Appendix B: Three Groups

In this appendix we consider the possibility that there exists three groups in the sample. The three groups being: (1) developed that remained developed, (2) developing that remained developing and (3) developing that became developed. Note that we only have three groups listed because no countries in the sample during this time period went from developed to developing. We considered the case of the following 16 countries for Group 3: Argentina, Chile, Greece, Hong-Kong, Ireland, Israel, Japan, Korea, Mexico, the Philippines, Portugal, Spain, Syria, Taiwan, Thailand and Turkey. An anonymous referee, who originally suggested we attempt this, actually suggested only the 11 countries: Chile, Greece, Hong-Kong, Ireland, Israel, Korea, the Philippines, Portugal, Spain, Taiwan and Thailand. The referee's argument was that this classification is not ad-hoc. The refereed argued that these could be derived using Hansen's (2000) endogenous threshold methodology. We originally started here, but found that we could not get any significant differences in our results. This may simply be a problem due to sample size. Thus, we decided to expand our group of 'intermediate' countries to try to obtain 'significant' results.

Although we find some interesting results, some are these are conflicting. Thus, we decided that they would be best fit an appendix. Again, we believe that this is due to sample size, but suggest that future research focus on at least three groups given a sufficient size sample. In what follows we again present the results for the Simar-Zelenyuk adapted Li-Tests for the equality of efficiency distributions across the three groups as well as the group-wise heterogeneous sub-sampling bootstrap for aggregate efficiencies across the three groups.

The results from Table B.1 show an interesting, but conflicting pattern. As before, the groups of the developed (1) and developing (2) countries are significantly different from one another in each period (in terms of efficiency scores). However, now we have a third group. In 1965, the intermediate (3) group is not significantly different from the developing group, but is significantly different from the developed group (as expected). In 1990 we see that group 3 is now significantly different from group 2. Further, we are

Null Hypothesis: Distributions are the same	Test Statistic	p-value
Group 1 vs 2: 1965	3.5221	0.0028
Group 1 vs 3: 1965	2.9286	0.0064
Group 2 vs 3: 1965	-0.3628	0.6202
Group 1 vs 2: 1990	5.4029	0.0002
Group 1 vs 3: 1990	1.0387	0.0966
Group 2 vs 3: 1990	2.9924	0.0078
Group 1: 1965 vs. 1990	-0.5005	0.4642
Group 2: 1965 vs. 1990	0.0553	0.9410
Group 3: 1965 vs. 1990	0.4760	0.4890

Notes: The same methods that were used to calculate Table 3 were used to calculate the above table.

Table B.1: Simar-Zelenyuk Adapted Li-Tests for the Equality of Efficiency Distributions Across Groups

only able to reject that the developed and intermediate group are different at the 10% level. As for the comparison between periods for each group, we again find that the groups of developing and developed countries did not change significantly. We also find that the group of intermediate countries also did not change significantly. Thus what the table suggests is that Groups 2 and 3 were similar in 1965, but different in 1990. However, both groups did not show a significant change over time. This is difficult to understand by simply examining the table.

Given this difficulty, we also plot the distributions of the efficiency scores. Figure B.1 plots four separate graphs. Panel (a) plots both Group 2 (Developing) and Group 3 (Intermediate) in each time period. It is obvious that the group of developing countries became less efficient as a group whereas the group of intermediate countries became more efficient as a group. This figure appears to uncover our paradoxical result. Each distribution shifted slightly in opposite directions. Thus, given the sample size, although we were not able to show that either group significantly differed from itself over time, we were able to show that over time Groups 2 and 3 moved significantly apart.

Panel (b) shows the group of intermediate countries versus the developed countries. This panel supports the results of the Simar-Zelenyuk adapted Li-Test. We can see that the group of developed countries became less efficient over time whereas the group of.

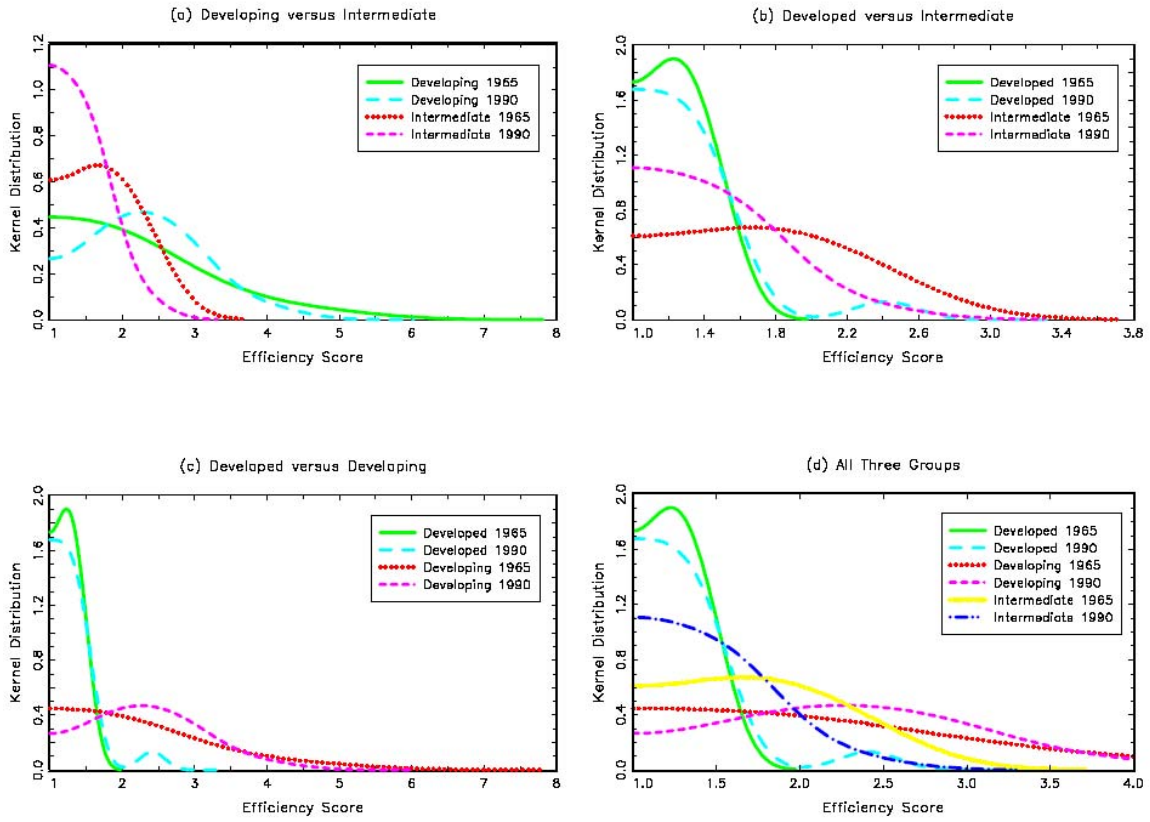

Figure B.1: Kernel Distributions of Efficiency Scores

intermediate countries became more efficient as a group over time. Again, neither was considered significantly different from itself over time

Panel (c) is analogous to Figure 1 in the text. However, here we eliminated the 'intermediate' countries. Here the mass of the distribution for the developing group shifted away from unity. At the same time, the variance of the developed countries appears to have lessened. From this panel it is clear that although there were slight changes, the difference in efficiency scores between the developed and developing countries stayed more or less constant over the time period.

Finally, panel (d) plots all three groups on one graph. The intermediate group truly appears intermediate in this figure. Even in the earlier time period, the group of intermediate countries was slightly stronger (in efficiency) than the developing countries, but far worse than the developed countries. As shown in the other figures, these differences appear to lessen over time.

		DEA	Standard	Estimated	Bias	Confidence Bounds	
		Estimate	Error	Bias	Corrected	Lower	Upper
1965	Group 1 (weighted)	1.1273	0.0692	-0.0254	1.1527	0.9797	1.2389
	Group 2 (weighted)	2.1929	0.3744	-0.3240	2.5169	1.828	3.1683
	Group 3 (weighted)	1.5543	0.236	-0.1005	1.6548	1.1775	2.0392
	All (weighted)	1.2954	0.1431	-0.0503	1.3457	1.0008	1.5361
	Group 1 (unweighted)	1.2436	0.0647	-0.0815	1.3251	1.1939	1.4358
	Group 2 (unweighted)	2.1139	0.3191	-0.2326	2.3465	1.6102	2.8816
	Group 3 (unweighted)	1.6718	0.1791	-0.1148	1.7866	1.4415	2.1108
	All (unweighted)	1.6766	0.1265	-0.1443	1.8209	1.5407	2.0445
	Eff1/Eff2 (weighted)	0.5141	0.1417	0.1022	0.4119	0.0868	0.6133
	Eff1/Eff3 (weighted)	0.7253	0.1413	0.0538	0.6715	0.3726	0.8932
	Eff2/Eff3 (weighted)	1.4109	0.3396	-0.0937	1.5046	0.7367	2.0312
	Eff1/Eff2 (unweighted)	0.5883	0.1112	0.0468	0.5415	0.2975	0.7366
	Eff1/Eff3 (unweighted)	0.7439	0.0994	0.0127	0.7312	0.5110	0.8981
	Eff2/Eff3 (unweighted)	1.2644	0.2565	-0.0396	1.3040	0.6959	1.7197
1990	Group 1 (weighted)	1.147	0.0646	-0.0549	1.2019	1.0561	1.2862
	Group 2 (weighted)	2.0804	0.3089	-0.3327	2.4131	1.7803	3.0771
	Group 3 (weighted)	1.5163	0.1492	-0.1715	1.6878	1.417	1.9635
	All (weighted)	1.3416	0.1178	-0.1149	1.4565	1.1938	1.6327
	Group 1 (unweighted)	1.3299	0.1061	-0.1142	1.4441	1.2086	1.6093
	Group 2 (unweighted)	2.1360	0.2647	-0.3584	2.4944	1.9317	2.9862
	Group 3 (unweighted)	1.4401	0.1183	-0.1385	1.5786	1.3248	1.7890
	All (unweighted)	1.6429	0.1125	-0.2047	1.8476	1.6128	2.0595
	Eff1/Eff2 (weighted)	0.5513	0.1316	0.0949	0.4564	0.1025	0.6456
	Eff1/Eff3 (weighted)	0.7565	0.1057	0.0659	0.6906	0.4535	0.8491
	Eff2/Eff3 (weighted)	1.3720	0.2580	-0.0605	1.4325	0.8731	1.8957
	Eff1/Eff2 (unweighted)	0.6226	0.1195	0.0763	0.5463	0.2838	0.7419
	Eff1/Eff3 (unweighted)	0.9235	0.1158	0.0179	0.9056	0.6568	1.1095
	Eff2/Eff3 (unweighted)	1.4832	0.2222	-0.1094	1.5926	1.1190	1.9795

Notes: The same methods that were used to calculate Tables 4 and 5 were used to calculate the above table.

Table B.2: Group-Wise Heterogeneous Sub-Sampling Bootstrap for Aggregate Efficiencies (1965 and 1990)

We now turn our attention to the aggregate efficiency scores. Table B.2 gives the results for both 1965 and 1990. Again, we fail to reject the null that the group of developed countries (weighted) is technically efficient. However, now we no longer fail to reject the null that the countries as a whole (weighted) are technically efficient (lower bound is 1.0008). As the figure shows, the group of intermediate countries appears to be

more efficient than the developing countries in 1965. However, we should note that the RD statistic has a confidence bound that covers unity (when we compare Groups 2 and 3). Thus we cannot reject equality of the efficiency scores between groups 2 and 3. This is true for both the weighted and unweighted measures.

The results for 1990 are also interesting. Again we find that the group of developed countries is now significantly different from unity. The group of developing countries worsened in terms of efficiency and the group of intermediate countries improved. However, we now find peculiar results when we examine the RD statistics. When using the weighted measures, we still cannot reject equality between Groups 2 and 3 when using the weighted or unweighted measures. However, now the unweighted RD statistic between the developed and intermediate countries covers unity. This says that we cannot reject equality in terms of efficiency between the developed and intermediate countries when we use the unweighted measure.

We believe the reason for this paradox can be understood by observing that the weighted efficiency score is larger than the unweighted one for Group 3. At the same time, we find the opposite case for Group 2. Intuitively, in Group 3, less efficient countries dominate in terms of total output (which determines the weight), while in the other groups more efficient countries dominate. As a result, the difference between the efficiency scores between Groups 2 and 3 is smaller when we account for the weight of countries. However, this difference cannot be identified as significant in this particular sample, unless we are willing to accept a 12% level of significance.

To conclude: it is unfortunate that the results of this experiment did not prove as fruitful as we had hoped. We believe that with a larger sample, we would be able to find significant differences between the groups, but at this time it is not possible to do so. We encourage others to try to find ways to uncover statistically significant differences amongst these groups.