$	(1)	(2)	(3)
	Importers only	Exporters	Non-exporters
Output tariff $\left(\frac{\tau_{jt}^O}{100}\right)$	0.017**	0.020	0.012
	(0.007)	(0.015)	(0.098)
Input tariff $\left(\frac{\tau_{jt}^I}{100}\right)$	-0.030**	-0.038**	0.013
	(0.013)	(0.018)	(0.046)
Capital goods tariff $\left(\frac{\tau_{jt}^K}{100}\right)$	-0.037***	-0.034*	-0.036
	(0.012)	(0.020)	(0.151)
Number of observations	8,016	7,014	2,472
Number of firms	1,911	1,607	905

Heterogeneity in firm size

▶ A growing number of theoretical and empirical papers (e.g., Bustos (2011); Bas and Berthou (2017)) show that faced with lower tariffs, firms will have an incentive to upgrade technology.

▶ They also show that this incentive varies with productivity: only firms in the middle-range productivity will be affected.

▶ To test whether the impact on investment changes with firm productivity, we divide the firms into the four quartiles, and estimate the following expanded equation:

$$\frac{I_{ijt}}{K_{ijt-1}} = \alpha_1 \frac{I_{ijt-1}}{K_{ijt-2}} + \alpha_2 \frac{S_{ijt}}{K_{ijt-1}} + \alpha_3 \frac{S_{ijt-1}}{K_{ijt-2}} + \alpha_4 \frac{C_{ijt}}{K_{ijt-1}} + \alpha_5 \frac{C_{ijt-1}}{K_{ijt-2}} +$$

$$+ \sum_{r=1}^{4} \gamma_{\tau^{KT}}^r (\tau_{jt}^{KT} \times Q_{ij}^r) + \sum_{r=1}^{4} \gamma_{\tau^{IT}}^r (\tau_{jt}^{IT} \times Q_{ij}^r) + \sum_{r=1}^{4} \gamma_{\tau^{OT}}^r (\tau_{jt}^{OT} \times Q_{ij}^r) + \upsilon_i + \eta_t + \varepsilon_{ijt}$$

where $Q_{ij} = 1$ when the firm i belongs to quartile j.

Table: Heterogeneity of the impacts across size groups

Dependent Variable: $\frac{I_{Mijt}}{K_{ijt-1}}$	(1)	(2)
	Productivity quartiles	Sales quartiles
Capital goods tariff– First quartile	-0.033	-0.072
	(0.024)	(0.048)
Capital goods tariff– Second quartile	-0.025	-0.026
	(0.029)	(0.023)
Capital goods tariff– Third quartile	-0.075**	-0.044**
	(0.029)	(0.022)
Capital goods tariff– Fourth quartile	-0.017	-0.032
	(0.026)	(0.021)

Mark-ups and Quality Ladder

- The theoretical model predicts that the elasticity of mark-up adjusted sales with respect to the output tariff is increasing in the size of the mark-up:

$$\frac{\partial \left(x_{it} p_{it}/\psi_i\right)}{\partial \tau_t^O} \frac{\tau_t^O}{\left(x_{it} p_{it}/\psi_i\right)} \frac{1}{(1+\psi_i)^2} (1-a) \left(\frac{P_{Ft}}{P_t}\right)^{1-\theta} > 0$$

- Firms with large mark-ups (i.e. larger profit-to-cost margins) will be more affected by the intensified competition brought generated by the lower output tariffs, and therefore may reduce investment in both imported capital goods and domestic goods more aggressively.

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▶ Firms with large mark-ups (i.e. larger profit-to-cost margins) will be more affected by the intensified competition brought generated by the lower output tariffs, and therefore may reduce investment in both imported capital goods and domestic goods more aggressively.

▶ On the other hand, the adverse effects of competition on investment should be lower in industries with larger scope for product differentiation, since it is more feasible for firms to upgrade the quality of their products in order not to lose marginal profitability.

▶ To test for these mechanisms, we augment the baseline specification with interaction terms between the output tariff and average firm mark-up, and the quality ladder index constructed by Khandelwal (2010).

Table: Mark-ups and Quality Ladder

Dependent Variable: $\frac{I_{Mijt}}{K_{ijt-1}}$	(1)	(2)
Output tariff $\left(\frac{\tau_{jt}^O}{100}\right)$	-0.092**	0.078**
	(0.044)	(0.037)
Output tariff*mark-up $\left(\frac{\tau_{jt}^O}{100} * \psi_i^H\right)$	0.190***	
	(0.068)	
Output tariff*Log quality ladder indicator		-0.025*
		(0.014)
Input tariff $\left(\frac{\tau_{jt}^I}{100}\right)$	-0.022	-0.032*
	(0.014)	(0.018)
Capital goods tariff $\left(\frac{\tau_{jt}^K}{100}\right)$	-0.039***	-0.037**
	(0.014)	(0.018)
Herfindahl index		-0.150**
		(0.069)
Herfindahl index*quality ladder indicator		0.059*
		(0.032)
Number of observations	9,485	9,486
Number of firms	2,511	2,512

Firm's Mark-up

- The estimates suggest that a firm with a mark-up equal to the sample mean, would lower investment in imported capital by 7.06 percent following a 10pp reduction in output tariffs. A firm with a mark-up that is 1 standard deviation above the mean would lower investment by 11.71 percent.

- The negative coefficient on the interaction terms suggests that only firms with mark-ups higher than 0.48 lower investment (more than 90 percent of the firms).

Conclusions

- We find that the trade liberalization in India during the 1990s led to an increase in investment in imported capital goods as a result of lower tariffs on capital goods and intermediate inputs. The reduction in output tariffs led to some off-setting reduction in investment.

- The impact of capital and input tariffs are larger for for firms that rely on imported intermediate inputs, and exporters.

- The impact of output tariffs are larger for for firms that have higher mark-ups, and smaller for firms that are in industries with larger scope for quality upgrading.

- The majority of the overall increase in investment in foreign capital goods between 1990-1997 can be attributed to trade liberalization.

Table: Trading partner share of total imported capital

Rank	Trading Partner	Imported Capital (Percent of Total)
1	U.S.	20.14
2	Japan	16.80
3	Germany	16.73
4	U.K.	6.60
5	Singapore	4.98
6	France	4.96
7	Italy	4.63
8	Switzerland	3.10
9	Korea	2.18
10	Taiwan	1.91
	All Other	17.98
	Total	100.00