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Investigating Product Cycles Using Indian Import Data

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Abstract

We derive country ranks using disaggregated Indian import data over 1991-2005 using the intuition that developed countries would export more advanced goods to India earlier than other countries. We find that, consistent with theory, the degree of innovation is a significant determinant of our ranks.

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Introduction

The product cycle theory of international trade implies an ordering of the sophistication of goods exported by countries. Using data on exports by rest of the world to the United States of America, for the period, 1972-94, Feenstra and Rose (2000) (F&R henceforth) propose a methodology to rank commodities and countries.

The ranking of countries is based on the following intuition. Countries exporting more sophisticated goods are considered more advanced. Alternatively, given two countries, the one exporting earlier is ranked more advanced.

F&R find the country ranks consistent with theoretical predictions. Would one generate similar rankings using data on imports by a different country given recent trade patterns?

Apart from the fact that disaggregated (6-digit) import data (India Trades database) are available, India presents itself as an ideal candidate for such an exercise since its import patterns fit the model. India's imports increased over the period 1991-2005 (Figure 1). India imported 5248 distinct commodities[2] from 230 countries mirroring the export pattern of countries at various stages of development. The number of commodities banned by India have been far and few.

We find that the degree of innovation is a significant determinant of our rank ordering. In terms of rankings, while India's neighbours have higher than expected ranks, one significant departure from F&R is the rise of China.

Empirical Model

Kendall and Dickinson (1990) established the procedure for ranking countries for a balanced panel, i.e. if every country exported all commodities. However, not all goods are exported by all countries implying that the data are censored and the panel is unbalanced. A

[2] We observe 1,090,747 country commodity pairs in the data.

country may be too advanced to export the good during the sample period. Alternatively, it may not be advanced enough to export a particular good during the period, but could do so in the future.

F&R generalise the method for an unbalanced panel. Following F&R, we use the year a country first exported the commodity to India (during our sample period) to generate two sets of ranks: Goods Based Ranks (GBR) and Country Based Ranks (CBR).

Goods exported to India earlier are considered less advanced than goods exported later. Countries exporting more advanced goods are ranked more advanced (GBR). Alternatively, for each commodity, a country exporting to India earlier is deemed more advanced (CBR). Apriori, there is no mathematical reason to expect that GBR and CBR would be identical.

We now discuss the derivation of GBR. Let G be the set of N commodities exported to India, G_k the set of N_k commodities exported by country k in the sample period and M the set of exporting countries. Let $X_i(G)$ be the true rank of good i. For each country k, we rank good $i \in G_k$ by the first year that it was exported[3]. Let this rank be x_{ik}. Since many factors drive trading patterns, $X_i(G)$ and x_{ik} need not be identical. Let ρN_k be the number of goods for which $X_i(G) = x_{ik}$. Moreover, for country k, we do not have rank of the goods not exported by it. Let $\left(1,2,.....x_k^{\min}\right)$ be the set of goods too primitive to be produced by country k and $(x_k^{\max}, x_k^{\max}+1,...N)$ the set of goods too sophisticated to be produced during the period. Hence, for country k, $x_k^{\max} = x_k^{\min} + N_k + 1$.

If $x_k^{\min}$ were known, we could have inflated the actual rank x_{ik} by $x_k^{\min}$ to calculate what would have been the ranking of goods had we observed the unsophisticated products[4]. The crux of the empirical exercise is to estimate $x_k^{\min}$ in order to calculate $X_i(G)$. F&R establish that $X_i(G)$ can be derived by an iterative procedure where the initial estimate of $X_i(G)$ is given by the average of x_{ik}, for all $i \in G_k$. The parameters ρ and $x_k^{\min}$ are estimated from the following least square dummy variable fixed effects weighted regression[5]

$$\left[x_{ik}(G_k) - \frac{(N+1)}{2}\right] = -x_k^{\min} + \rho\left[X_i(G) - \frac{(N+1)}{2}\right] + \varepsilon_{ik}, \qquad i \in G_k, k = 1,...,M$$

[3] Analogously, in case of CBR, for each good, we rank countries in the order in which they exported the good.
[4] The assumption is that there are no commodities missing in the middle of the rankings.
[5] The weights are given by the number of countries exporting a commodity during the sample period.

Next, inflate x_{ik} by $x_k^{\min}$ and update $X_i(G)$ by recalculating the average over the updated x_{ik}, for all $i \in G_k$. We repeat the procedure till $X_i(G)$ converges. Using $X_i(G)$ we rank countries by the average sophistication of goods exported by them. Countries exporting more sophisticated goods are ranked more advanced.

Country Rankings and Macroeconomic Indicators

The rankings[6] are reported in Table 1. The GBR has a correlation of 0.5 with those by F&R. We investigate whether the country ranks, as suggested by theory, are related to measures of innovation like ratio of expenditure on research and development (R&D) to gross domestic product (GDP). We source data on R&D expenditure from UNDP–CDROM (Fifteen Years of HDR 1990-2004). Using the data for the most recent year available during the period 1990-2004, we regress the country ranks on R&D-GDP ratio and a distance variable[7] to proxy for transport costs. We find that countries with a higher R&D-GDP ratio are ranked as more advanced countries[8].

We now turn to a discussion of some interesting outliers. India's neighbouring countries are ranked higher than expected. Their ranks are driven by two reasons: preferential free trade agreements, and Indian firms with operations in these countries and exporting to India. In every year, the number of goods exported to India by its neighbours is higher than the median number of goods exported by all countries. In particular, despite not having a well developed manufacturing sector, Nepal is ranked fourth (Mfg. GBR). This suggests inflow of manufacturing goods from a third country through Nepal stemming from an inability to enforce domestic content requirements.

The case of China illustrates why GBR and CBR need not be identical[9]. For most goods China was a late entrant to Indian markets. But when China entered, it exported sophisticated goods. In contrast, USA and other OECD countries have exported to India for a long time, hence their high CBR.

[6] After dropping countries trading infrequently, we have observations on 184 countries.
[7] Source: www.cepii.fr.
[8] Our results are robust to alternate specifications where instead of R&D-GDP ratio we used Hall and Jones measure of productivity for 1988, GDP per capita for 1990 and 2004. The regression results are along expected lines and in these specifications the distance variable is also significant.
[9] The correlation between CBR and GBR, and between manufacturing GBR and CBR are 0.69 and 0.89 respectively.

Conclusion

We empirically investigate product cycles using the intuition that developed countries would export either earlier or more advanced goods to India. We derive country ranks using disaggregated Indian import data over 1991-2005 and find that the degree of innovation is a significant determinant of the ranks. However, a few country rankings are driven by proximity and inability to enforce domestic content requirements.

References

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Figure 1: India's Imports from 1991-2005

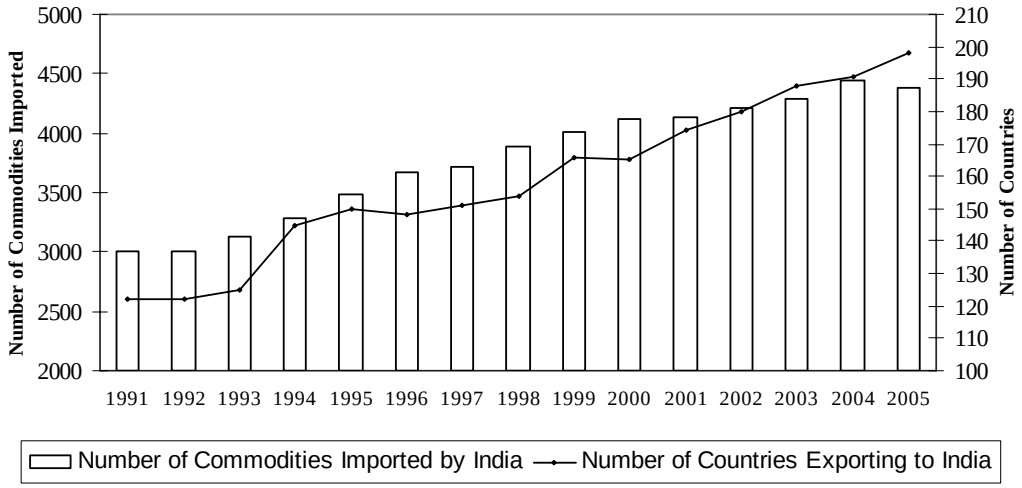

Table 1: Country Rankings

	GBR	CBR	Man'g GBR		GBR	CBR	Man'g GBR		GBR	CBR	Man'g GBR
China	1	17	1	Bahamas	63	102	101	Macedonia	125	70	169
USA	2	2	2	Portugal	64	55	55	Mozambique	126	61	134
Nepal	3	34	4	Finland	65	25	73	Azerbaijan	127	145	115
Germany	4	1	3	Russia	66	30	90	Luxembourg	128	59	162
UK	5	4	5	Honduras	67	120	88	Algeria	129	93	146
Italy	6	7	6	Norway	68	32	78	Guatemala	130	169	109
Japan	7	3	7	Suriname	69	151	41	Seychelles	131	171	71
Hong Kong	8	12	18	Cote d'Ivoire	70	106	43	Bulgaria	132	54	107
France	9	5	9	Djibouti	71	109	57	Bolivia	133	84	136
Singapore	10	6	10	Madagascar	72	114	72	Zambia	134	31	154
South Korea	11	13	11	Ireland	73	40	77	Belize	135	155	174
Bangladesh	12	48	8	Somalia	74	90	79	New Caledonia	136	132	84
Turks and Caicos Isl.	13	68	54	Ukraine	75	63	89	Turkmenistan	137	127	126
Indonesia	14	27	15	Nigeria	76	82	80	Uganda	138	130	114
Thailand	15	22	13	Uruguay	77	79	68	Malta	139	139	179
Taiwan	16	8	17	Bahrain	78	51	110	Tajikistan	140	80	129
UAE	17	23	19	Jordan	79	72	120	Venezuela	141	81	155
Malaysia	18	24	16	Kazakhstan	80	83	128	Barbados	142	167	56
Bhutan	19	44	12	Reunion	81	160	74	Qatar	143	98	152
Switzerland	20	11	23	Macau	82	147	143	French Guiana	144	99	149
Pakistan	21	35	21	Poland	83	41	91	Nicaragua	145	174	116
Netherlands	22	9	22	Liberia	84	135	156	Guyana	146	173	130
Viet Nam	23	69	30	Colombia	85	92	112	Libya	147	143	142
Papua New Guinea	24	77	20	Zimbabwe	86	52	82	Niger	148	140	133
Spain	25	21	31	Tanzania	87	36	75	Croatia	149	85	161
Sri Lanka	26	46	29	Ecuador	88	111	94	Uzbekistan	150	95	111
Australia	27	16	24	Ethiopia	89	107	87	Georgia	151	141	145
Belgium	28	15	28	Slovenia	90	74	105	Antigua and Barbuda	152	163	141
Fiji	29	142	178	Greece	91	65	92	Congo, D.R.	153	152	140
Myanmar	30	43	33	Cambodia	92	122	122	Central African Rep.	154	157	147
Eritrea	31	164	39	Benin	93	133	67	Grenada	155	175	131
Turkey	32	50	32	Mexico	94	56	117	Belarus	156	110	153
Sierra Leone	33	125	14	Gabon	95	117	106	Guinea	157	146	135
Unknown	34	86	40	Saint Pierre	96	182	25	Channel Island	158	75	151
Canada	35	18	37	Cameroon	97	108	93	Nauru	159	165	167
US Virgin Islands	36	101	60	Moldova	98	153	69	Panama Central Zone	160	183	113
Mauritius	37	71	34	Togo	99	123	70	Armenia	161	159	163
Sweden	38	14	52	Christmas Isl.	100	96	62	Lesotho	162	10	158
El Salvador	39	158	83	Jamaica	101	150	85	Chad	163	121	132
Bermuda	40	103	86	Lithuania	102	128	99	Albania	164	137	139
Oman	41	64	36	Peru	103	87	97	Namibia	165	144	164
Denmark	42	20	47	Kuwait	104	57	124	Zaire	166	39	182
South Africa	43	42	46	North Korea	105	26	118	Puerto Rico	167	176	175
Austria	44	19	53	Yemen	106	97	100	Dominica	168	178	159
Panama	45	136	42	Estonia	107	118	95	Iraq	169	66	168
Iran	46	60	49	Mongolia	108	105	123	Dominican Republic	170	177	148
Malawi	47	129	44	Romania	109	49	81	Mauritania	171	181	150
Afghanistan	48	88	27	Guadeloupe	110	179	160	Saint Helena	172	184	172
Burundi	49	156	65	Senegal	111	134	96	Trinidad and Tobago	173	149	173
Saudi Arabia	50	33	63	Hungary	112	29	127	Paraguay	174	91	170
Burkina Faso	51	154	35	Sudan	113	115	104	Brunei	175	168	176
Egypt	52	67	45	Lebanon	114	131	137	Swaziland	176	89	171
Ghana	53	58	26	Cyprus	115	78	102	Costa Rica	177	161	157
Philippines	54	47	59	Maldives	116	76	50	Portuguese Timor	178	138	183
New Zealand	55	37	48	Argentina	117	45	98	Solomon Islands	179	94	165
Kenya	56	53	51	Guinea-Bissau	118	170	103	Botswana	180	116	181
Israel	57	38	61	Tunisia	119	119	119	Cuba	181	73	180
Gambia	58	162	38	Iceland	120	124	138	Norfolk Island	182	166	177
Brazil	59	28	58	Latvia	121	126	125	Liechtenstein	183	172	166
Mali	60	112	64	Kyrgyztan	122	104	144	Laos	184	180	184
Chile	61	62	66	Syria	123	113	121				
Bosnia-Herzegovina	62	148	76	Morocco	124	100	108				

Table 2: R&D – GDP Ratio & Ranking Regression

	GBR		CBR		Manufacturing GBR	
	Coefficient	t-stat	Coefficient	t-stat	Coefficient	t-stat
R&D-GDP Ratio	-1.6	-2.74	-1.88	-3.01	-1.25	-1.88
Distance	0.001	1.45	0.0006	0.62	0.001	1.31
Constant	80.31	5.73	81.18	6.08	79.22	5.43
N=77						