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ECONOMICS

THE INTERNATIONAL VOLATILITY OF GROWTH

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DISCUSSION PAPER 07.10

May 2007

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Abstract

Growth in the world economy is not shared equally among all countries, with some growing faster, some slower and some not at all. The cross-country distribution of growth is a useful tool for analysing the inequality of growth. The appropriately-weighted first moment of this distribution is world growth, while the second measures cross-country volatility. This paper introduces a methodology to examine the cross-country distribution of growth, and the components of its volatility. Using data from the Penn World Table, we find countries within geographic regions are seeing a harmonisation of growth, but between regions there is increasing dispersion.

* We thank Ze Min Hu for research assistance, and Callum Jones for helpful comments. This research was financed in part by the ARC.

1. Introduction

Suppose there is a surge in world economic growth. Assuming it is possible to isolate this common shock from country-specific shocks, we can then ask how is this higher growth in the world economy likely to be distributed across countries and groups of countries? Several considerations make it unlikely that all countries in the world would share equally in this growth.

First, the nature of the shock that increases world growth is likely to matter: Consider, for example, the impact of a major fall in oil prices that stimulates the world economy. As this involves an income transfer from oil exporters to importers, the latter group of countries would be likely to grow faster than the former. Second, due to policy choices and geography, countries are integrated into the world economy to differing degrees. Economies more open to trade are likely to be more synchronised with world growth. A further consideration is cross-country differences in initial GDPs. According to what is known as "β convergence", poor countries grow faster than the rich, so that in simple versions of growth models per capita GDPs are equalised over the longer term.[1] Even if both types of countries share equally in world growth, during the transition period this faster growth of poor countries makes for an uneven distribution of world growth.

This paper deals with the links between world economic growth and its distribution across countries and groups of countries. This is related to prior studies that find a link between growth and its variability (or volatility) such as Ramey and Ramey (1995). We also investigate the extent to which the cross-country dispersion of growth is falling over time, as would be predicted by increased globalisation and international policy co-ordination. To do this, we decompose the variance of growth into internal (within each group of countries) and external (between groups) components; introduce a methodology that isolates the role of the world economy in determining a country's growth rate; and then employ that approach to decompose growth in autonomous, world and residual factors. To set the scene for this analysis, we provide in the next section a geometric representation of growth under the special case in which it is uniformly distributed around the world.[2]

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[1] See, e.g., Barro and Sala-i-Martin (2004, pp. 50-51, 462-65).

[2] This paper deals with world economic growth, its relation to growth in each country and its dispersion (or volatility) across countries. There is a related literature on growth and its volatility *within* a country. Ramey and Ramey (1995) identify four streams of this literature. First, if there are irreversibilities in investment, then increased volatility can lead to lower investment and lower growth (Bernanke, 1983, Pindyck, 1991, Ramsey and Ramsey, 1991). Second, Black (1987) sees countries facing choices between risky, high-variance technologies that have higher expected returns on the one hand, and safer, low-variance technologies with lower expected returns on the other. In this environment, there is a positive association between growth and its volatility. The third stream of the literature focuses on the possibility that due to precautionary motives, higher volatility may stimulate saving, investment and growth (Mirman, 1971). Again, here volatility and growth are

2. The Geometry of the World Economy and its Components

Consider the world economy that is made up of N countries with $y_1,\ldots,y_N$ denoting their GDPs. World GDP is then $Y = \sum_{c=1}^{N} y_c$ and the share of country c in the world economy is $w_c = y_c/Y$, with $\sum_{c=1}^{N} w_c = 1$. Geometrically, we can represent the size of the world economy and country c in three equivalent ways.

1. *One Dimension:* World GDP can be measured by the length of the circumference of a circle $2\pi r_L$ with radius $r_L = Y/2\pi$, as in Panel A of Figure 1. Country c's GDP is given by the length of the segment AB, where $AB = w_c \times 2\pi r_L$.
2. *Two Dimensions:* World GDP can be measured by the area of a circle. This circle has radius r_A, so that $Y = \pi r_A^2$, with r_A defined as $\sqrt{Y/\pi}$. See Panel B of Figure 1. Country c's GDP is a fraction w_c of this total area, such as OAB, where $w_c = OAB/\pi r_A^2$.
3. *Three Dimensions:* Finally, the size of the world economy can be measured by the volume of a sphere $(4/3)\pi r_V^3$. The radius r_V is $\sqrt[3]{3Y/4\pi}$, and GDP in country c is the fraction w_c of this, which is represented by the volume of the shaded shape labelled NASB in Panel C of Figure 1.

It is to be noted that because of the way in which the radius is chosen, these ways of measuring world GDP are all equivalent; the length of the circumference, the area and the volume are all equal to the same value of world GDP, Y. The share of country c in the total is also the same no matter how we measure things:

$$w_c = \frac{AB}{2\pi r_L} = \frac{OAB}{\pi r_A^2} = \frac{NASB}{(4/3)\pi r_V^3}.$$

Next, using the spherical representation of GDP, suppose the world economy grows, so that it is now measured by the volume of a larger sphere, as in Panel A of Figure 2. The increase in the volume is $(4/3)\pi\left(r_{V1}^3 - r_{V0}^3\right)$, where r_{V0} is the initial radius (equal to $\sqrt[3]{3Y_0/4\pi}$, with Y_0 the initial value of world GDP) and r_{V1} the larger radius (equal to $\sqrt[3]{3Y_1/4\pi}$, with Y_1 the higher world GDP). The proportionate increase in the volume is, of course, just the growth in world GDP:

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positively related. Fourth, there is a statistical literature on the association between growth and volatility (see, e. g., Kormendi and Meguire, 1985, and Zarnowitz and Moore, 1986). For recent related contributions that emphasise the role of technology, see Arias et al. (2006) and Tang (2002).

$$\frac{\frac{4}{3}\pi\left(r_{V1}^3 - r_{V0}^3\right)}{\frac{4}{3}\pi r_{V0}^3} = \frac{Y_1 - Y_0}{Y_0}.$$

The volume of the shaded shape in Panel B of Figure 2 measures the new value of country c's GDP under the assumption that its share in world GDP remains unchanged at w_c. The growth in this volume is $\left(y_{c1} - y_{c0}\right)/y_{c0}$, which if the share is constant, equals growth in world GDP, $\left(Y_1 - Y_0\right)/Y_0$. If all N countries in the world behave in this manner, then a surge in world growth results in the same increase in growth of all countries, so that growth is uniformly distributed across countries and shares all remain unchanged.

We can describe the above situation as one of uniform growth, or proportionate growth. To visualise uniform growth, think of the sphere as a rubber balloon filled with air. Then when more air is injected and if the thickness and strength of the rubber is the same at all points on the surface, the balloon expands in a uniform manner that maintains all prior relativities. Such is the growth described in Figure 2. While uniform growth is most unlikely to be literally true, it forms a useful starting point for thinking about the nature of the distribution of growth across countries. Has growth become more uniform over time as a result of globalisation? If growth is non-uniform, which countries, or groups of countries, consistently grow faster or slower than the world? Is the distribution of growth more or less dispersed when world growth rises? With non-uniformity, can we devise simple procedures to decompose each country's growth into components due to world and domestic factors? These are some of the issues analysed below.

3. The Distribution of Growth

We measure growth in the world economy from year t-1 to t and that for country c by $R_t = \log Y_t - \log Y_{t-1}$ and $r_{ct} = \log y_{ct} - \log y_{c,t-1}$, respectively. As discussed in the Appendix, except for a third-order remainder term, the growth rates are linked according to

$$R_t = \sum_{c=1}^{N} \overline{w}_{ct} r_{ct}, \tag{1}$$

where $\overline{w}_{ct}$ is the arithmetic average share over the years t and t-1 of the country share $w_{ct} = y_{ct}/Y_t$, with $\sum_{c=1}^{N} \overline{w}_{ct} = 1$. Equation (1) defines world growth as a share weighted-average of the N country growth rates, and is a Törnqvist (1936)-Theil (1965, 1967) index. Using data from the Penn Table 6.2 (Heston et al., 2006), we find the world economy has

expanded every year over the period 1956 to 2003.[3] Figure 3 shows there were also periods of sharp slowdowns in growth (indicated by the shading), which were recessionary for some individual countries. The two mid-period slowdowns, one around 1975 and the other in the early 1980s, were the result of oil shocks and high inflation. The most recent slowdown, in the early 1990s, was mainly the product of events in the United States.

Equation (1) is a weighted first-order moment of $r_{1t},\ldots,r_{Nt}$. The corresponding second-order moment is

$$V_t = \sum_{c=1}^{N} \overline{w}_{ct}\left(r_{ct} - R_t\right)^2. \tag{2}$$

Since V_t increases the further the individual country growth rates differ from that of the world, it is a measure of the dispersion of growth; if $r_{ct} = R_t$ for $c = 1, ..., N,$ then $V_t = 0$. We shall thus refer to V_t, or the standard deviation $\sqrt{V_t}$, as the "volatility of growth in the world economy", or for short, the "volatility of growth". Figure 3 plots $\sqrt{V_t}$ against time and as can be seen, there is a tendency for volatility to rise as the world economy slows down.

Figure 4 illustrates how the country growth rates are distributed around the world average in the years 1957 and 1998. World growth is approximately the same in these two years at about 3 percent, while the volatility is substantially higher in 1998 than 1957. Notwithstanding Figure 4, Figure 5 shows that on average there is a negative relationship between volatility and world growth, which is similar to the finding of Ramey and Ramey (1995) in a slightly different context.[4]

4. A Decomposition Analysis

As many countries in the world have similar characteristics, they can be aggregated in several meaningful ways. We consider two aggregation schemes whereby countries are divided into (i) two economic groups, the OECD (developed countries) and non-OECD (less developed); and (ii) the six geographic regions listed in Panel B of Table 1. The countries in each group are given in the Table A7 of the Appendix.

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[3] Real GDP in c, y_{ct}, is measured in terms of international dollars (equivalent to US dollars in 2000) of the Penn World Table 6.2. Throughout the paper, we divide up the whole period into three sub-periods. From 1956 – 1970, the number of countries is N = 23; from 1971 – 1990, N = 28; and from 1991 – 2003, N = 29. Countries are included on the basis of (i) the availability of continuous data; and (ii) their importance in the world economy. The included countries represent about 85 percent of the world economy as measured by GDP according to the Penn World Table. In the Appendix, we give r_{ct} and $\overline{w}_{ct}$ for each country and year.

[4] The context is the relation between growth and volatility within a country. Ramsey and Ramsey (1995) use data pertaining to 92 countries and find a negative relationship between this type of growth and volatility. See footnote 1 for more on this literature.

As can be seen in Table 1, the non-OECD countries as a group have grown faster than the OECD, and this has raised their share of the world economy from 24 percent in 1956-1970 to 41 percent in 1991-2003. Geographically, East Asia has seen the largest increase of its share in the world economy, from 13 percent in 1956-1970 to 23 percent in 1991-2003. This has come mainly at the expense of North America and Europe, whose combined share has declined from 66 percent to under 50 percent over the period. The shares of the other regions have been roughly steady over the period.

To decompose the distribution of growth, divide the N countries into $G<N$ groups, denoted by $\mathbf{S}_1,...,\mathbf{S}_G$, such that each country belongs to one group. The share of group g in the world economy is then $\bar{W}_{gt}=\sum_{c\in\mathbf{S}_g}\bar{w}_{ct}$, so that $\bar{w}'_{ct}=\bar{w}_{ct}/\bar{W}_{gt}$ is the share of country c within its respective group, with $\sum_{c\in\mathbf{S}_g}\bar{w}'_{ct}=1$. Growth of group g and the corresponding volatility is

$$(3)\qquad r_{gt}=\sum_{c\in\mathbf{S}g}\bar{w}'_{ct}r_{ct},\qquad V_{gt}=\sum_{c\in\mathbf{S}_g}\bar{w}'_{ct}\left(r_{ct}-r_{gt}\right)^2.$$

Using equation (3) in (2), we obtain a decomposition of the variance for the world (see the Appendix for derivations)

$$(4)\qquad V_t=\sum_{g=1}^{G}\bar{W}_{gt}V_{gt}+\sum_{g=1}^{G}\bar{W}_{gt}\left(R_{gt}-R_t\right)^2.$$

In words, equation (4) states that: *the variance of the growth in the N countries in the world economy is the sum of (i) a weighted average of the variances for the G regions and (ii) the variance between regions.* This provides an elegant decomposition of total volatility into a "within-group" (or internal) component, $\sum_{g=1}^{G}\bar{W}_{gt}V_{gt}$, and a "between-group" (or external) component, $\sum_{g=1}^{G}\bar{W}_{gt}\left(R_{gt}-R_t\right)^2$.

Tables 2 and 3 give the decompositions on the basis of the economic and geographic groupings of countries. Column 2 of Table 2 shows that the internal component of the OECD variance has decreased substantially over time, suggesting that the growth of developed countries is becoming more harmonised. Dispersion within non-OECD countries, on the other hand, has risen over time (column 3); as this term dominates over the five decades, the total internal component also rises over time (column 4). The external component (column 5) also increases over time, reflecting the divergent growth of the world economy characterised by the faster (slower) growth of developing (developed) economies. Column 6 of Table 2 shows that over the last five decades, volatility of growth for the world as a whole first declines and then increases to end up higher at $V=12.16\left(\times10^{-2}\right)$; this finding contradicts the

idea that increased globablisation could be expected to lead to greater harmonisation of the component countries of the world economy. On average over the whole period, volatility is $V = 10.58$, or $\sqrt{V} = 3.3$ percent p. a. (see the last entry of column 6). From columns 4 and 5, the internal component of this volatility accounts for the majority at $9.22/10.58 \approx 90$ percent, with the external component absorbing the other 10 percent.

Table 3 reveals that the geographical perspective on volatility provides an essentially different picture to the economic one: The external divergence effect is much greater among geographic regions at $3.84/10.58 \approx 35$ percent of the total for the whole period, which is more than three times the same share for the economic decomposition. Evidently, more divergent shocks become apparent when the world economy is split on the basis of geography rather than economics. Because the two groups of countries span most regions of the globe, when we confine attention to the OECD/non-OECD distinction, regional shocks tend to be masked as they hit both groups simultaneously, making the between group component of volatility smaller. The geographic disaggregation of the world economy is thus more informative as only it reveals the substantially different patterns of growth.

Three further aspect of Table 3 are worth noting. First, the declining volatility of North America and Europe (column 2) is consistent with the pattern for the OECD in Table 2. Second, within the geographic regions, countries in East Asia have the most divergent growth rates (column 3), reflecting the different stages of growth of countries like China, Japan and South Korea. Third, the contribution to volatility of Eastern Europe is high relative to its weight, because of events in Russia over the period 1992-2003.

5. Leaders and Laggards

In this section we identify those regions that grow systematically faster or slower than the world. To do this, we could use the information in Table 1 to compute the deviation of the growth in each region from the world rate $r_{gt} - R_t$. Thus the East Asians are leaders, while the North American and European countries are laggards, at least on average. However, this approach is subject to at least two problems. First, world growth is a *weighted* average of regional growth, which means that the weighted sum of the G regional growth deviations $\sum_{g=1}^{G} \bar{W}_{gt} \left(r_{gt} - R_t \right)$ is zero. As the same property does not hold for the unweighted average and unweighted sum, this suggests that a weighted formulation has more attractive aggregation properties. The second problem with using $r_{gt} - R_t$ is that it implies that the elasticity of each region's GDP with respect to the world counterpart is unity, which is too rigid. As some regions are more (less) open to international trade than others, it is reasonable

to expect these economies will be more (less) sensitive to world growth. In what follows, we introduce an approach that deals with these issues.

Although we shall analyse regions, it is instructive to start at the more basic level of countries. The deviation of growth in country c from world growth is $r_{ct} - R_t$, and $\bar{w}_{ct}\left(r_{ct} - R_t\right)$ is the deviation weighted by c's share in the world economy. Consider this weighted deviation as a linear function of world growth:

$$\bar{w}_{ct}\left(r_{ct} - R_t\right) = \alpha_c + \beta_c R_t + \varepsilon_{ct}, \tag{5}$$

where α_c is the intercept and β_c the slope, and ε_{ct} is a zero-mean disturbance term. The intercept represents for country c the systematic changes in the weighted growth differential $\bar{w}_{ct}\left(r_{ct} - R_t\right)$ that take place independently of world growth. It can be shown that $\alpha_c / \bar{w}_{ct}$ is the exponential rate of growth of c attributable to autonomous (that is, local) factors. The slope β_c represents the impact of world growth on country c; it is easy to show that $1 + \beta_c / \bar{w}_{ct}$ is the elasticity of GDP in c with respect to world GDP, so that this elasticity exceeds (is less than) unity if $\beta_c > 0 \ \ (< 0)$. Finally, the term ε_{ct} captures the influence of random factors. As the right-hand side variable of equation (5) has a zero sum over the N countries, it follows that

$$\sum_{c=1}^{N} \alpha_c = \sum_{c=1}^{N} \beta_c = \sum_{c=1}^{N} \varepsilon_{ct}. \tag{6}$$

These constraints serve to preserve identity (1).

Next, we add both sides of equation (5) over the members of region $\mathbf{S}_g$, the region that contains country c. On the right, we obtain

$$\sum_{c \in \mathbf{S}_g} \bar{w}_{ct}\left(r_{ct} - R_t\right) = \sum_{c \in \mathbf{S}_g} \bar{w}_{ct} r_{ct} - \bar{W}_{gt} R_t = \bar{W}_{gt} \sum_{c \in \mathbf{S}_g} \bar{w}'_{ct} r_{ct} - \bar{W}_{gt} R_t = \bar{W}_{gt}\left(r_{gt} - R_t\right),$$

where the first step is based on $\bar{W}_{gt} = \sum_{c \in \mathbf{S}_g} \bar{w}_{ct}$, and the third on equation (3). On the left-hand side, we obtain $A_g + B_g R_t + E_{gt}$, where $A_g = \sum_{c \in \mathbf{S}_g} \alpha_c$, $B_g = \sum_{c \in \mathbf{S}_g} \beta_c$ and $E_{gt} = \sum_{c \in \mathbf{S}_g} \varepsilon_{ct}$. Accordingly, the aggregated version of equation (5) for region g is

$$\bar{W}_{gt}\left(r_{gt} - R_t\right) = A_g + B_g R_t + E_{gt}. \tag{5'}$$

As $\sum_{g=1}^{G} \bar{W}_{gt}\left(r_{gt} - R_t\right) = 0$, equation $(5')$ satisfies

$$\sum_{g=1}^{G} A_g = \sum_{g=1}^{G} B_g = \sum_{g=1}^{G} E_{gt} = 0. \tag{6'}$$

A comparison of equations (5) and (6) with $(5')$ and $(6')$ reveals that the model is consistent in aggregation. Accordingly, all of the basic micro information at the country level that is contained in model (5) is also contained in aggregated form in model $(5')$.

Rearranging equation $(5')$, growth in region g is

$$r_{gt} = \frac{A_g}{\bar{W}_{gt}} + \left(1 + \frac{B_g}{\bar{W}_{gt}}\right) R_t + \frac{E_{gt}}{\bar{W}_{gt}}. \tag{7}$$

The term $A_g / \bar{W}_{gt}$ on the right of this equation is the autonomous growth in region g, or the growth in g that is independent of world growth. The term $1 + B_g / \bar{W}_{gt}$ is the elasticity of GDP in g with respect to world growth. If region g grows at the world rate, so that its elasticity $1 + B_g / \bar{W}_{gt}$ is unity, then B_g is zero. This shows that model $(5')$ provides a convenient way to test the hypothesis of proportional growth via the parametric restriction $B_g = 0$. There are two other convenient features of model $(5')$. First, the least-squares estimates of equation $(5')$ for $g = 1, ..., G$ automatically satisfy the aggregation constraints $(6')$. Note in particular that the restriction $\sum_{g=1}^{G} B_g = 0$ implies $\sum_{g=1}^{G} \bar{W}_{gt} \left(1 + B_g / \bar{W}_{gt}\right) = 1$, so that the GDP-share-weighted average of the G world elasticities is unity, as required. Second, the elasticities from model $(5')$ can be expressed as weighted averages of the corresponding country counterparts,

$$\frac{A_g}{\bar{W}_{gt}} = \sum_{c \in S_g} \bar{w}'_{ct} \left(\frac{\alpha_c}{\bar{w}_{ct}}\right), \quad 1 + \frac{B_g}{\bar{W}_{gt}} = \sum_{c \in S_g} \bar{w}'_{ct} \left(1 + \frac{\beta_c}{\bar{w}_{ct}}\right),$$

which again reflects the consistency-in-aggregation property of the model.

Table 4 gives estimates of equation $(5')$ for each of the G = 2 economic and the G = 6 geographical groups of the world for the period 1991 to 2003. Panel A shows that the elasticity of GDP for the OECD with respect to world GDP as a whole is 0.9, while that of the non-OECD is 1.2; both these elasticities are insignificantly different from unity. Next, we see from Panel B that North America and Europe as a group have a world GDP elasticity of about unity, which is not surprising as the countries in this group alone account for almost one-half of the world economy. East Asia (row 4) has a large and significant intercept, indicating the importance for this region's growth of autonomous factors that are independent of world growth. But to a certain extent at least, this large positive effect for East Asia is offset by the negative slope coefficient, which leads to the world elasticity being substantially less than unity at 0.6. The opposite result applies for East Europe, which has a relatively

large negative intercept and a world elasticity well above unity. Qualitatively, the results are not too different for the two earlier periods.[5]

6. Further Decompositions

Equation (4) decomposes world volatility into within and between region components, the latter being

$$V'_t = \sum_{g=1}^{G} \bar{W}_{gt} \left(R_{gt} - R_t \right)^2 . \tag{8}$$

As in the previous section we analysed the determinants of regional growth, we now combine these two elements to investigate the impact of world growth on between region volatility.[6]

Substituting the right-hand side of equation (7) into (8) gives

$$V'_t = \sum_{g=1}^{G} \bar{W}_{gt} \left[\frac{A_c}{\bar{W}_{gt}} + \frac{B_c}{\bar{W}_{gt}} R_t + \frac{E_{gt}}{\bar{W}_{gt}} \right]^2 .$$

As the regional disturbance term is defined as $E_{gt} = \sum_{c \in s_g} \varepsilon_{ct}$ and as $E(\varepsilon_{ct}) = 0$, it follows that $E(E_{gt}) = 0$ also. This implies that the terms linear in E_{gt} also have a zero expectation, so that expected volatility can be written as

$$E(V'_t) = \sum_{g=1}^{G} \left[\frac{A_g^2}{\bar{W}_{gt}} + \frac{B_g^2}{\bar{W}_{gt}} R_t^2 + \frac{2A_g B_g}{\bar{W}_{gt}} R_t + \frac{E_{gt}^2}{\bar{W}_{gt}} \right] .$$

Expected volatility can then be decomposed into a nonnegative share for each region:

$$\lambda_{gt} = \frac{\left[\frac{A_g^2}{\bar{W}_{gt}} + \frac{B_g^2}{\bar{W}_{gt}} R_t^2 + \frac{2A_g B_g}{\bar{W}_{gt}} R_t + \frac{E_{gt}^2}{\bar{W}_{gt}} \right]}{E(V'_t)}, \tag{9}$$

which satisfies $\sum_{g=1}^{G} \lambda_{gt} = 1$. In words, λ_{gt} is the fraction of between region volatility that is accounted for by region g at time t.

The four components of equation (9) are:

$$\lambda_{gt}^A = \frac{A_g^2 / \bar{W}_{gt}}{E(V'_t)}, \quad \lambda_{gt}^W = \frac{\left(B_g^2 / \bar{W}_{gt} \right) R_t^2}{E(V'_t)}, \quad \lambda_{gt}^I = \frac{\left(2A_g B_g / \bar{W}_{gt} \right) R_t}{E(V'_t)}, \quad \lambda_{gt}^R = \frac{E_{gt}^2 / \bar{W}_{gt}}{E(V'_t)} , \tag{10}$$

which satisfy $\lambda_{gt}^A + \lambda_{gt}^W + \lambda_{gt}^I + \lambda_{gt}^R = \lambda_{gt}$. The term λ_{gt}^A is the component of λ_{gt} due to autonomous growth in region g; this λ_{gt} is nonnegative. The second component, λ_{gt}^W, is that

[5] For details, see Table A8 of the Appendix.

[6] The decomposition analysis of this section is similar to that used by Clements and Nguyen (1982) in the context of inflation and relative prices. In personal communication with Clements, Andrew Buck of Temple University correctly pointed that Clements and Nguyen (1982) neglected the residual component in their decompositions. This omission is corrected in this section.

part of λ_{gt} due to growth in the world, and is also nonnegative. If region g grows at the same rate as the world economy in the sense that its world elasticity is unity, $B_g = 0$, the term involving squared world growth in equation (9) drops out and $\lambda_{gt}^W = 0$. If the region's GDP is proportional to that of the world, world growth per se has no impact on volatility. The third component, λ_{gt}^I, is due to the interaction between autonomous and world growth, which can be either positive or negative, and can be thought of as being similar to a covariance term. As with the second component, in the case of equiproportional growth the interaction term is zero. The final component is the residual term, λ_{gt}^R, which measures the impact of random factors on volatility and is also nonnegative.

Table 5 gives in columns 2-6 the decompositions (9) and (10) averaged over the period 1991 - 2003.[7] Among the geographical regions, East Europe accounts for by far the largest share of volatility at 45 percent (column 2, Panel B); this is much larger than its share in the world economy of 6 percent. By contrast, North America and Europe as a group is more tranquil, accounting for only 9 percent of total volatility (but 49 percent of the world economy). As can be seen from column 5, in many cases the interaction component λ_g^I is large and mostly negative. As this component is difficult to interpret, it seems desirable to attempt to eliminate it. One way that yields an attractively simple result is to allocate λ_g^I to the other three components $\lambda_g^A, \lambda_g^W, \lambda_g^R$ as follows. Let $\lambda_g^* = \lambda_g^A + \lambda_g^W + \lambda_g^R$ be the sum of these three components, and $\lambda_g^j / \lambda_g^*$ be the normalised component j (j = A, W, R), which is nonnegative and satisfies $\lambda_g^A / \lambda_g^* + \lambda_g^W / \lambda_g^* + \lambda_g^R / \lambda_g^* = 1$. Allocate to component j the fraction $\lambda_g^j / \lambda_g^*$ of λ_g^I, so that the share becomes $\left(\lambda_g^j / \lambda_g^*\right)\left(1 + \lambda_g^I\right)$, the sum over j of which is $1 + \lambda_g^I$. Renormalising a second time by dividing by $1 + \lambda_g^I$, we obtain $\lambda_g^j / \lambda_g^*$ again as the new component attributable to factor j after the allocation of the interaction term. The values of these three components are given in columns 7 to 9 of Table 5. For the OECD as a whole, the autonomous share accounts for a little over 40 percent of the total volatility, the world economy almost 30 percent and the residual the remaining 30 percent. Splitting the world geographically, the autonomous component increases substantially in importance to a little over 60 percent, the world factor falls to about 10 percent and the order of magnitude of the residual component remains unchanged at a bit less than 30 percent.

[7] The decompositions for the other sub-periods are given in the Appendix.

It is worthwhile discussing further the autonomous/world contributions to volatility. Consider the volatility components in each of the three periods:

Period	Component (Percent)			Autonomous / World
	Autonomous	World	Residual	
1956-70	61	20	19	3.1
1971-90	64	14	22	4.6
1991-03	64	11	25	5.8

The above information for the last period is derived from the last entries of columns 7-8 of Table 5, and thus refer to weighted averages over all regions. The information for the other two periods refers to the same concepts, presented in Tables A9 and A10 of the Appendix. In view of the perceived wisdom regarding the growing importance of the world economy on the fate of local economies, it may comes as a surprise that the internal determinant of volatility dominates the world determinant, and dominates by a factor that has risen from about three in the first period to almost six in the last. But this result has to be interpreted carefully as the world component is zero when the relevant $B_g = 0$; that is, when the elasticity of the region's GDP with respect to the world's is unity. In other words, the world economy contributes nothing to volatility when all regions (and thus the world as a whole) grow at the same rate. The above finding can thus be interpreted as saying that over time world GDP elasticties have moved toward unity on average, so that in this sense the world economy has become more harmonised regionally. Of course, as an overall qualification to our findings, we need to keep in mind that a sizeable component of volatility (about one-fifth to one-quarter) is attributed to random factors that are not explained by our framework.

7. Concluding Comments

When world economic growth surges, it is unlikely that all countries share in this higher growth in a uniform manner; some countries would be likely to grow faster than average, others less than average. In fact, as world growth is a weighted average of the growth rates of all countries, the above-average growers must be just balanced by those countries growing at below-average rates. This paper investigated how a change in world economic growth is distributed across countries by analysing the extent to which growth is nonuniform.

To measure noninformity, we introduced the cross-country variance of growth which is zero only when all countries grow at the same rate and increases as growth becomes more

disproportionate; we called this variance the *volatility of growth*. We then aggregated countries into groups on an economic and regional basis, and showed how the volatility of growth can be conveniently decomposed into internal and external components. This analysis revealed that more divergent shocks become apparent when the world economy is split on a geographic, rather than economic, basis.

We also introduced a simple model that identifies countries/regions as leaders or laggards with respect to growth. This leads to further decompositions of volatility into local, world and residual components. The local component has been increasing over the last five decades and accounts for almost two-thirds of total volatility, leaving little role for world factors. But as world growth makes no contribution to volatility if all countries expand equiproportionately, this result is not as surprising as it may seem and can be interpreted as saying that growth is becoming more uniformly distributed.

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APPENDIX

A1. Notes on Measuring Growth in the World Economy

In the text, we approximated the growth in the world economy by equation (1), which we reproduce here

(A1) $$R_t = \sum_{c=1}^{N} \bar{w}_{ct} r_{ct} \ .$$

Equation (A1) defines the world growth rate, R_t, from year t-1 to t as a weighted average of the individual country growth rates in the N countries, $r_{1t},\ldots,r_{Nt}$, where the weights are the arithmetical averages over the years t-1 and t of the GDP shares, $\bar{w}_{1t},\ldots,\bar{w}_{Nt}$. In this section, we analyse the nature of this approximation, provide a justification for this choice of the weights and discuss some related issues.

Theil's Quadratic Approximation Lemma

Let $f(\mathbf{x})$ be a scalar function of the vector $\mathbf{x}$, $\mathbf{g_x} = \partial f/\partial \mathbf{x}$ be the gradient vector evaluated at $\mathbf{x}$ and $\mathbf{H_x} = \partial^2 f/\partial \mathbf{x}\partial \mathbf{x}'$ be the Hessian matrix at $\mathbf{x}$. A linear approximation to $f(\bullet)$ is

(A2) $$f(\mathbf{x}+\mathbf{h}) - f(\mathbf{x}) = \mathbf{h}'\mathbf{g_x} + 0_2 ,$$

where $\mathbf{h}$ is a vector of small elements and 0_2 is a remainder term whose leading term is of second degree in the elements of $\mathbf{h}$. A quadratic approximation to $f(\bullet)$ is

(A3) $$f(\mathbf{x}+\mathbf{h}) - f(\mathbf{x}) = \mathbf{h}'\mathbf{g_x} + \frac{1}{2}\mathbf{h}'\mathbf{H_x}\mathbf{h} + 0_3 ,$$

where 0_3 is a remainder term of third degree.

Application of result (A2) to the gradient vector, viewed as a function, yields

(A4) $$\mathbf{g_{x+h}} - \mathbf{g_x} = \mathbf{H_x}\mathbf{h} + \mathbf{0}_2 .$$

As $\mathbf{h}$ is of the order 0_1, it follows that $\mathbf{h}'\mathbf{0}_2 = 0_3$, so that if we premultiply both sides of equation (A4) by $\mathbf{h}'$, we obtain $\mathbf{h}'\mathbf{g_{x+h}} - \mathbf{h}'\mathbf{g_x} = \mathbf{h}'\mathbf{H_x}\mathbf{h} + 0_3$, or

$$\mathbf{h}'\mathbf{H_x}\mathbf{h} = \mathbf{h}'\mathbf{g_{x+h}} - \mathbf{h}'\mathbf{g_x} + 0_3 .$$

Using the above to substitute for the quadratic form in equation (A3), we obtain

(A5) $$f(\mathbf{x}+\mathbf{h}) - f(\mathbf{x}) = \frac{1}{2}\mathbf{h}'(\mathbf{g_x} + \mathbf{g_{x+h}}) + 0_3 .$$

This approximation involves just the gradient, but has an error of third degree. This is Theil's lemma which he describes as "providing us with an approximation which is as simple as the

linear approximation [A2] and as accurate as the quadratic approximation [A3]" (Theil, 1975, p. 38).

Application to World Growth

GDP in country c, measured in terms of international dollars, is y_c, and as there are N countries in the world, $Y = \sum_{c=1}^{N} y_c$ is world GNP. Write this identity in logarithmic form as

(A6) $$\log Y = f\left(\log y_1, \ldots, \log y_N\right).$$

Our objective is to apply lemma (A5) to equation (A6).

In view of the initial definition $Y = \sum_{c=1}^{N} y_c$, we have $\partial Y / \partial y_c = 1$. Thus

$$\frac{\partial\left(\log Y\right)}{\partial\left(\log y_c\right)} = \frac{\partial Y / \partial y_c}{Y / y_c} = w_c \ ,$$

where $w_c = y_c / Y$ is the share of country c in world GDP. We interpret $\mathbf{x}$ and $\mathbf{x}+\mathbf{h}$ in (A5) as referring to years t-1 and t, respectively, so that $w_{c,t-1}$ and w_{ct} are the corresponding derivatives. Define the arithmetic average of these two shares as $\bar{w}_{ct} = \frac{1}{2}\left(w_{c,t-1} + w_{ct}\right)$, so that the average of the two gradients in (A5) is $\frac{1}{2}\left(\mathbf{g}_{\mathbf{x}} + \mathbf{g}_{\mathbf{x}+\mathbf{h}}\right) = \left(\bar{w}_{1t}, \ldots, \bar{w}_{Nt}\right)'$. The vector $\mathbf{h}'$ then comprises $\left(\log y_{1t} - \log y_{1,t-1}, \ldots, \log y_{Nt} - \log y_{N,t-1}\right)$, so that the lemma implies

$$\log Y_t - \log Y_{t-1} = \left(\log y_{1t} - \log y_{1,t-1}, \ldots, \log y_{Nt} - \log y_{N,t-1}\right)\begin{pmatrix} \bar{w}_{1t} \\ \vdots \\ \bar{w}_{Nt} \end{pmatrix} + 0_3$$

$$= \sum_{c=1}^{N} \bar{w}_{ct}\left(\log y_{ct} - \log y_{c,t-1}\right) + 0_3,$$

or with $R_t = \log Y_t - \log Y_{t-1}$, the exponential rate of growth of the world economy, and $r_{ct} = \log y_{ct} - \log y_{c,t-1}$ that in country c, we have

(A7) $$R_t = \sum_{c=1}^{N} \bar{w}_{ct} r_{ct} + 0_3 \, .$$

As the remainder term in this equation is of third degree in the growth rates of the individual countries, the approximation in this equation is of third order. On an annual basis, growth in GDP in excess of 10 percent is highly unusual, so the remainder term can be expected to be small and the approximation (A1) good. Note that in any year t we observe both world growth, R_t, and that for the N countries, $r_{1t}, \ldots, r_{Nt}$. But in order to avoid the approximation error, we define world growth as $\sum_{c=1}^{N} \bar{w}_{ct} r_{ct}$.

Related Issues

It is worthwhile making three other comments. First, if each country has the same growth rate r_t^*, then no matter what weights are used, world growth equals this r_t^*, without any approximation error. That is,

$$R_t = \sum_{c=1}^{N} \omega_{ct} r_t^* = r_t^* \sum_{c=1}^{N} \omega_{ct} = r_t^*,$$

where ω_{ct} is the weight accorded to c in t. All that is required is that the weights have a unit sum.

Second, going back to the definition of world GDP, $Y = \sum_{c=1}^{N} y_c$, consider a slightly different way of proceeding by formulating the analysis in terms of proportionate changes rather than logarithmic changes. The change in the value of world GDP from t-1 to t is just the sum of the N changes, $\Delta Y_t = \sum_{c=1}^{N} \Delta y_{ct}$, so that if we divide both sides by Y_{t-1}, we obtain

$$\text{(A8)} \qquad \frac{\Delta Y_t}{Y_{t-1}} = \sum_{c=1}^{N} \frac{y_{c,t-1}}{Y_{t-1}} \frac{\Delta y_{ct}}{y_{c,t-1}} = \sum_{c=1}^{N} w_{c,t-1} \frac{\Delta y_{ct}}{y_{c,t-1}}.$$

This equation says that the proportionate change (or if we multiply by 100, the percentage change) in world GDP is a weighted average of the corresponding changes in GDP in each of the countries, with last period's shares in world GDP serving as weights. Although there is no approximation error in equation (A8), it is not a particularly attractive way to proceed. For one thing, proportionate changes are not symmetric in t-1 and t, meaning that

$$\frac{Y_t - Y_{t-1}}{Y_{t-1}} \neq -\frac{Y_{t-1} - Y_t}{Y_t}.$$

Thus if GDP is α percent higher in year t relative to t-1, then it is not true that GDP in t-1 is α percent lower than in t. This problem with percentage changes is also known as "base drift", and leads to anomalous results when these changes are accumulated or averaged. Logarithmic changes, or exponential growth rates, are not subject to these problems. To illustrate, consider the logarithmic change from t_1 to $t_2 > t_1$, $\log y_{c,t_2} - \log y_{c,t_1}$. As adjacent values cancel, this multi-period change is just the sum of the intervening one-period changes, that is,

$$\begin{aligned} \log y_{c,t_2} - \log y_{c,t_1} &= \left(\log y_{c,t_2} - \log y_{c,t_2-1}\right) + \left(\log y_{c,t_2-1} - \log y_{c,t_2-2}\right) + \ldots + \left(\log y_{c,t_1+1} - \log y_{c,t_1}\right) \\ &= \sum_{t=t_2}^{t_1+1} \left(\log y_{ct} - \log y_{c,t-1}\right). \end{aligned}$$

Thus if the data are annual, the annual average exponential rate of growth over the period t_1 to t_2 is just the average of that in the component years:

$$\frac{1}{t_2 - t_1}\left(\log y_{c,t_2} - \log y_{c,t_1}\right) = \frac{1}{t_2 - t_1}\sum_{t=t_2}^{t_1+1}\left(\log y_{ct} - \log y_{c,t-1}\right) = \frac{1}{t_2 - t_1}\sum_{t=t_2}^{t_1+1} r_{ct} \ .$$

This convenient consistency property is not shared by percentage changes. In fact, Törnqvist et al. (1985) show that the log change is the *only* symmetric, additive and normed indicator of relative change.[8]

Third, consider the relationship of our measure of world growth, equation (A1), to index-number theory. Suppose, for example, we wish to form an index of the overall volume of the consumption basket comprising the quantities consumed of N goods, $q_1,\ldots,q_N$. The Divisia (1926) approach is to formulate the problem in terms of infinitesimal logarithmic changes, $d\left(\log q_1\right),\ldots,d\left(\log q_N\right)$, by taking a budget-share-weighted average of these changes, $\sum_{i=1}^{N} w_i d\left(\log q_i\right)$, where $w_i = p_i q_i / M$ is the budget share of good i, the share of i in total expenditure (p_i = the price of i and $M = \sum_{i=1}^{N} p_i q_i$ is total expenditure). A popular way to implement this index with finite-change data for the transition from t-1 to t is $\sum_{i=1}^{N} \bar{w}_{it}\left(\log q_{it} - \log q_{i,t-1}\right)$, where $\bar{w}_{it} = \frac{1}{2}\left(w_{it} + w_{i,t-1}\right)$ is the arithmetic average of the budget share over t-1 and t. This finite-change index is known as a Törnqvist (1936)-Theil (1965, 1967) index; see Diewert (1976) for a further discussion. Clearly, equation (A1) is an index of the Törnqvist -Theil form.

A2. The Data

Tables A1-A3 give growth rates for each country in each of the three sub-periods, while Tables A4-A6 give the corresponding shares in the world economy. The membership of each group of countries is given in Table A7.

[8] In the context of relative changes, the properties of symmetry, additivity and normed have the following meanings. Define an indicator of the relative difference between the two positive numbers x and y as $H\left(y/x\right)$ such that $H\left(y/x\right) = 0$ iff $y/x = 1$; $H\left(y/x\right) > 0$ iff $y/x > 1$; $H\left(y/x\right) < 0$ iff $y/x < 1$; and $H(\bullet)$ is a continuous increasing function in y/x. Then this indicator is *symmetric* iff $H\left(y/x\right) = -H\left(x/y\right)$. Next, suppose in addition to the chnage $x \to y$, we have the further change $y \to z$. The indicator $H(\bullet)$ is then said to be *additive* iff it can be expressed as the sum of the indicator of the two intermediate differences; that is, iff $H\left(z/x\right) = H\left(y/x\right) + H\left(z/y\right)$. Finally, $H(\bullet)$ is *normed* iff its derivative at $y/x = 1$ is unity; that is, iff $H'(1) = 1$. The last property rules out the multiplication of the indicator function by a scaling factor. For further details, see Törnqvist et al. (1985).

A3. Derivation of Equation (4)

To derive equation (4) we first use equation (2) to express the world variance as

$$V_t = \sum_{c=1}^{N} \bar{w}_{ct}\left(r_{ct} - R_t\right)^2 = \sum_{c=1}^{N} \bar{w}_{ct} r_{ct}^2 - R_t^2, \tag{A9}$$

And similarly for the regional variance equation (3):

$$V_{gt} = \sum_{c \in \mathbf{S_g}} \bar{w}'_{ct}\left(r_{ct} - r_{gt}\right)^2 = \sum_{c \in \mathbf{S}_g} \bar{w}'_{ct} r_{ct}^2 - r_{gt}^2 .$$

Taking the weighted sum of the regional variances over $g = 1, \ldots, G$, we obtain

$$\sum_{g=1}^{G} \bar{W}_{gt} V_{gt} = \sum_{g=1}^{G} \bar{W}_{gt} \left\{ \sum_{c \in \mathbf{S}_g} \bar{w}'_{ct} r_{ct}^2 - r_{gt}^2 \right\} = \sum_{c=1}^{N} \bar{w}_{ct} r_{ct}^2 - \sum_{g=1}^{G} \bar{W}_{gt} r_{gt}^2 ,$$

so that

$$\sum_{c=1}^{N} \bar{w}_{ct} r_{ct}^2 = \sum_{g=1}^{G} \left(\bar{W}_{gt} V_{gt} + \bar{W}_{gt} r_{gt}^2 \right).$$

Using the right-hand of the above in equation (A9), we obtain

$$V_t = \sum_{g=1}^{G} \bar{W}_{gt} V_{gt} + \sum_{g=1}^{G} \bar{W}_{gt} \left(r_{gt}^2 - R_t^2 \right) = \sum_{g=1}^{G} \bar{W}_{gt} V_{gt} + \sum_{g=1}^{G} \bar{W}_{gt} \left(r_{gt} - R_t \right)^2 ,$$

which is equation (4).

A4. Further Results

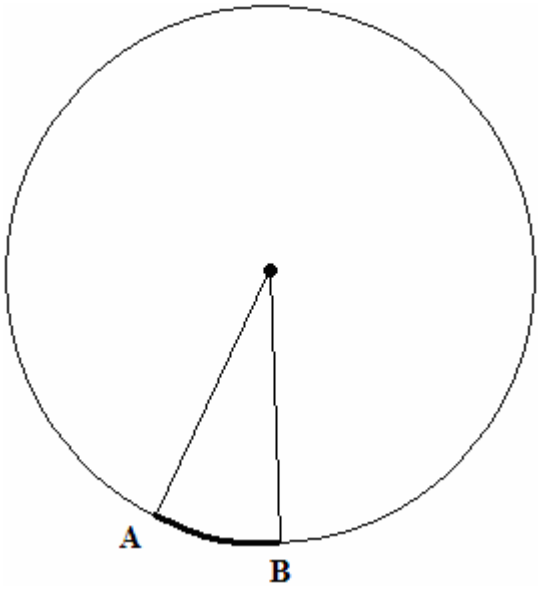
Tables 4 and 5 of the text contain results for the most recent period 1991 – 2003. Tables A8-A10 contain the corresponding results for the two earlier periods.

FIGURE 1

THREE REPRESENTATIONS OF

THE WORLD ECONOMY AND ONE COUNTRY

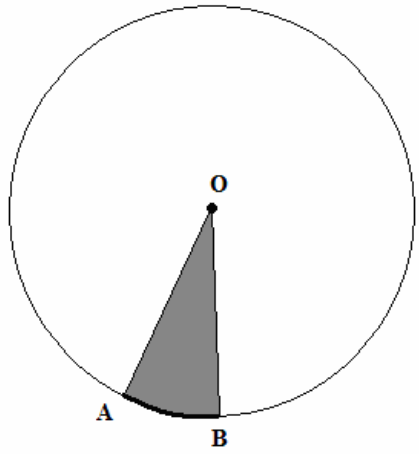
A. Length



Radius:

$$r_L = \frac{Y}{2\pi}$$

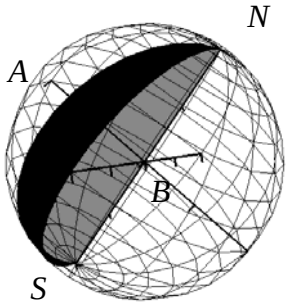
B. Area



Radius:

$$r_A = \sqrt{\frac{Y}{\pi}}$$

C. Volume



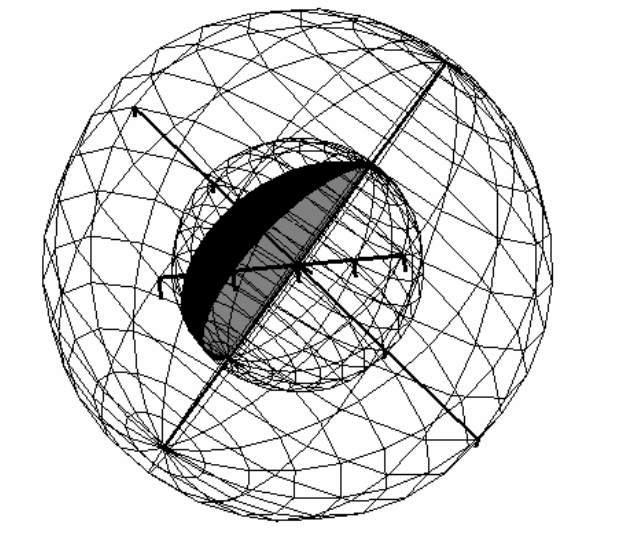
Radius:

$$r_V = \sqrt[3]{\frac{3Y}{4\pi}}$$

FIGURE 2

GROWTH IN THE WORLD ECONOMY

A. An Increase in World GDP



B. Country c in the Bigger World

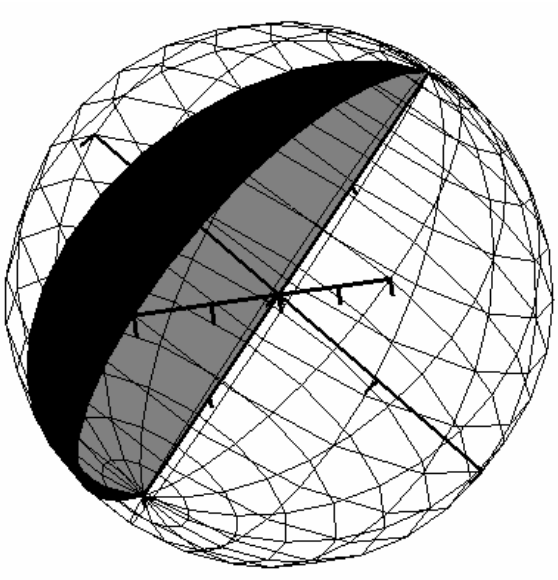


FIGURE 3

WORLD GROWTH AND VOLATILITY, 1956 - 2003

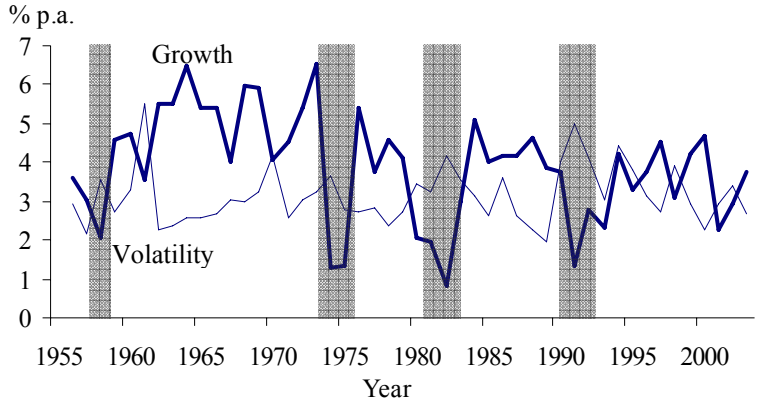


FIGURE 4

DISTRIBUTIONS OF GROWTH RATES

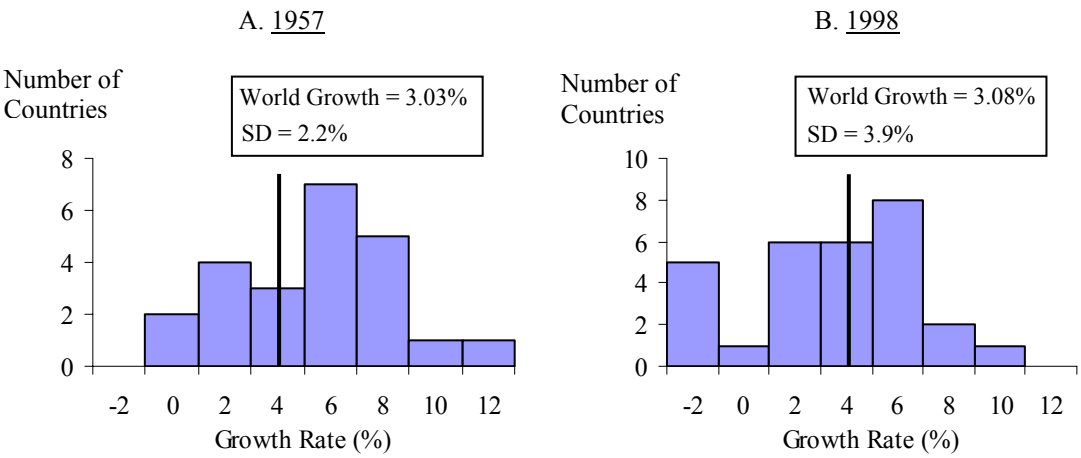


FIGURE 5

VOLATILITY VS GROWTH

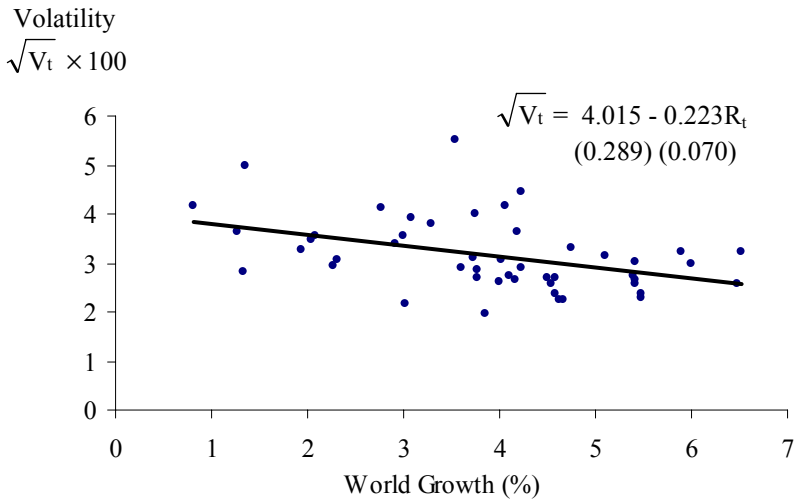


TABLE 1

COUNTRY GROUPS, SHARES AND GROWTH

	Region	1956-1970		1971-1990		1991-2003	
		Share	Growth	Share	Growth	Share	Growth
	A. Economic groups						
1.	OECD	76.03	4.48	71.06	3.11	59.21	2.33
2.	Non-OECD	23.97	5.22	28.94	5.25	40.79	4.70
3.	World	100.00	4.66	100.00	3.68	100.00	3.29
	B. Geographic groups						
4.	N. America and Europe	66.47	3.90	60.45	2.94	49.32	2.51
5.	East Asia	12.82	7.45	17.02	5.56	23.15	5.55
6.	East Europe	-	-	-	-	6.16	0.45
7.	Middle East and Africa	3.12	6.00	4.55	3.87	3.83	3.34
8.	South America	8.20	5.76	9.20	4.16	7.97	2.56
9.	South Asia	9.39	4.66	8.78	4.36	9.58	4.64
10.	World	100.00	4.66	100.00	3.68	100.00	3.29

Note: All entries are averages over the corresponding periods. All entries are to be divided by 100.

TABLE 2

FIRST VOLATILTY DECOMPOSITION: ECONOMIC GROUPS

Period	Internal components			External component	World variance
	OECD	Non-OECD	Sum		
	$\overline{W}_1 V_1$	$\overline{W}_2 V_2$	$\Sigma_{g=1}^{2} \overline{W}_g V_g$	$\sum_{g=1}^{2} \overline{W}_g \left(R_g - R\right)^2$	V_t
(1)	(2)	(3)	(4)	(5)	(6) = (4) + (5)
1956-1970	4.69	4.29	8.98	1.09	10.07
1971-1990	1.43	6.75	8.18	1.32	9.51
1991-2003	1.34	9.15	10.49	1.67	12.16
Average	2.47	6.73	9.22	1.36	10.58

Note: All entries are averages over the corresponding periods. All entries are to be divided by 100.

TABLE 3

SECOND VOLATILTY DECOMPOSITION: GEOGRAPHIC GROUPS

Period	Internal components							External component	World variance
	North America and Europe	East Asia	South Asia	Latin America	Eastern Europe	Middle East	Sum		
	$\overline{W}_1 V_1$	$\overline{W}_2 V_2$	$\overline{W}_3 V_3$	$\overline{W}_4 V_4$	$\overline{W}_5 V_5$	$\overline{W}_6 V_6$	$\sum_{g=1}^{6} \overline{W}_g V_g$	$\sum_{g=1}^{6} \overline{W}_g \left(R_g - R\right)^2$	V_t
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10) = (8) + (9)
1956-1970	2.06	2.90	0.55	0.70	-	0.34	6.55	3.52	10.07
1971-1990	1.02	1.35	0.78	1.00	-	2.10	6.26	3.25	9.51
1991-2003	0.65	3.77	1.19	0.45	1.07	0.29	7.40	4.76	12.16
Average	1.25	2.67	0.84	0.71	1.07	0.91	6.74	3.84	10.58

Note: All entries are averages over the corresponding periods. All entries are to be divided by 100.

TABLE 4

DEPENDENCE OF REGIONAL GROWTH ON
AUTONOMOUS AND WORLD FACTORS, 1991 – 2003

$$\bar{W}_{gt}\left(r_{gt} - R_t\right) = A_g + B_g R_t + E_{gt}$$

(Standard errors in parenthesis)

	Region	Share in world economy $\bar{W}_g \times 100$	Intercept A_g	Slope B_g	Elasticity $1 + B_g / \bar{W}_{gt}$
			A. Economic groups		
1.	OECD	59.21	-0.3177 (0.289)	-0.0774 (0.084)	0.87
2.	Non-OECD	40.79	0.3177 (0.289)	0.0774 (0.084)	1.19
	Sum	100.00	0.0000	0.0000	
			B. Geographic groups		
3.	N Amer and Euro	49.32	-0.4246 (0.268)	0.0131 (0.078)	1.03
4.	East Asia	23.15	0.8124 (0.250)	-0.0919 (0.073)	0.60
5.	East Europe	6.16	-0.7110 (0.315)	0.1536 (0.092)	3.49
6.	ME and Africa	3.83	0.1171 (0.061)	-0.0350 (0.018)	0.09
7.	S. America	7.97	0.1107 (0.162)	-0.0506 (0.047)	0.37
8.	S. Asia	9.58	0.0954 (0.148)	0.0108 (0.043)	1.11
	Sum	100.00	0.0000	0.0000	

Notes: 1. Shares in world economy are averages over 1991-2003.
2. "N Amer and Euro" denotes North America and Europe; and "ME and Africa" denotes the Middle East and Africa.

TABLE 5

MORE VOLATILITY DECOMPOSITIONS, 1991 – 2003

Region	Total	Component				Share of total		
		Autonomous	World	Interaction	Residual	Autonomous	World	Residual
	λ_g	λ_g^A	λ_g^W	λ_g^I	λ_g^R	$\frac{\lambda_g^A}{\lambda_g^A+\lambda_g^W+\lambda_g^R}$	$\frac{\lambda_g^W}{\lambda_g^A+\lambda_g^W+\lambda_g^R}$	$\frac{\lambda_g^R}{\lambda_g^A+\lambda_g^W+\lambda_g^R}$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
A. Economic groups								
OECD	40.79	10.29	6.72	16.63	7.15	42.6	27.81	29.59
Non-OECD	59.21	14.94	9.75	24.14	10.38	42.6	27.81	29.59
Sum	100	25.23	16.47	40.77	17.53			
Weighted ave.	48.3	12.19	7.96	19.69	8.47	42.6	27.81	29.59
B. Geographic groups								
NA Europe	9.03	7.70	0.08	-1.57	2.82	72.67	0.76	26.58
East Asia	28.67	60.10	8.45	-45.08	5.19	81.50	11.46	7.04
East Europe	45.06	173.05	88.84	-247.99	31.16	59.05	30.32	10.63
ME Africa	1.89	7.55	7.41	-14.96	1.89	44.82	43.97	11.21
S. America	7.17	3.24	7.44	-9.82	6.31	19.07	43.78	37.15
S. Asia	8.17	2.00	0.28	1.5	4.39	29.99	4.20	65.81
Sum	100	253.66	112.51	-317.93	51.76			
Weighted ave.	15.29	29.11	8.37	-27.69	5.51	64.45	10.47	25.09

Note: The weighted averages in the last row use average $\overline{W}_{gt}$ values over the period as weights. All entries are to be divided by 100.

TABLE A1

GROWTH RATES AND VOLATILITY, 1956 - 1970

	Country	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	Mean
1.	USA	1.95	1.58	-0.93	5.58	2.36	2.16	6.05	4.47	5.70	6.41	5.93	2.15	5.09	3.25	0.00	3.45
2.	UK	1.18	1.50	0.43	3.24	4.40	2.11	1.55	3.85	4.91	2.64	1.90	2.61	3.60	1.83	2.48	2.55
3.	Japan	6.73	6.82	4.51	8.47	11.92	11.63	8.39	8.37	10.95	5.18	10.16	10.68	12.21	11.68	10.49	9.21
4.	France	7.98	5.11	1.46	4.25	5.98	5.34	6.69	5.19	6.69	4.37	5.16	4.58	4.44	7.04	5.06	5.29
5.	India	0.71	2.38	7.00	2.62	4.44	4.75	4.76	8.94	6.10	-0.78	-0.48	7.49	6.40	10.53	2.45	4.49
6.	Italy	4.13	4.05	4.46	6.56	8.46	8.01	6.18	5.63	2.45	3.15	6.03	6.70	6.52	5.99	5.29	5.57
7.	China	10.22	4.37	10.65	1.88	0.28	-17.28	-0.29	8.09	11.81	11.01	7.58	-3.21	-2.95	10.51	9.59	4.15
8.	Brazil	4.51	8.92	6.25	7.29	8.21	12.68	4.72	6.36	3.50	5.54	3.75	5.80	10.04	6.62	9.66	6.92
9.	Canada	8.30	1.37	1.86	3.61	2.00	2.50	6.74	5.30	6.93	6.19	6.19	2.15	4.97	5.39	2.17	4.38
10.	Spain	7.36	4.28	4.17	-2.37	11.09	11.77	9.89	9.47	5.25	6.60	7.38	4.09	6.09	8.90	3.97	6.53
11.	Argentina	1.21	4.55	6.69	-6.12	8.29	4.23	0.33	-3.91	7.77	9.96	-0.50	2.94	4.84	8.34	2.48	3.41
12.	Mexico	6.94	7.76	5.07	2.20	8.44	2.79	4.07	8.84	12.51	5.09	5.90	5.61	8.33	4.32	6.42	6.29
13.	N'lands	6.11	2.02	-4.18	4.69	9.83	0.79	6.11	3.56	8.24	4.84	2.41	5.18	6.33	5.64	5.61	4.48
14.	Australia	0.29	2.14	6.72	5.93	2.25	1.44	6.35	6.90	6.95	2.90	5.73	4.08	8.21	5.46	4.21	4.64
15.	S. Africa	6.04	4.58	1.02	6.00	4.63	8.70	8.32	3.27	2.38	6.27	6.35	3.63	6.82	3.67	4.33	5.07
16.	Belgium	3.10	1.94	-0.86	3.31	5.50	4.98	5.50	4.94	6.79	3.18	3.19	3.81	4.28	6.32	6.08	4.14
17.	Iran	-0.90	6.14	5.46	7.08	9.38	0.49	8.50	5.02	5.96	13.99	6.68	7.17	11.17	9.10	16.89	7.47
18.	P'pines	12.64	-1.23	7.53	8.93	4.00	5.13	5.75	7.66	2.58	5.75	4.18	2.90	3.89	4.20	5.71	5.31
19.	Pakistan	6.23	-0.14	1.88	3.90	0.27	3.83	3.94	9.64	8.63	8.14	6.78	4.99	5.95	2.98	14.72	5.45
20.	S. Korea	4.09	7.21	3.24	1.71	1.22	5.08	2.06	8.74	7.59	4.92	11.68	5.42	10.61	13.28	7.97	6.32
21.	Egypt	3.49	4.09	8.01	2.59	7.47	5.71	0.60	0.50	18.31	4.13	-0.37	3.97	7.32	4.56	4.18	4.97
22.	Thailand	4.68	11.78	1.85	10.20	11.95	5.13	6.80	7.82	6.50	7.91	10.10	7.55	8.12	6.46	11.11	7.86
23.	Taiwan	4.84	7.18	6.49	7.15	6.05	6.83	7.67	8.96	11.76	10.53	8.51	9.92	8.67	8.48	10.65	8.25
	World growth R	3.61	3.03	2.08	4.58	4.76	3.54	5.49	5.48	6.48	5.43	5.41	4.03	6.00	5.90	4.06	4.66
	Volatility $\sqrt{V}$	2.91	2.18	3.55	2.70	3.30	5.49	2.27	2.37	2.58	2.58	2.66	3.04	2.99	3.22	4.14	3.07

Note: All entries are to be divided by 100.

TABLE A2

GROWTH RATES AND VOLATILITY, 1971 - 1990

	Country	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	Mean
1.	USA	3.43	5.46	5.55	-0.72	-0.14	5.50	4.67	5.32	2.90	-0.70	2.42	-1.53	4.83	7.20	4.10	3.37	3.26	3.93	3.40	1.73	3.20
2.	Japan	4.44	8.09	8.08	-1.59	2.71	3.83	4.16	5.32	5.47	2.29	2.85	2.63	1.45	3.02	5.09	2.99	3.77	6.74	5.20	5.13	4.08
3.	Germany	3.36	4.00	4.04	-0.57	-0.73	4.82	3.01	3.03	4.23	0.90	-0.72	-1.22	1.83	2.33	1.72	2.81	1.66	3.62	3.58	5.08	2.34
4.	India	5.06	-0.13	2.62	-1.02	6.70	4.28	5.95	6.97	-0.41	6.96	5.14	4.58	4.06	6.34	6.09	5.25	6.16	6.71	5.09	4.92	4.57
5.	China	9.22	2.90	6.91	1.97	6.59	2.06	5.47	9.42	9.40	5.01	7.89	11.70	7.56	12.93	8.06	14.49	10.60	6.80	2.08	12.82	7.69
6.	France	4.59	4.44	5.46	2.66	-0.57	4.59	2.80	3.20	3.29	1.89	1.25	3.13	1.44	1.39	2.12	2.83	2.33	4.38	3.77	2.72	2.89
7.	UK	2.73	3.22	7.25	-0.82	-0.65	3.20	0.78	3.37	2.75	-1.76	-0.92	1.46	3.64	2.45	3.46	4.06	4.54	5.45	2.35	0.70	2.36
8.	Italy	1.71	3.04	6.50	5.20	-2.47	6.42	2.13	3.50	5.51	3.68	0.56	0.56	1.06	2.78	2.94	2.53	2.96	3.88	2.92	1.98	2.87
9.	Brazil	9.31	10.60	12.20	6.56	6.32	9.87	3.68	3.49	7.09	7.69	-3.42	2.01	-2.75	3.57	9.28	8.04	6.18	0.07	5.47	-5.42	4.99
10.	Canada	5.59	4.77	6.41	2.86	2.31	5.02	3.87	3.59	3.66	1.74	2.70	-3.30	3.36	5.80	4.61	2.68	4.54	4.42	2.78	-0.11	3.36
11.	Mexico	4.59	8.12	7.86	5.77	6.05	4.27	2.97	7.90	8.59	7.80	8.11	-0.60	-4.32	3.46	2.90	-3.68	1.11	0.66	4.25	4.93	4.04
12.	Spain	4.18	8.33	7.84	5.78	0.53	3.57	2.15	1.14	0.51	2.25	-0.23	1.21	1.69	1.69	2.31	3.27	5.46	5.04	4.79	3.73	3.26
13.	Indonesia	8.43	12.70	13.48	3.62	3.41	9.64	8.42	6.83	2.38	3.14	1.87	-3.51	8.80	8.96	0.56	6.45	6.02	9.54	8.55	6.17	6.27
14.	Argentina	3.77	1.67	4.04	5.68	-0.49	-0.80	5.54	-2.32	7.66	2.51	-5.24	-4.36	3.94	2.53	-7.65	7.56	2.46	-2.71	-7.19	-1.39	0.76
15.	Australia	4.28	3.25	4.70	-0.50	2.70	3.98	2.16	4.56	2.68	3.55	4.08	-1.11	4.03	4.07	4.95	2.27	4.73	3.25	3.92	-0.28	3.06
16.	N'lands	3.64	1.93	4.62	3.82	-0.09	4.32	3.10	2.77	1.43	1.33	-2.02	-1.42	1.79	2.72	2.68	3.29	1.75	2.77	4.65	3.89	2.35
17.	S. Arabia	18.62	20.83	26.83	21.86	-0.53	8.84	2.34	1.23	14.80	6.70	5.09	-16.22	-15.52	-3.45	0.69	4.12	-2.45	6.64	0.54	9.58	5.53
18.	Iran	15.36	11.88	11.70	-2.23	-1.38	18.93	-13.20	-2.61	-0.87	-11.07	-13.38	8.97	8.18	8.49	3.55	-9.05	-3.26	-1.80	0.93	14.23	2.17
19.	S. Africa	3.79	5.57	2.91	0.46	6.26	4.85	4.65	1.71	4.38	6.57	1.96	4.28	5.35	2.25	1.23	-0.72	2.55	3.25	4.02	2.61	3.40
20.	S. Korea	8.28	5.00	10.75	8.95	4.73	10.01	9.89	10.66	8.25	-3.48	5.09	7.23	9.99	8.90	6.28	9.58	10.59	10.24	7.43	10.83	7.96
21.	Belgium	3.60	5.07	6.23	4.25	-1.54	5.56	0.79	2.95	2.38	4.16	-0.79	0.50	0.09	2.62	1.56	1.89	2.41	4.99	3.60	3.28	2.68
22.	P'pines	5.52	6.69	9.49	1.76	7.02	8.73	5.73	3.59	2.56	7.16	5.09	0.32	2.85	-1.70	-6.57	5.71	0.46	6.01	4.81	3.74	3.95
23.	Pakistan	3.33	6.63	2.55	2.14	6.15	3.24	7.12	2.36	8.84	8.97	6.38	7.30	5.86	7.18	5.62	7.11	7.86	6.31	3.44	4.32	5.64
24.	Thailand	8.49	1.97	8.22	5.17	6.03	9.89	9.71	11.63	1.61	6.01	8.14	6.46	1.50	6.79	7.26	4.48	6.48	8.73	10.34	12.86	7.09
25.	Taiwan	12.14	12.68	12.08	0.93	5.00	12.90	9.72	12.76	7.68	6.95	6.10	3.73	8.27	10.19	5.09	11.10	11.76	7.42	8.00	5.21	8.48
26.	Egypt	2.62	5.45	-3.55	3.47	-1.82	13.13	11.45	3.66	7.23	12.96	2.72	5.56	7.04	5.75	5.63	6.30	6.42	3.67	6.71	6.13	5.53
	World growth R	4.55	5.41	6.53	1.26	1.33	5.39	3.78	4.59	4.11	2.04	1.93	0.81	3.00	5.10	4.00	4.19	4.17	4.62	3.85	3.75	3.72
	Volatility $\sqrt{V}$	2.58	3.03	3.23	3.65	2.80	2.74	2.85	2.38	2.71	3.45	3.26	4.15	3.54	3.16	2.62	3.63	2.65	2.25	1.95	3.99	3.03

Note: All entries are to be divided by 100.

TABLE A3

GROWTH RATES AND VOLATILTY, 1991 - 2003

	Country	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Mean
1.	USA	-0.38	3.43	2.93	4.27	2.60	3.88	4.73	4.37	4.52	3.73	0.41	1.34	2.66	2.96
2.	China	8.23	10.96	8.35	15.15	10.71	8.91	10.90	8.26	6.91	8.86	7.42	8.48	7.70	9.29
3.	Japan	3.30	0.81	0.13	0.93	1.94	3.42	1.67	-1.27	-0.27	2.36	0.11	-0.60	1.32	1.06
4.	India	0.22	3.43	3.71	4.03	8.07	5.35	4.57	7.04	10.73	3.53	4.56	5.93	6.38	5.20
5.	Germany	4.52	2.20	-0.83	2.59	1.83	0.86	1.72	2.00	1.97	3.11	1.12	-0.15	-0.18	1.60
6.	Russia	-13.51	-8.76	-3.53	-6.60	-5.11	-6.67	4.72	-2.81	4.52	7.86	7.77	7.58	7.79	-0.52
7.	France	1.00	1.71	-1.48	2.23	2.43	0.89	2.36	3.84	3.44	4.19	1.96	0.97	0.73	1.87
8.	UK	-1.42	0.38	2.46	4.26	2.73	2.85	3.32	3.47	2.98	3.92	2.23	1.86	2.38	2.42
9.	Italy	1.43	0.74	-1.30	2.23	2.96	1.07	2.09	1.91	1.78	2.93	1.66	0.42	0.26	1.40
10.	Brazil	0.91	-0.22	3.20	4.53	0.40	2.39	2.57	0.48	2.12	3.77	0.05	-1.05	4.77	1.84
11.	Indonesia	8.61	7.69	6.33	4.87	5.07	7.35	3.05	-7.65	1.45	6.49	3.03	5.38	5.12	4.37
12.	Canada	-2.67	1.04	2.70	5.29	3.02	1.72	4.91	4.00	5.75	5.33	1.47	3.09	2.23	2.91
13.	Spain	2.51	0.91	-1.16	2.34	2.74	2.37	3.77	4.41	4.60	4.86	3.48	2.62	2.85	2.79
14.	Mexico	4.21	3.51	1.94	4.24	-6.18	4.44	6.27	4.79	3.79	6.30	0.08	0.80	1.50	2.75
15.	S. Korea	9.04	4.90	6.28	8.78	8.34	7.06	3.88	-8.47	10.10	8.12	3.43	6.32	3.08	5.45
16.	Australia	1.07	3.31	3.56	4.45	4.07	3.94	4.37	5.08	4.02	1.87	3.81	3.33	3.84	3.59
17.	Argentina	11.44	11.36	6.00	5.33	-2.39	4.39	7.42	4.00	-1.78	-1.09	-4.71	-10.08	7.26	2.86
18.	Thailand	8.31	8.40	7.27	7.94	6.60	4.67	-0.90	-8.36	4.67	2.49	3.56	4.62	6.51	4.29
19.	N'lands	2.32	1.40	0.51	2.82	3.02	3.13	3.76	4.27	3.96	3.56	1.29	0.00	-0.26	2.29
20.	Iran	7.92	11.08	1.95	7.05	-3.31	3.52	2.20	6.30	3.28	5.04	0.67	6.66	1.72	4.16
21.	Taiwan	7.18	7.09	6.85	7.08	6.26	5.99	6.01	4.23	5.51	5.68	-1.60	3.93	3.28	5.19
22.	Turkey	1.50	5.17	7.53	-5.30	6.35	7.31	6.84	3.12	-3.11	6.18	-6.97	5.59	4.29	2.96
23.	S. Arabia	7.83	4.34	-1.96	2.26	0.79	3.97	1.92	1.49	-2.35	5.04	1.09	-2.00	11.87	2.64
24.	S. Africa	-0.16	-1.91	1.65	1.61	1.57	3.97	2.82	1.44	3.73	4.57	3.17	2.76	2.19	2.11
25.	Pakistan	5.22	2.70	2.45	5.18	4.86	0.51	3.17	3.48	4.26	1.83	1.04	4.37	5.37	3.42
26.	Poland	-1.44	2.23	4.03	4.22	6.36	5.65	6.14	4.36	4.12	3.59	1.31	1.52	3.81	3.53
27.	Egypt	5.85	4.03	2.72	4.35	4.54	10.98	1.98	5.97	6.12	4.52	3.59	3.64	3.40	4.75
28.	P'pines	1.59	1.47	1.75	6.31	1.78	4.29	7.30	-3.73	6.17	12.15	-2.83	1.22	0.81	2.94
29.	Belgium	1.67	1.53	-1.04	3.21	2.39	1.06	3.43	1.97	3.00	3.88	0.91	1.38	0.84	1.86
	World growth R	1.35	2.76	2.30	4.23	3.29	3.74	4.51	3.08	4.24	4.66	2.26	2.92	3.76	3.32
	Volatility $\sqrt{V}$	4.98	4.11	3.06	4.43	3.79	3.12	2.71	3.90	2.91	2.25	2.92	3.39	2.68	3.40

Note: All entries are to be divided by 100.

TABLE A4

SHARES IN THE WORLD ECONOMY, 1956 - 1970

	Country	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	Mean
1.	USA	40.9	40.3	39.4	39.0	38.7	38.0	37.9	37.8	37.4	37.5	37.8	37.5	37.0	36.3	35.1	38.0
2.	UK	9.0	8.8	8.6	8.5	8.4	8.4	8.1	7.9	7.8	7.6	7.4	7.2	7.1	6.9	6.7	7.9
3.	Japan	5.7	5.9	6.1	6.3	6.6	7.2	7.6	7.8	8.1	8.3	8.4	8.9	9.5	10.1	10.8	7.8
4.	France	5.9	6.1	6.2	6.1	6.2	6.3	6.4	6.4	6.4	6.4	6.3	6.3	6.3	6.3	6.3	6.3
5.	India	6.1	6.0	6.1	6.2	6.1	6.2	6.2	6.3	6.4	6.2	5.8	5.7	5.8	6.0	6.1	6.1
6.	Italy	5.1	5.2	5.3	5.4	5.5	5.8	5.9	5.9	5.8	5.6	5.6	5.7	5.8	5.8	5.8	5.6
7.	China	4.3	4.5	4.7	4.8	4.7	4.1	3.6	3.5	3.7	3.9	4.1	4.0	3.6	3.6	3.8	4.1
8.	Brazil	2.6	2.6	2.8	2.9	3.0	3.2	3.3	3.3	3.3	3.2	3.2	3.2	3.3	3.4	3.5	3.1
9.	Canada	3.1	3.1	3.1	3.1	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	2.9	3.0
10.	Spain	2.3	2.3	2.4	2.3	2.3	2.5	2.6	2.8	2.8	2.8	2.8	2.9	2.9	2.9	3.0	2.6
11.	Argentina	2.6	2.6	2.7	2.6	2.5	2.6	2.5	2.3	2.2	2.3	2.3	2.2	2.2	2.2	2.2	2.4
12.	Mexico	1.9	2.0	2.1	2.1	2.1	2.1	2.1	2.1	2.2	2.3	2.3	2.3	2.4	2.4	2.4	2.2
13.	N'lands	1.9	1.9	1.9	1.8	1.9	1.9	1.9	1.8	1.8	1.9	1.8	1.8	1.8	1.8	1.8	1.8
14.	Australia	1.7	1.7	1.7	1.8	1.8	1.7	1.7	1.7	1.8	1.7	1.7	1.7	1.7	1.8	1.8	1.7
15.	S. Africa	1.3	1.3	1.3	1.3	1.3	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
16.	Belgium	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.2
17.	Iran	1.0	1.0	1.0	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.2	1.2	1.3	1.3	1.5	1.1
18.	P'pines	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
19.	Pakistan	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
20.	S. Korea	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.8	0.6
21.	Egypt	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
22.	Thailand	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.5
23.	Taiwan	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.3
	Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	

Note: All entries are to be divided by 100.

TABLE A5

SHARES IN THE WORLD ECONOMY, 1971 - 1990

	Country	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	Mean
1.	USA	30.5	30.3	30.2	29.7	29.2	29.0	29.2	29.4	29.4	28.8	28.5	28.2	28.1	28.7	29.0	28.9	28.6	28.4	28.3	27.9	29.0
2.	Japan	9.9	10.0	10.2	10.2	10.1	10.1	10.0	10.1	10.2	10.3	10.3	10.5	10.5	10.3	10.2	10.2	10.2	10.2	10.4	10.6	10.2
3.	Germany	8.8	8.7	8.5	8.3	8.2	8.1	8.0	7.9	7.9	7.8	7.7	7.5	7.4	7.2	7.1	6.9	6.8	6.7	6.6	6.7	7.6
4.	India	5.4	5.2	5.0	4.9	4.9	5.0	5.1	5.2	5.1	5.1	5.3	5.5	5.7	5.7	5.8	5.9	6.0	6.1	6.2	6.3	5.5
5.	China	3.5	3.6	3.5	3.5	3.6	3.7	3.6	3.8	4.0	4.1	4.3	4.7	5.1	5.4	5.7	6.2	6.7	7.0	7.0	7.3	4.8
6.	France	5.7	5.7	5.6	5.6	5.6	5.5	5.5	5.4	5.3	5.3	5.3	5.3	5.4	5.2	5.1	5.0	4.9	4.9	4.9	4.8	5.3
7.	UK	5.8	5.7	5.7	5.6	5.5	5.4	5.3	5.2	5.1	5.0	4.8	4.7	4.8	4.7	4.7	4.6	4.6	4.7	4.7	4.6	5.1
8.	Italy	5.2	5.0	5.0	5.1	5.1	5.0	5.0	4.9	4.9	5.0	5.0	5.0	4.9	4.8	4.7	4.7	4.6	4.5	4.5	4.4	4.9
9.	Brazil	3.3	3.4	3.6	3.8	4.0	4.2	4.3	4.3	4.3	4.5	4.5	4.4	4.3	4.2	4.3	4.5	4.6	4.5	4.5	4.3	4.2
10.	Canada	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.4	2.6
11.	Mexico	2.2	2.2	2.2	2.3	2.4	2.5	2.4	2.5	2.6	2.7	2.9	2.9	2.8	2.7	2.6	2.5	2.4	2.3	2.3	2.3	2.5
12.	Spain	2.6	2.7	2.7	2.8	2.9	2.8	2.8	2.7	2.6	2.6	2.5	2.5	2.5	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.6
13.	Indonesia	1.3	1.4	1.5	1.6	1.6	1.7	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.9	1.9	1.9	1.9	2.0	2.1	2.2	1.8
14.	Argentina	1.9	1.9	1.8	1.9	1.9	1.8	1.8	1.7	1.7	1.7	1.7	1.6	1.5	1.5	1.4	1.4	1.4	1.3	1.2	1.1	1.6
15.	Australia	1.6	1.5	1.5	1.5	1.5	1.5	1.5	1.4	1.4	1.4	1.5	1.5	1.5	1.5	1.5	1.5	1.4	1.4	1.4	1.4	1.5
16.	N'lands	1.6	1.6	1.6	1.6	1.6	1.6	1.5	1.5	1.5	1.5	1.4	1.4	1.4	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.4
17.	S. Arabia	0.8	1.0	1.1	1.4	1.5	1.5	1.6	1.5	1.6	1.7	1.8	1.7	1.4	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.3
18.	Iran	1.5	1.6	1.7	1.7	1.6	1.7	1.7	1.5	1.4	1.3	1.1	1.1	1.2	1.2	1.2	1.2	1.0	1.0	0.9	1.0	1.3
19.	S. Africa	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.1	1.2
20.	S. Korea	0.7	0.7	0.7	0.8	0.8	0.9	0.9	1.0	1.0	1.0	1.0	1.1	1.1	1.2	1.2	1.3	1.3	1.4	1.5	1.6	1.1
21.	Belgium	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.9
22.	P'pines	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.9
23.	Pakistan	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	0.8
24.	Thailand	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	1.0	0.7
25.	Taiwan	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.8	0.8	0.9	0.9	0.6
26.	Egypt	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.6
	Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	

Note: All entries are to be divided by 100.

TABLE A6

SHARES IN THE WORLD ECONOMY, 1991 - 2003

	Country	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Mean
1.	USA	25.1	24.9	25.1	25.2	25.1	25.0	25.1	25.3	25.5	25.4	25.0	24.6	24.3	25.0
2.	China	7.2	7.8	8.3	9.1	10.0	10.6	11.2	11.9	12.4	12.8	13.4	14.2	14.8	11.1
3.	Japan	9.8	9.8	9.6	9.4	9.2	9.1	8.9	8.6	8.3	8.0	7.8	7.6	7.4	8.7
4.	India	5.8	5.8	5.8	5.9	6.0	6.2	6.2	6.4	6.7	6.9	6.9	7.1	7.3	6.4
5.	Germany	6.3	6.3	6.2	6.1	6.0	5.9	5.7	5.6	5.5	5.4	5.3	5.2	5.0	5.7
6.	Russia	6.2	5.4	5.0	4.6	4.1	3.8	3.6	3.5	3.4	3.4	3.6	3.8	4.0	4.2
7.	France	4.4	4.4	4.3	4.1	4.1	4.0	3.9	3.9	3.9	3.9	3.8	3.8	3.7	4.0
8.	UK	4.1	3.9	3.9	3.9	3.9	3.9	3.8	3.8	3.8	3.8	3.7	3.7	3.7	3.8
9.	Italy	4.0	4.0	3.9	3.8	3.7	3.7	3.6	3.5	3.5	3.4	3.3	3.3	3.2	3.6
10.	Brazil	3.8	3.7	3.7	3.7	3.6	3.5	3.5	3.4	3.3	3.3	3.2	3.1	3.1	3.5
11.	Indonesia	2.1	2.2	2.3	2.4	2.4	2.5	2.5	2.3	2.2	2.2	2.2	2.2	2.3	2.3
12.	Canada	2.2	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1
13.	Spain	2.2	2.2	2.2	2.1	2.1	2.0	2.0	2.0	2.1	2.1	2.1	2.1	2.1	2.1
14.	Mexico	2.1	2.2	2.2	2.2	2.1	2.0	2.0	2.1	2.1	2.1	2.1	2.0	2.0	2.1
15.	S. Korea	1.6	1.6	1.7	1.8	1.8	1.9	1.9	1.8	1.8	1.9	1.9	2.0	2.0	1.8
16.	Australia	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
17.	Argentina	1.0	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.0	0.9	1.1
18.	Thailand	1.0	1.1	1.1	1.2	1.2	1.3	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1
19.	N'lands	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.0	1.1
20.	Iran	1.0	1.0	1.1	1.1	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
21.	Taiwan	0.9	0.9	0.9	1.0	1.0	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.0
22.	Turkey	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.1	1.0	1.0	1.0	0.9	0.9	1.0
23.	S. Arabia	1.0	1.1	1.1	1.0	1.0	1.0	1.0	1.0	0.9	0.9	0.9	0.9	0.9	1.0
24.	S. Africa	1.0	1.0	1.0	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
25.	Pakistan	0.9	0.9	0.9	1.0	1.0	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
26.	Poland	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.8	0.8	0.8
27.	Egypt	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
28.	P'pines	0.8	0.7	0.7	0.7	0.7	0.7	0.8	0.7	0.7	0.8	0.8	0.7	0.7	0.7
29.	Belgium	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.7
	Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	

Note: All entries are to be divided by 100.

TABLE A7

MEMBERSHIP OF COUNTRY GROUPS

Period	Economic groups		Geographic groups					
	OECD	Non-OECD	East Asia	Eastern Europe	Middle East and Africa	N. America and Europe	South America	South Asia
1956-1970	Australia Belgium Canada France Italy Japan Netherlands Spain UK USA	Argentina Brazil China Egypt India Iran Mexico Pakistan Philippines S. Africa S. Korea Taiwan Thailand	China Japan Taiwan Thailand S. Korea		Egypt Iran S. Africa	Belgium Canada France Italy Netherlands Spain UK USA	Argentina Brazil Mexico	Australia India Pakistan Philippines
1971-1990	Germany	Indonesia Saudi Arabia			Saudi Arabia	Germany		Indonesia
1991-2003	Turkey	Poland Russia		Poland Russia Turkey				
No. of countries	12	17	5	3	4	9	3	5

TABLE A8

DEPENDENCE OF REGIONAL GROWTH ON
AUTONOMOUS AND WORLD FACTORS, 1956 - 1970 AND 1971 - 1990

$$\bar{W}_{gt}\left(r_{gt} - R_t\right) = A_g + B_g R_t + E_{gt}$$

(Standard errors in parenthesis)

	Region	1956 – 1970				1971 – 1990			
		Share in world economy $\bar{W}_g \times 100$	Intercept A_g	Slope B_g	Elasticity $1+B_g/\bar{W}_{gt}$	Share in world economy $\bar{W}_g \times 100$	Intercept A_g	Slope B_g	Elasticity $1+B_g/\bar{W}_{gt}$
	A. Economic groups								
1.	OECD	76.03	-0.7896 (0.435)	0.1405 (0.090)	1.18	71.06	-0.7130 (0.161)	0.0766 (0.040)	1.11
2.	Non-OECD	23.97	0.7896 (0.435)	-0.1405 (0.090)	0.41	28.94	0.7130 (0.161)	-0.0766 (0.040)	0.74
	Sum	100.00	0.0000	0.0000		100.00	0.0000	0.0000	
	B. Geographic groups								
3.	NA and Europe	66.47	-1.0562 (0.508)	0.1192 (0.106)	1.18	60.45	-0.7564 (0.188)	0.0849 (0.047)	1.14
4.	East Asia	12.82	0.2889 (0.329)	0.0172 (0.068)	1.13	17.02	0.3948 (0.174)	-0.0166 (0.044)	0.90
5.	East Europe	-				-			
6.	ME and Africa	3.12	0.0906 (0.062)	-0.0102 (0.013)	0.67	4.55	-0.1120 (0.109)	0.0326 (0.027)	1.72
7.	S. America	8.20	0.4532 (0.175)	-0.0782 (0.036)	0.05	9.20	0.1309 (0.149)	-0.0247 (0.038)	0.73
8.	S. Asia	9.39	0.2235 (0.230)	-0.0479 (0.048)	0.49	8.78	0.3427 (0.090)	-0.0762 (0.023)	0.13
	Sum	100.00	0.0000	0.0000		100.00	0.0000	0.0000	

Notes: 1. Shares in world economy are averages over the relevant period.
2. “NA and Europe” denotes North America and Europe; and “ME and Africa” denotes the Middle East and Africa.

TABLE A9

MORE VOLATILITY DECOMPOSITIONS, 1956 - 1970

Region	Total	Component				Share of total		
		Autonomous	World	Interaction	Residual	Autonomous	World	Residual
	λ_{gt}	λ_{gt}^{A}	λ_{gt}^{W}	λ_{gt}^{I}	λ_{gt}^{E}	$\frac{\lambda_{gt}^{A}}{\lambda_{gt}^{A}+\lambda_{gt}^{W}+\lambda_{gt}^{R}}$	$\frac{\lambda_{gt}^{W}}{\lambda_{gt}^{A}+\lambda_{gt}^{W}+\lambda_{gt}^{R}}$	$\frac{\lambda_{gt}^{R}}{\lambda_{gt}^{A}+\lambda_{gt}^{W}+\lambda_{gt}^{R}}$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
A. Economic groups								
OECD	23.97	87.30	60.02	-144.78	21.42	51.74	35.57	12.70
Non-OECD	76.03	276.90	190.37	-459.18	67.95	51.74	35.57	12.70
Sum	100.00	364.20	250.39	-603.96	89.37	-	-	-
Weighted ave.	36.45	132.75	91.27	-220.14	32.58	51.74	35.57	12.70
B. Geographic groups								
NA & Europe	20.07	48.72	13.46	-51.21	9.10	68.35	18.88	12.77
East Asia	50.64	18.90	1.45	10.46	19.83	47.04	3.60	49.36
East Europe	-	-	-	-	-	-	-	-
ME & Africa	4.59	7.63	2.12	-8.04	2.88	60.42	16.78	22.80
S. America	11.52	72.67	46.90	-116.76	8.71	56.65	36.56	6.79
S. Asia	13.19	15.46	15.42	-30.87	13.19	35.08	34.99	29.93
Sum	100.00	163.38	79.33	-196.43	53.71	-	-	-
Weighted ave.	22.16	42.46	14.49	-45.43	10.63	61.29	19.82	18.89

Notes: 1. The weighted averages in the last row use average $\overline{w}_g$ values over the period as weights.

2. "NA & Europe" denotes North America and Europe; and "ME & Africa" denotes the Middle East and Africa.

TABLE A10

MORE VOLATILITY DECOMPOSITIONS, 1971 - 1990

Region	Total	Component				Share of total		
		Autonomous	World	Interaction	Residual	Autonomous	World	Residual
	λ_{gt}	λ_{gt}^{A}	λ_{gt}^{W}	λ_{gt}^{I}	λ_{gt}^{E}	$\frac{\lambda_{gt}^{A}}{\lambda_{gt}^{A}+\lambda_{gt}^{W}+\lambda_{gt}^{R}}$	$\frac{\lambda_{gt}^{W}}{\lambda_{gt}^{A}+\lambda_{gt}^{W}+\lambda_{gt}^{R}}$	$\frac{\lambda_{gt}^{R}}{\lambda_{gt}^{A}+\lambda_{gt}^{W}+\lambda_{gt}^{R}}$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
A. Economic groups								
OECD	29.15	59.78	9.56	-47.81	7.62	77.68	12.42	9.90
Non-OECD	70.85	145.28	23.23	-116.18	18.52	77.68	12.42	9.90
Sum	100.00	265.33	66.49	-265.66	33.83			
Weighted ave.	41.31	109.60	27.47	-109.74	13.97	72.56	18.18	9.25
B. Geographic groups								
NA & Europe	15.05	30.55	5.33	-25.52	4.70	75.29	13.13	11.57
East Asia	35.38	29.56	0.72	-9.24	14.34	66.25	1.62	32.13
East Europe	-	-	-	-	-	-	-	-
ME & Africa	21.01	8.89	10.44	-19.27	20.95	22.08	25.92	52.00
S. America	19.91	6.01	2.97	-8.44	19.38	21.19	10.46	68.35
S. Asia	8.64	43.17	29.56	-71.44	7.36	53.90	36.91	9.19
Sum	100.00	118.18	49.01	-133.91	66.72	-	-	-
Weighted ave.	18.67	28.24	6.69	-24.92	8.66	64.47	13.60	21.93

Notes: 1. The weighted averages in the last row use average $\overline{w}_g$ values over the period as weights.

2. "NA & Europe" denotes North America and Europe; and "ME & Africa" denotes the Middle East and Africa.