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***On the tyranny of numbers: East Asian
miracles in world perspective***

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On The Tyranny of Numbers: East Asian Miracles in World Perspective*

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1 Introduction

In a widely cited paper, Young (1995) showed that the so-called East Asian miracles (Hong Kong, Korea, Singapore and Taiwan) grew mostly through input accumulation during the 1966-1990 period. To some degree, this result is puzzling. Recent papers by Klenow and Rodriguez-Clare (1997), Prescott (1998) and Hall and Jones (1999), among others, have established what now seems to be a consensus that total factor productivity (TFP) is more relevant than factors of production in explaining output per worker dispersion. To the extent that the level of output per worker of a given country can be thought of as the result of its cumulative growth experience, it is difficult to reconcile this evidence with Young's results.

This note intends to provide such a reconciliation. Using data for 83 countries taken from the Penn World Table, version 6.1, and Barro and Lee (2000), we use a common methodology in order to compare the growth performance of the East Asian miracles with the rest of the world. Even though our data is much less detailed than the one Young assembled for the four Asian Tigers, we are able to assess in which dimensions the growth experience of the East Asian miracles is exceptional in comparison to the rest of the world. Our goal is not to obtain new estimates of total factor productivity growth for the East Asian miracles. In

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fact, with the exception of Singapore, our calculations of TFP growth are very similar to Young's. The contribution of this note is to compare the growth performance of the East Asian Tigers to the rest of the world, in particular with respect to productivity growth.

We find that, although the TFP growth rates of the four East Asian miracles were not remarkable in absolute values, they were extraordinary in *relative* terms. We argue that, since Young (1995) focused only on the four East Asian miracles, he did not notice that 1966-1990 was a period of particularly low TFP growth and very high factor accumulation in the world. In fact, whereas the average annual rate of TFP growth in the world was -0.17%, the Asian Tigers had an average TFP growth rate of 2.09%. Despite the fact that they had high rates of physical capital accumulation, the distinguishing feature of these miracles was their relative productivity growth performance.

The comparison with the rest of the world is crucial for two reasons. First, just by definition, a miracle is necessarily a relative concept. A few studies, including Klenow and Rodriguez-Clare (1997) and Hsieh (2002), have argued that TFP growth in East Asia was higher than found by Young, using different methods. The first study argues that growth in physical capital induced by rising productivity should be attributed to productivity. Once this adjustment is made, Klenow and Rodriguez-Clare (1997) conclude that, in three of the four East Asian miracles, growth in output per worker came primarily from gains in total factor productivity. Hsieh (2002) argues that the low estimates of TFP growth obtained by Young result from flaws in National Account Data. Using estimates of total factor productivity growth based on factor prices (which in principle are more accurate), he found considerably higher TFP growth rates in East Asia than the ones obtained by Young. However, even though these two studies show that TFP growth rates in East Asia were probably higher than found by Young, they imply that TFP growth rates in the rest of the world were higher as well. For this reason, they cannot establish if TFP growth was the distinctive characteristic of the East Asian miracles.

Second, several models point toward a focus on relative rather than absolute growth performance. For example, the neoclassical growth model assumes that all countries have access to world knowledge. Moreover, models of technology transfer across countries typically have the implication that, in the long run, all economies grow at the same rate, determined by the growth rate of the technological frontier (e.g., Parente and Prescott (1994)). These models thus imply that the growth performance of any given country should not be assessed in isolation, but should instead be compared with the rest of the world.

This note is organized in four sections in addition to this introduction. In Section 2 we present the results of growth accounting exercises. Section 3 presents ranking comparisons of sources of growth for the East Asian miracles relative to the rest of the world. Section 4

compares our results to Young (1995) and Young (1994). Section 5 concludes.

2 Methodology, Data and Growth Accounting Results

Let the production function in terms of output per worker be given by:¹

$$y_{it} = A_{it}k_{it}^{\alpha}H_{it}^{1-\alpha}, \quad (1)$$

where y_{it} is the output per worker of country i at time t , k stands for physical capital per worker, H is human capital (education) per worker, and A is total factor productivity (TFP). We use a Mincerian (e.g., Mincer (1974)) formulation of schooling returns to skills to model human capital, H . In particular, it is assumed that the skill level of a worker with h years of schooling is $H = \exp \phi(h)$ greater than that of a worker with no education. The specification of the function $\phi(h)$ takes into account international evidence (e.g., Psacharopoulos (1994)) of a positive and diminishing relationship between average schooling and return to education. Hence, instead of the more usual linear return to education we follow Bils and Klenow (2000) and set the ϕ function as $\phi(h) = \frac{\theta}{1-\psi}h^{1-\psi}$. According to their calibration, we have $\psi = 0.58$ and $\theta = 0.32$.

In addition to these parameters we need to set the values of α and δ , the depreciation rate used to construct the capital series. For α , we use 0.40: estimates in Gollin (2002) of the capital share of output for a variety of countries fluctuate around this value, a number also close to that of the American economy according to the National Income and Product Accounts (NIPA). We use the same depreciation rate for all economies, which was calculated from US capital and investment data. From this calculation, we obtained $\delta = 3.5\%$ per year (average of the 1950-2000 period).

We used data for 83 countries during the period 1966-1990.² Data on output per worker and investment rates were obtained from the Penn-World Tables (PWT), version 6.1. We used data on the average educational attainment of the population aged 15 years and over, interpolated (in levels) to fit an annual frequency, taken from Barro and Lee (2000).

The physical capital series is constructed with real investment data from the PWT using the Perpetual Inventory Method. In this case we need an estimate of the initial capital stock. We approximate it by $K_0 = I_0/[(1+g)(1+n) - (1-\delta)]$, where K_0 is the initial

¹For a more detailed description of the methodology, see Ferreira, Pessôa and Veloso (2004).

²See the Appendix for a list of the countries included in the sample. We choose the period 1966-1990 because this is the period used in Young (1995). We also present results for total factor productivity growth during other periods in Section 4.

capital stock, I_0 is the initial investment expenditure, g is the rate of technological progress and n is the growth rate of the population.³ In this calculation it is assumed that all economies were in a balanced growth path at time zero, so that $I_{-j} = (1+n)^{-j} (1+g)^{-j} I_0$. To minimize the impact of economic fluctuations we used the average investment of the first five years as a measure of I_0 . When data was available we started this procedure taking 1950 as the initial year in order to reduce the effect of K_0 in the capital stock series. We obtained the rate of technological progress by adjusting an exponential trend to the U.S. output per worker series, correcting for the increase in the average schooling of the labor force and obtained $g = 1.53\%$. The population growth rate, n , is the average annual growth rate of population in each economy between 1960 and 2000, calculated from population data in the PWT.

In order to compute the value of A_{it} , we use the observed values of y_{it} and the constructed series of k_{it} and H_{it} so that the productivity of the i -th economy at time t was obtained as:

$$A_{it} = \frac{y_{it}}{k_{it}^\alpha H_{it}^{1-\alpha}}.$$

We now investigate the contribution of the various components of the production function to the growth experience, from 1966 to 1990, of 83 economies, with special emphasis on the East Asian miracles. We use equation (1), so that the variation of the log of output per worker in the period is decomposed into the contribution of total factor productivity, capital per worker and human capital per worker according to:

$$\ln \frac{y_{i90}}{y_{i66}} = \ln \frac{A_{i90}}{A_{i66}} + \alpha \ln \frac{k_{i90}}{k_{i66}} + (1 - \alpha) \ln \frac{H_{i90}}{H_{i66}}. \quad (2)$$

In addition to Young's group of East Asian miracles (Hong Kong, Korea, Singapore and Taiwan), we divided the economies in 5 groups, according to their growth rates of output per worker: in the economic "Miracles" group (9 economies) the growth rate of output per worker ranged from 4.09% to 8.37% per year, in the "Fast Growth" group (15 economies), it ranged from 2.52% to 4.09%; in "Medium Growth" (31 economies), from 0.94% to 2.52%; in "Slow Growth" (19 economies), from -0.63% to 0.94% and in the economic "Disasters" group (9 economies), the average growth rate ranged from -2.65% to -0.63% per year.⁴

Table 1 presents the growth decomposition exercises for each group between 1966 and

³This follows Hall and Jones (1999), among others.

⁴We emphasize in the paper a group division based on growth rates, not geographical factors. In this sense, the East Asian Tigers are part of the "Miracles" group and not a group by themselves. Of course, given the focus of this note, we isolated these four countries as a "special group", and that is why when we add up the countries in the groups we obtain 87 countries and not 83.

1990. Throughout the period, output per worker grew at 1.68% per year on average, whereas average total factor productivity *decreased* at an annual rate of 0.17%. The first line of the table shows the important role played by factors to explain growth rates. On average, 110% of the observed growth of output per worker can be accounted by human and physical capital accumulation, since TFP accounted for a negative contribution of 10%. Physical capital per worker alone accounts for 68% of output per worker growth. If we exclude the Disasters, the contribution of TFP is positive, but still very small (8%).

Table 1: Growth Decomposition (1966-1990)

country groups	y	k	H	TFP
Full Sample	1.68%	1.15%	0.70%	-0.17%
		(68%)	(42%)	(-10%)
Full Sample (Excluding Disasters)	2.24%	1.30%	0.72%	0.18%
		(60%)	(32%)	(8%)
East Asian Miracles	5.68%	2.78%	0.80%	2.09%
		(49%)	(14%)	(37%)
Miracles	4.57%	2.22%	0.80%	1.55%
		(49%)	(17%)	(34%)
Fast Growth	2.60%	1.50%	0.68%	0.43%
		(58%)	(26%)	(16%)
Medium Growth	1.65%	1.03%	0.68%	-0.06%
		(63%)	(41%)	(-4%)
Slow Growth	0.69%	0.85%	0.74%	-0.90%
		(123%)	(108%)	(-130%)
Disasters	-1.09%	0.19%	0.59%	-1.86%
		(-17%)	(-54%)	(171%)

Note: The numbers in parenthesis are the relative contributions of each factor to output per worker growth.

Notice, however, that the sample average hides a lot of information with respect to the behavior of different economies. In the East Asian Miracles group, TFP increased at an annual rate of 2.09%, accounting for 37% of output per worker growth. For the “Miracles” economies, the importance of TFP is similar (34%). This number falls monotonically with the average growth rate in each group: it is 16% in the “Fast Growth” group, -4% for the “Medium Growers” and -130% for the “Slow Growers.” For the “Disasters,” the fall in productivity accounts for 171% of the decline in output per worker.

In other words, the East Asian miracles were productivity miracles. In addition, poor performers in general, and disasters in particular, had a very bad record of productivity growth. The correlation between the growth rates of output per worker and TFP between 1966 and 1990 was 0.85. On the other hand, the correlation between the growth rates of output per worker and capital per worker was also high, but smaller (0.73), whereas the correlation of the first with human capital per worker was only 0.17.

With regard to the East Asian miracles, a few additional facts drawn from Table 1 should be emphasized. First, they grew on average 4% higher than the sample average (if we exclude Disasters, the difference is 3.44%). If we compare their relative performance in terms of the sources of growth, Table 1 shows that they had a slightly above average growth rate of human capital per worker (0.80% in comparison to a sample average of 0.70%), and a much higher than average growth rate of physical capital per worker (2.78% in comparison to a sample average of 1.15%). As mentioned above, they also had an exceptional *relative* performance in terms of TFP growth (2.09% in comparison to a sample average of -0.17%).

As several studies have pointed out (e.g., Klenow and Rodriguez-Clare (1997), Hall and Jones (1999)), the standard growth accounting procedure does not take into account the fact that, according to the neoclassical growth model, a portion of the increase in the capital-labor ratio is induced by an increase in total factor productivity. In order to attribute this portion to TFP, we can perform a growth decomposition exercise in which the capital-labor ratio is replaced by the capital-output ratio (κ), according to:

$$y_{it} = A_{it}^{\frac{1}{1-\alpha}} \left(\frac{K_{it}}{Y_{it}} \right)^{\frac{\alpha}{1-\alpha}} H_{it} = A_{it}^{\frac{1}{1-\alpha}} \kappa_{it}^{\frac{\alpha}{1-\alpha}} H_{it},$$

so that the decomposition of the variation of the log of output per worker in the period is now given by:

$$\ln \frac{y_{i90}}{y_{i66}} = \frac{1}{1-\alpha} \ln \frac{A_{i90}}{A_{i66}} + \frac{\alpha}{1-\alpha} \ln \frac{\kappa_{i90}}{\kappa_{i66}} + \ln \frac{H_{i90}}{H_{i66}}. \quad (3)$$

Table 2 presents the results. The table confirms that the East Asian miracles experienced, at least in relative terms, exceptional TFP growth. On the other hand, their human capital performance was very close to the world average. The table shows, in addition, that when capital deepening is measured by the capital-output ratio, the performance of the East Asian miracles was not extraordinary: their average annual growth rate in the period was just 0.06% above the sample average. In fact, the average growth of κ of these countries was smaller than that of the Disasters economies (1.03% per year). In this formulation, TFP explains almost two thirds of output per worker growth of the East Asian Miracles, in contrast to a negative contribution for the world mean (full sample).

Table 2: Alternative Growth Decomposition (1966-1990)

country groups	y	κ	H	TFP
Full Sample	1.68%	0.79%	1.16%	-0.28%
		(47%)	(69%)	(-16%)
Full Sample (Excluding Disasters)	2.24%	0.75%	1.20%	0.30%
		(33%)	(54%)	(13%)
East Asian Miracles	5.68%	0.85%	1.34%	3.49%
		(15%)	(24%)	(61%)
Miracles	4.57%	0.65%	1.33%	2.59%
		(14%)	(29%)	(57%)
Fast Growth	2.60%	0.76%	1.13%	0.71%
		(29%)	(43%)	(27%)
Medium Growth	1.65%	0.62%	1.13%	-0.10%
		(38%)	(68%)	(-6%)
Slow Growth	0.69%	0.96%	1.24%	-1.50%
		(138%)	(179%)	(-217%)
Disasters	-1.09%	1.03%	0.98%	-3.10%
		(-95%)	(-90%)	(285%)

Note: The numbers in parenthesis are the relative contributions of each factor to output per worker growth.

3 Ranking Comparisons

Another way to assess the relative importance of total factor productivity growth for the East Asian miracles is to rank all countries in terms of the sources of growth. Table 3 presents rankings for the growth rates of output per worker, capital per worker, capital-output ratio, human capital per worker and total factor productivity.⁵

As one can see, between 1966 and 1990 Singapore was the fastest TFP grower, Hong Kong the second and Taiwan the fifth. Even though Korea's TFP record was not exceptional, it ranked among the top 15 nonetheless. With the exception of the latter, the group did not experience remarkable human capital growth rates. Even though they had very strong growth rates of capital per worker, they were not unusual with respect to their growth rates of the capital-output ratio. In other words, although these countries had very high rates of physical capital accumulation, once we take into account their productivity performance,

⁵From now on all results for total factor productivity refer to the standard decomposition procedure, based on (2).

they did not experience exceptionally high capital deepening.

Table 3: Ranking Comparisons, Growth Rates, 1966-1990

countries	y	TFP	k	κ	H
Hong Kong	5	2	20	76	33
Korea	3	14	4	15	11
Singapore	4	1	7	42	68
Taiwan	2	5	3	20	21

In order to assess the quantitative importance of differences in TFP growth rates for relative performance, our methodology allow us to decompose easily the variations in the growth rates of output per worker between each group and the East Asian miracles into differences in the growth rates of its sources, as shown in Table 4.

Table 4: Decomposition of Growth Differences Between East Asian Miracles and Groups, 1966-1990

country groups	y	k	H	TFP
Full Sample	4.00%	1.63%	0.11%	2.26%
Full Sample (Excluding Disasters)	3.44%	1.43%	0.08%	1.92%
Miracles	1.10%	0.56%	0.01%	0.54%
Fast Growth	3.07%	1.28%	0.13%	1.67%
Medium Growth	4.03%	1.74%	0.13%	2.15%
Slow Growth	4.99%	1.93%	0.06%	2.99%
Disasters	6.76%	2.59%	0.22%	3.95%

For example, differences in TFP growth rates account for 58.4% of the difference in growth rates of output per worker between the East Asian Miracles and the Disasters. Specifically, out of the 6.76% difference in growth rates of output per worker between these two groups, 2.59% and 0.22% are due to differences in the growth rates of physical capital per worker and human capital per worker, respectively, whereas TFP growth differences account for the remaining 3.95%. By the same token, differences in TFP growth rates account for 56.5% of the differences in the growth rates of output per worker between the East Asian Miracles and the world mean (full sample).⁶

⁶We used geometric averages in the calculation of the mean growth rate of each group. As we can see easily from expression (2), the mean growth rate of y is equal to the sum of the mean growth rate of each of its sources (A, k and H). Hence, we find the contribution of, say, A to differences in the growth of y , by simply comparing its mean growth among the Asian Tigers (2.09%) to its mean growth among the Disasters (-1.86%). This 3.95% gap explains 58.4% of the 6.76% difference in y growth between these two groups.

In the case of the alternative decomposition, the relative importance of TFP growth is overwhelming: differences in TFP growth rates account for 97.4% of the difference in growth rates of output per worker between the East Asian Miracles and the Disasters. Specifically, out of the 6.76% difference in growth rates of output per worker between these two groups, -0.19% and 0.37% are due to differences in the growth rates of the capital-output ratio and human capital per worker, respectively, whereas TFP growth differences account for 6.59%. Using the same procedure, we find that differences in TFP growth rates account for 94.2% of the differences in the growth rates of output per worker between the East Asian Miracles and the world mean.⁷

4 Comparison with Young's Results

In this section, we compare our results with those of Young (1995) and Young (1994) for the corresponding periods. Table 5 presents the results.

Table 5: TFP Ranking and Annual Growth Rate Comparisons

	66-90		70-85		60-2000		66-90 Young, 95	70-85 Young, 94	
countries	rank	$\widehat{\text{TFP}}$	rank	$\widehat{\text{TFP}}$	rank	$\widehat{\text{TFP}}$	$\widehat{\text{TFP}}$	rank	$\widehat{\text{TFP}}$
Hong Kong	2	2.50%	1	2.28%	1	3.35%	2.30%	6	2.50%
Korea	14	1.35%	33	0.11%	10	1.52%	1.70%	24	1.40%
Singapore	1	2.55%	11	1.13%	3	2.68%	0.20%	63	0.10%
Taiwan	5	1.98%	18	0.82%	7	1.97%	2.10%	21	1.50%

Note: $\widehat{\text{TFP}}$ is the average annual growth rate of TFP.

Several results deserve comment. First, when considering the 1966-1990 period we can observe that, with the exception of Singapore, our numbers are very close to those in Young (1995), which used the same time span.⁸ In fact, for Korea and Taiwan, TFP growth rates in Young's paper are greater than ours. What should be stressed is that, even though these rates are not particularly high in absolute values, they are well above those experienced by the rest of the world during the same period. Specifically, three out of the four East Asian miracles were among the top five TFP performers from 1966 to 1990. The reason is that, as

⁷The full results are available from the authors upon request.

⁸Klenow and Rodriguez-Clare (1997) find a value for the growth rate of TFP in Singapore similar to ours. As they argue, the discrepancy between our numbers and the one obtained by Young is due to two reasons. First, the census data used by him show faster growth of the labor force than the Penn World Table. Second, Young uses a larger value for the capital share parameter (0.49).

shown in Table 1, average TFP growth was either negative (including Disasters) or positive but very small (excluding Disasters) during this period.

Second, Young (1994) argued that the East Asian miracles did not have extraordinarily high total factor productivity growth rates in comparison with other countries, using a sample of 114 countries during the period 1970-1985. As shown in Table 5, when we use the same period we obtain rankings for these countries similar to Young's.⁹ Hence, for this particular period, it turns out that the East Asian miracles did not have particularly remarkable productivity performances. However, as shown in Table 5, if we consider a longer period, such as 1960-2000, the pattern again resembles the one observed for 1966-1990. Specifically, for the period 1960-2000, all the four East Asian miracles were among the top 10 TFP performers.

In summary, since Young (1995) focused only on the four East Asian miracles, he did not notice that this was a period of particularly low TFP growth in the world. Even though the TFP growth rates of these countries were not remarkable in absolute values, they were extraordinary in relative terms. On the other hand, although Young (1994) was correct in pointing out that from 1970 to 1985 TFP growth of the Asian Tigers economies did not rank high, this period is not representative of their productivity performance in the last four decades. The reason may be that these countries did not postpone the necessary macroeconomic adjustments in face of the oil shocks of the seventies, so that they experienced initial recessions followed by strong recoveries. Hence, the period chosen by Young (1994) may be capturing this short-run adjustment, whereas the longer periods reveal their true long-run productivity gains.

5 Conclusions

Alwyn Young's papers on East Asian growth (Young, 1994, 1995) have spurred a controversy regarding the importance of TFP for the extraordinary growth performance of the East Asian Miracles (Hong Kong, Korea, Singapore and Taiwan) that is yet to be settled.¹⁰ This note presented a contribution to this debate by analyzing their TFP growth performance from a comparative perspective. We found that, despite the fact that these countries experienced very high rates of physical capital accumulation, the distinguishing feature of their recent development experience was their extraordinary productivity growth performance. The im-

⁹In fact, and again with the exception of Singapore, he obtains higher growth rates, as the growth decompositions from which his TFP results were obtained did not include human capital. This and his larger sample account for the differences between his ranking and ours.

¹⁰See Islam (2001) for a recent survey of this literature.

portant point is that, even though the TFP growth rates of the East Asian miracles were not particularly high in absolute values, they were unusually high in comparison to the TFP growth rates experienced by the rest of the world during the same period (1966-1990).

Even though we focused on the four East Asian Tigers for the sake of comparability with Young (1994, 1995), our results can be extended to other fast growers. Specifically, a common feature of “miracles” and fast-growing countries is above average TFP growth, at the same time that productivity decreased in most of the “disasters” and slow-growing economies. When put in world perspective, growth miracles (disasters) are TFP growth miracles (disasters). This helps reconcile the world growth experience in the last decades with the recent evidence that TFP accounts for the bulk of output per worker dispersion among countries, as found by Klenow and Rodriguez-Clare (1997) and Prescott (1998), among many.

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6 Appendix

A List of Countries by Growth Groups

East Asian Miracles: Taiwan, Hong Kong, Korea, Singapore.

Miracles: Botswana, Taiwan, Korea, Singapore, Hong Kong, Thailand, Indonesia, Japan, Cyprus.

Fast Growth: Barbados, Ireland, Portugal, Pakistan, Italy, Malaysia, Finland, Austria, India, Spain, Greece, Syria, Turkey, Brazil, Paraguay.

Medium Growth: Ecuador, Israel, Tunisia, France, Lesotho, Belgium, Mauritius, Colombia, Norway, Zimbabwe, Dominican Republic, United Kingdom, Germany, Fiji, Netherlands, Nepal, USA, Guatemala, Panama, Iceland, Sweden, Jordan, Australia, Malawi, South Africa, Philippines, Canada, Denmark, Kenya, Bangladesh, Uruguay.

Slow Growth: Switzerland, Trinidad & Tobago, Mexico, Cameroon, Honduras, Chile, Costa Rica, Uganda, Tanzania, Papua New Guinea, Togo, Iran, Ghana, Argentina, Jamaica, New Zealand, Bolivia, El Salvador, Senegal.

Disasters: Zambia, Central African Republic, Peru, Guyana, Mozambique, Niger, Venezuela, Nicaragua, Congo.

B Building the Groups

The procedure to divide the 83 countries in 5 groups can be described as follows. First, we divided by 7 the interval between the lowest and the highest average annual growth rate of output per worker between 1966 and 1990, obtaining a value of 1.57%. The average growth rate of output per worker throughout this period was 1.73% (this is the exact average growth rate, which is slightly different from the average logarithmic growth rate of 1.68% used in the growth decompositions). Then we obtained the limits of the central interval: $2.52\% = 1.73\% + (1.57\%/2)$ and $0.94\% = 1.73\% - (1.57\%/2)$. The resulting interval, $[0.94\%, 2.52\%]$, gives the “Medium Growth” group. We obtained the successive intervals by adding and subtracting 1.57%, for example, $-0.63\% = 0.94\% - 1.57\%$ and $4.09\% = 2.52\% + 1.57\%$. By adding 1.57% to 4.09%, we obtain 5.66%. The interval $[5.66\%, \infty)$ would correspond to a category of “Super Miracles,” including only four countries (Botswana, Taiwan, Korea and Singapore). We included these four countries in the group of “Miracles.” Analogously, if we subtract 1.57% from -0.63%, we obtain -2.21%. The interval $(-\infty, -2.21\%]$ would correspond to “Super Disasters,” including two countries, Nicaragua and Congo, which were incorporated to the “Disasters.” This procedure leads to the group division presented in the text.

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