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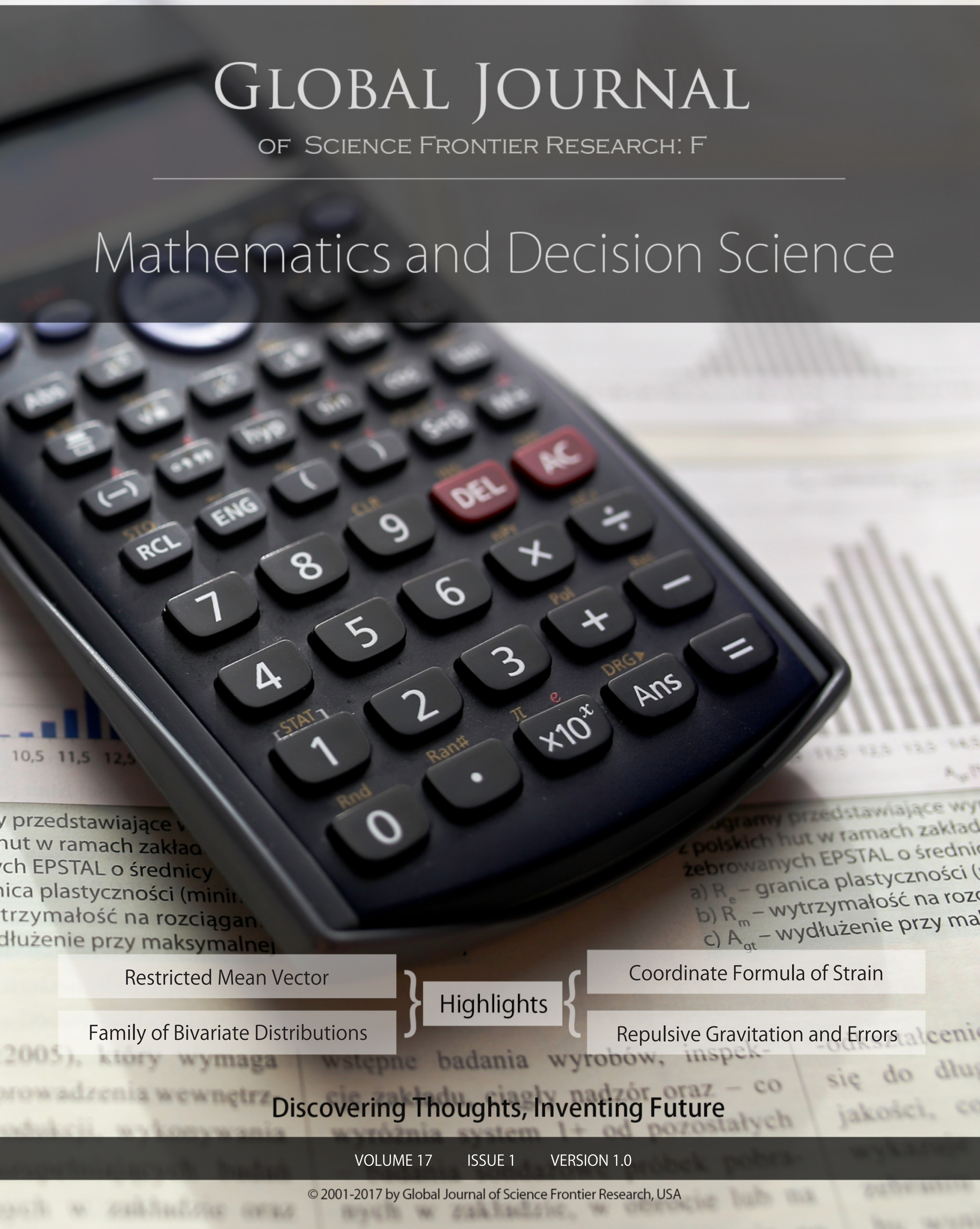

Highlights

- Restricted Mean Vector
- Family of Bivariate Distributions
- Coordinate Formula of Strain
- Repulsive Gravitation and Errors

Discovering Thoughts, Inventing Future

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The Repulsive Gravitation and Errors of Einstein

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Abstract- Einstein rejected repulsive gravitation which Galileo and Newton also over-looked although the repulsive gravitation can be identified if one calculates the static Einstein equation for a charged particle carefully. However, Einstein believed incorrectly the speculation of unconditional validity of $E = mc^2$. Because of inadequacy in pure mathematics, Einstein failed to see that the photons have gravitational energy, and his equation has no dynamic solution and that the coupling constants cannot have unique sign. Otherwise, the Einstein equation is in conflict with the notion of photons and violates the principle of causality. Einstein also failed to see a crucial error, the inconsistency between the Einstein equation and $E = mc^2$. Now, experiments have proven that the gravitational force consists of three components: 1) the mass-mass attractive interaction, 2) the repulsive charge-mass interaction, 3) the current-mass attractive interaction. Thus, Einstein's unification is necessary, and would start another revolution in physics. A main problem in physics is, however, the incompetence of APS in pure mathematics.

Keywords: *repulsive gravitation; $E = mc^2$; charge-mass interaction.*

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THEREPULSIVEGRAVITATIONANDERRORSOFEINSTEIN

Strictly as per the compliance and regulations of :

The Repulsive Gravitation and Errors of Einstein

C. Y. Lo

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I. Introduction

Since the existence of repulsive gravitation was proposed in 1997, it is known that $E = mc^2$ can be invalid [1]. 1) There are several types of experimental supports for this new physics [2-5]. It is interesting that at the earlier stage, I cannot find a physicist to do the experiment that would show Einstein could be wrong because it was generally believed that Einstein cannot be wrong in classical physics [6].

However, such experiments actually have been done because the meanings of these experiments were not understood [4, 5]. They are: 1) the weight reduction of a charged metal ball done by Tsipenyuk and Andreev [7]; 2) The weight reduction of charged capacitor done by scientists from several countries, including the US, Japan, China, etc. [5]; 3) The weight reduction of heated-up metals done by scientists in Russia and China [3, 4]. Note that the weight reduction of a charged capacitor is proportional to the square of the electric potential [5]. Overlooking the repulsive gravitation led to the failure to show the necessary unification of gravitation and electromagnetism.

Moreover, these experiments can be difficult to understand in a four-dimensional theory, and thus they were either not recognized as due to repulsive gravitation or incorrectly regarded as experimental errors because many theorists failed to explain them [6]. I found out these in the American Physical Society meeting in April 2015.

Some believed that the weight reduction is due to a reduction of mass [4]. However, the pendulum made of charged capacitors or heated-up metals would show

Ref

5. C. Y. Lo, Gravitation, Physics, and Technology, Physics Essays, **25** (4), 553-560 (Dec. 2012).

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also the extension of period and this also means a reduction of gravitation, because the related mass has not been changed [8].

A common error of Einstein and his followers is that they failed to see the simple fact that the formula $E = mc^2$ is inconsistent with the Einstein equation, $R_{\mu\nu} - (1/2) g_{\mu\nu}R = - KT_{\mu\nu}$, where $R_{\mu\nu}$ is the Ricci tensor, $R = R_{\alpha\beta}g^{\alpha\beta} = K\ T_{\alpha\beta}g^{\alpha\beta}$, $g_{\mu\nu}$ is the space-time metric, and $T_{\mu\nu}$ is the sum of energy-momentum tensors. Because the electromagnetic energy-momentum tensor is traceless, the electromagnetic energy cannot affect the Ricci curvature R, but the mass can. Thus, mass and the electromagnetic energy cannot be equivalent if the static Einstein equation is valid.

This error is related to Einstein's inadequate notion of photon which is only a quantization of electromagnetic energy [9]. From this basic error, many subsequent mistakes are derived.

II. The Inappropriate Award of 2016 APS Medal for Exceptional Achievements

For instance, the 2016 APS Medal for exceptional achievement in research was inappropriately awarded to Edward Witten of the Institute for Advanced Study. 2) The APS President Samuel Aronson even claimed "Witten's achievements in mathematical physics have had profound effects on many areas of active research. This award sets a very high standard for the prestigious new prize." However, in the 2016 APS award, there is no mention of experimental supports for Witten's achievements. Clearly, this "very high standard" has no experimental basis [10]. Thus, this award is against the standard established by Galileo that such an achievement must be supported by experiments.

Note that Witten [11] adapted Yau's erroneous view [12, 13] based on the false assumption on the existence of bounded dynamic solution for the Einstein equation, and "proved" another version of the misleading theorem on energy. However, because of the mathematicians in charge of the Fields Medal did not understand physics [13], Yau and Witten were awarded the Fields Medal in 1982 and 1990. 3) Consequently, their misleading theorem prevents the progress of general relativity for at least 13 years until 1995 [14] when the non-existence of dynamic solution for Einstein equation is proven [15, 16]. 4) Note that their theorem and the space-time singularity theorems of Hawking and Penrose have the same implicit assumption that are based on the invalid speculation of $E = mc^2$ [17].

The fact is that due to inadequacy in pure mathematics, Witten does not understand Einstein's equivalence principle (see Appendix A), and agrees with the misinterpretation of Wheeler [18, 19]. Witten also incorrectly believed that linearization of the Einstein equation always produces an approximate solution for the Einstein equation. However, for the dynamic case, the Einstein equation and its "linearization" actually are independent equations [20]. In addition, the invalid dynamic Einstein equation was derived again from the current string theory.

In short, the physicists made errors because they do not understand mathematics, and on the other hand the mathematicians proved misleading theorems because they do not understand physics. These combinations of errors of mathematicians and physicists reinforced each other, and formed part of the basis of general relativity [6]. 5)

III. The Repulsive Gravitation and Invalidity of $E = MC^2$

The discovery of the repulsive gravitation is due to the need to investigate $E = mc^2$ for the electromagnetic energy. In fact, the theoretical existence of the repulsive

Ref

8. C. Y. Lo, Could Galileo Be Wrong?, Phys. Essays, **24** (4), 477-482 (2011).

gravitation actually comes from a solution of the static Einstein equation for a particle Q with charge q and mass M, the Reissner-Nordstrom metric [18] as follows:

$$ds^2 = \left(1 - \frac{2M}{r} + \frac{q^2}{r^2}\right) dt^2 - \left(1 - \frac{2M}{r} + \frac{q^2}{r^2}\right)^{-1} dr^2 - r^2 d\Omega^2, \qquad (1)$$

(with c = 1) where q and M are the charge and mass of a particle, and r is the radial distance (in terms of the Euclidean-like structure [21]) from the particle center. In metric (1), the gravitational components generated by electricity have not only a very different radial coordinate dependence but also a different sign.

However, owing to the belief that the electric energy had a mass equivalence, theorists including Nobel Laureate t' Hooft [22], consider incorrectly that the mass *M* would include the electric energy, i.e.

$$M = m(r_0) + q^2/r_0 \qquad (2)$$

where $m(r_0)$ is the mass of the particle and q^2/r_0 is the electric energy of the particle outside the radius r_0 of the particle. [6)] Thus, in the net effect, there would be no repulsive gravitation since

$$\frac{1}{2}\frac{\partial}{\partial r}\left(1 - \frac{2M}{r} + \frac{q^2}{r^2}\right) = (M - \frac{q^2}{r})\frac{1}{r^2} = \left(m(r_0) + q^2(\frac{1}{r_0} - \frac{1}{r})\right)\frac{1}{r^2} > 0. \qquad (3)$$

Nevertheless, Tsipenyuk & Andreev [7] observed a weight reduction of a charged metal ball. [7)] Thus, the existence of repulsive gravitation is confirmed by experiments. This mistake in eq. (2) [2] is that the effect of the electric energy has been incorrectly counted twice in the Reissner-Nordstrom metric.

The crucial point is, as shown in metric (1), that the charge would create a repulsive gravitational force, which is: 1) proportional to the square of the particle charge and 2) diminished as $1/r^3$. These two characteristics are supported by the repulsive gravitational force generated by a charge capacitor [5].

The data of a charged capacitor shows that the repulsive gravitational force is proportional to V^2, where V the electric potential difference of the capacitor [5] (Q = VC, where Q is the charge, and C is the capacity). Also, the capacitor lifter would hover on earth [23, 24] shows that the repulsive force must diminish faster than $1/r^2$. [8)] Moreover, the time delay of weight recovery for a discharged capacitor shows that the heat would also reduce gravitation [3].

IV. The Attractive Current-Mass Interaction

While the electric energy leads to a repulsive force from a charge to a mass, the magnetic energy would lead to an attractive force from a current toward a mass [25]. It is also necessary to have the current-mass interaction to cancel out the charge-mass interaction. After a capacitor is charged, the only changes are that the motion of some electrons has become static. Thus, the attractive current-mass interaction is necessary to explain such a weight reduction [24].

Moreover, the existence of such a current-mass attractive force has been verified by Martin Tajmar and Clovis de Matos [26]. It is found that a spinning ring of superconducting material increases its weight much more than expected. According to quantum theory, spinning super-conductors should produce a weak magnetic field. Thus, they are measuring also the interaction between an electric current and the earth. This interaction would generate a force perpendicular to the current, and such interaction could be identified as the cause for the anomaly of flybys.

Ref

21. C. Y. Lo, Chinese J. of Phys., **41** (4), 233-343 (August 2003).

However, we are not yet ready to derive this current-mass force explicitly. This force would be beyond general relativity since a current-mass interaction would involve the acceleration of a charge that would generate electromagnetic radiation. Then, the variable of the fifth dimension must be considered [27]. This general force is related to the static charge-mass repulsive force similar to the Lorentz force is related to the Coulomb force (see Appendix B).

Nevertheless, we may assume [24] that the force on a charged capacitor is the interaction of net macroscopic charges with the mass. This current-mass interaction also explains the phenomenon that it takes time for a discharged capacitor to recover its weight. A discharged capacitor needs time to dissipate the heat that the motion of its charges would recover to normal. This was observed by Liu because his rolled-up capacitors keep heat better [5].

Thus, there are three factors that determine the weight of matter. They are; 1) the mass of the matter; 2) the charge-mass repulsive force; and 3) the attractive current-mass force. [9)] For a piece of a heated-up metal, the current-mass attractive force due to orbital electrons is reduced, but the charge-mass repulsive force would increase. Therefore, a net result is a reduction of weight [3] instead of increased weight as Einstein predicted [28].

V. The Torsion Balance Scale and Measurement of Repulsive Gravitation

Thus, measuring the temperature dependence of gravitation would show the existence of repulsive gravitation. Therefore, the experiment used the torsion balance scale to measure gravitation of metal balls provides, by far, the simplest verification of the repulsive gravitation without other complications such as the electric forces. The Torsion Balance Scale consists of four balls. The smaller two balls m are connected with a T bar shown in Figure 1. The T bar is attached with a mirror and hangs on a string which provides the torsion. The two large balls M are fixed and the centers of the balls are in the same plane. The torsion force is observed by a laser bean light spot. The relative distances among the balls are shown in Figure 2.

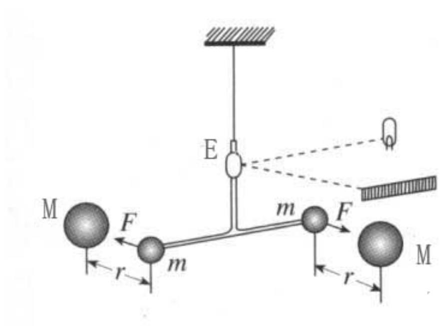

Figure 1: The torsion balance scale

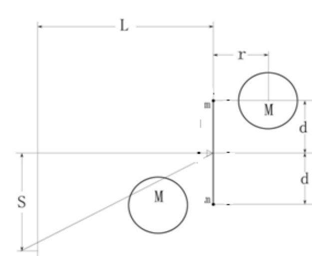

Figure 2: Details of the distances

1. The small brass ball has a mass m = 0.575kg and the large lead ball has a mass M = 1.5kg.
2. The two brass balls are connected with a bar of 2d = 0.40 meter, and suspended from the middle in a horizon orientation by a fine wire ("torsion balance") as shown in Fig. 1 and Fig. 2.
3. A mirror E is attached to the bar to reflect a light beam shined in the mirror.
4. A white board is placed at distance L = 10.3 meter from the mirror as shown in Figure 2.

Ref

28. A. Einstein, 'E = mc²' (Science Illustrated 1946) in *Ideas and Opinions* (Crown, New York, 1954).

5. A light spot is shown in the board at a distance S from the middle (the moving distance of the light spot).
6. The distance between the center of the brass ball and the lead ball is r as shown in Figure 2.
7. The natural period of the torsion balance is T, which depends on the string.

Then, according to Newtonian law, the gravitational force is $F = \pi^2 mdS/T^2L$.[10)] Thus, the torsion balance can be very sensitive since the sensitivity will increase with the distance L. At room temperature, the experiment shows that the gravitation decreases as the temperature of the balls increases, but gravitation increases as the temperature reduces. Thus, the existence of repulsive gravitation is clear. However, a short coming of this experiment is that since such a dependence on temperature was not clear, one might over-look the current - mass interaction.

I saw this experiment in a vacuum can in China in 2015 [29] and decided to design a similar experiment without the vacuum can. The experiments done in cooperation with Austin Napier [30] are also successful in showing the existence of repulsive gravitation. Thus, Einstein is clearly wrong in rejecting repulsive gravitation.

VI. The Question of the Photons and the Gravitational Waves

One may argue the equivalent between electromagnetic energy and mass with that the experiment shows that the pi-meson π_0 decays into two photons. However, this only means that the photons include the gravitational wave energy as general relativity requires [31, 32], i.e., the Einstein equation is modified into

$$G_{\mu\nu} \equiv R_{\mu\nu} - (1/2)\, g_{\mu\nu}R = - K[T(E)_{\mu\nu} - T(p)_{\mu\nu}], \tag{4}$$

where $T(E)_{ab}$ and $T(P)_{ab}$ are the energy-stress tensors for the electromagnetic wave and the related photons. Thus, we have that the photonic energy includes the energy from its gravitational wave component.

However, Einstein [33] believed incorrectly that for this case a valid solution could be obtained by the Einstein equation although he has never tried to obtain the gravity generated by an electromagnetic wave. Because such gravitation is very weak in physics, many journals such as the Chinese Physics B [11)] claimed that it could be obtained by perturbation. This is due to an inability to distinct the difference between mathematics and physics. Mathematically, a necessary condition for the application of a perturbation approach is the existence of a bounded solution. However, the evidence is the contrary [31, 32]. Thus, clearly Einstein does not fully understand general relativity.

Then, I proved in 1995 [15, 16] that, if the coupling constants of the Einstein equation have the same sign, the Einstein equation would have no dynamic solution as Gullstrand, Chairman (1922-1929) of the Nobel Committee for Physics suspected [34]. Thus, the space-time singularity theorems of Hawking and Penrose are irrelevant to physics because their assumptions are invalid in physics [17].

It turns out also the claim of Christodoulou and Klainerman [35] on their construction of dynamic solutions is also due to elementary mathematical errors [36] that they overlooked the need to prove the set of dynamic solutions is non-empty. Although Christodoulou got his Ph. D. degree from Princeton University, it should be noted that his thesis adviser is J. A. Wheeler, who has been known to make crucial mathematical errors at the undergraduate level [19] in their well-known book "Gravitation". [12)]

To have a dynamic solution, it is necessary to add an additional gravitational energy-stress tensor $t(g)_{\mu\nu}$ with an anti-gravitational coupling to the Einstein equation [16], i.e.,

Ref

30. A. Napier and C. Y. Lo, Measurements of the temperature dependence of gravitation, to be published.

$$G_{\mu\nu} \equiv R_{\mu\nu} - \frac{1}{2} g_{\mu\nu}R = - K[T_{\mu\nu} - t(g)_{\mu\nu}], \quad (5)$$

which is the Lorentz-Levi-Einstein equation because it was first proposed by Lorentz [37] and later by Levi-Civita [38]. It is eq. (5), but not the Einstein equation, $R_{\mu\nu} - (1/2)\, g_{\mu\nu} R = - KT_{\mu\nu}$, that is consistent with the linearized equation for the massive case [20]. [13)] However, Einstein [39] objected to eq. (5) on the ground that $t(g)_{\mu\nu}$ is zero in his equation. Einstein was wrong since his equation is proven invalid for the dynamic case. A remaining problem is that the exact form of $t(g)_{\mu\nu}$ is still not known [6].

For the non-existence of dynamic solutions, Professor P. Morrison of MIT went to Princeton University to ask Professor J. A. Taylor, a Nobel Laureate for his work on gravitational radiation, about the justification of their calculation on gravitational radiation. However, Taylor failed to give a justification. Therefore, Morrison advised me to write a book on this, but I believe that this problem should not be addressed alone then [40]. Now, clearly Einstein's theory has at least three serious mistakes that failed his unification [6].

VII. The Unification of Gravitation and Electromagnetism

Note that currently many theorists believed Einstein's conjecture of unification of gravitation and electromagnetism is not valid because they also failed to show this. The reason is that Einstein and his followers do not understand that the unification requires new interactions as Maxwell demonstrated. Moreover, due to not understanding non-linear mathematics, they have accumulated errors in mathematics and physics [40, 41]. In particular, the string theorists such as Witten have further confirmed errors in general relativity since the invalid dynamic equation was derived again [14]. The charge-mass interaction, however, provides a necessary new interaction for this unification.

a) *The Charge-Mass Repulsive Force and Unification*

The existence of the repulsive gravitation in the Reissner-Nordstrom metric makes clear that general relativity is incomplete. To show the static repulsive effect of a charged particle, one needs to consider only g_{tt} in metric (1).
According to Einstein [42], the equation of motion is

$$\frac{d^2x^\mu}{ds^2} + \Gamma^\mu{}_{\alpha\beta}\frac{dx^\mu}{ds}\frac{dx^\nu}{ds} = 0, \quad \text{where} \quad \Gamma^\mu{}_{\alpha\beta} = (\partial_\alpha g_{\nu\beta} + \partial_\beta g_{\nu\alpha} - \partial_\nu g_{\alpha\beta})g^{\mu\nu}/2 \quad (6)$$

where $ds^2 = g_{\mu\nu}dx^\mu dx^\nu$.

Let us consider the static case. (One need not worry whether the gauge is physically valid because the gauge affects only the second order approximation of $g_{t\,t}$ [43].) For a test particle P with mass m at $\mathbf{r}$, the force on P is

$$(-m\frac{M}{r^2} + m\frac{q^2}{r^3})\,\hat{r} \qquad \text{where } \hat{r} \text{ is a unit vector} \quad (7)$$

in the first order approximation because $g^{r\,r} \cong -1$. Thus, the second term is a repulsive force.

If the particles are at rest, then the force generated by p acting on the charged particle Q would be

$$(m\frac{M}{r^2} - m\frac{q^2}{r^3})\,\hat{r}, \qquad \text{where } \hat{r} \text{ is a unit vector}, \quad (8)$$

Ref

38. T. Levi-Civita, R. C. Accad Lincei (5), vol. 26, p. 381 (1917).

because the action and reaction forces are equal and in the opposite directions. However, for the motion of particle Q, if one calculates the metric according to the particle P of mass m, only the first term is obtained.

Thus, it is necessary to have a repulsive force with the coupling q^2 to the charged particle Q in a gravitational field generated by masses. It thus follows that, force (8) to particle Q is beyond current theoretical framework of gravitation + electromagnetism. As predicted by Lo, Goldstein, & Napier [27], general relativity leads to a realization of its inadequacy, just as electricity and magnetism lead to the exposition of their shortcomings.

The charge-mass repulsive force mq^2/r^3 for two point-like particles is inversely proportional to the cube power of the distances between the two particles. Thus, it diminishes faster than the attractive gravitational force. Moreover, this force is proportional to the square of the charge q, and thus is independent of the charge sign. Such characteristics would make the repulsive effects verifiable [24].

The term of repulsive force in metric (1) comes from the electric energy [2]. An immediate question would be whether such a charge-mass repulsive force mq^2/r^3 is subjected to electromagnetic screening. It is conjectured that this force, being independent of a charge sign, should not be subjected to such a screening. Moreover, from the viewpoint of physics, this force can be considered as a result of a field created by the mass m and the field interacts with the q^2. Thus such a field is independent of the electromagnetic field.

b) Extension of Einstein's Equivalence Principle and the Five-Dimensional Relativity

If we consider the need for coupling with q^2, this naturally leads to a five-dimensional space [27]. To maintain the theory, i.e., reproducing the Einstein equation and the Maxwell equation, Kaluza [44] proposed his cylindrical condition to reduce the five variables to four. Subsequently, Einstein and Pauli [45] wrote a paper to continue the work of Kaluza. However, their five-dimensional relativity does not have the coupling with the square of a charge since the "extra" metric elements other than those relating to the electromagnetic potentials, are neglected [27].

In the theory of Lo et al. [27], the fifth dimension is assumed as part of the physical reality, They denote the fifth axis as the w-axis (w stands for "wunderbar", in memorial of Kaluza), and thus the coordinates are (t, w, x, y, z). Our approach is to find out the full physical meaning of the w-axis as our understanding gets deeper. Currently, the meaning of the fifth dimension is given by the equation,

$$dx^5/d\tau = q/Mc^2\kappa \tag{9a}$$

where M and q are respectively the mass and charge of a test particle, and κ is a constant.

For a static case, we have the forces on the charged particle Q in the ρ-direction

$$-\frac{mM}{\rho^2} \approx \frac{Mc^2}{2}\frac{\partial g_{tt}}{\partial \rho}\frac{dct}{d\tau}\frac{dct}{d\tau}g^{\rho\rho}, \qquad \text{and} \qquad \frac{mq^2}{\rho^3} \approx -\Gamma_{\rho,55}\frac{1}{\kappa^2}\frac{q^2}{Mc^2}\, g^{\rho\rho} \tag{9b}$$

and

$$\Gamma_{k,55}\frac{q}{\kappa Mc^2}\frac{dx^k}{d\tau} = 0, \qquad \text{where} \qquad \Gamma_{k,55} \equiv \frac{\partial g_{k5}}{\partial x^5} - \frac{1}{2}\frac{\partial g_{55}}{\partial x^k} = -\frac{1}{2}\frac{\partial g_{55}}{\partial x^k} \tag{9c}$$

in the $(-r)$-direction. The meaning of (9c) is the energy momentum conservation. It is interesting that the same force would come from a different type of metric element depending on the test particle used. Thus,

Ref

45. A. Einstein & W. Pauli, Ann. Math. **44**, 133 (1943).

$$g_{tt} = 1 - \frac{2m}{\rho c^2}, \qquad \text{and} \qquad g_{55} = \frac{mMc^2}{\rho^2}\kappa^2 + \text{constant}。 \qquad (10)$$

In other words, g_{55} is a repulsive potential. Because g_{55} depends on M, it is a function of local property, and this is different from the metric element g_{tt} that depends on a distant source of mass m.

That the repulsive gravitational potential can be generated from a mass, would explain the fact that a charged capacitor can also have the repulsive force [24], but such a force is absent from the current four-dimensional theory. This is why many theorists would not accept the existence of the repulsive gravitation.

They are so involved in current theoretical considerations that they seem to forget that physics is based on experiments. Thus, Einstein's status as a leading theorist is enhanced because unification is proven necessary.

VIII. Repulsive Gravitation and Astrophysics

Einstein's theory was questioned because of the pioneer anomaly discovered by NASA. [14)] This discovery of the Pioneer anomaly gives strong supports to the $1/r^3$ factor in eq. (19).

The charge-mass interaction is a long-range one, and thus should have some consequences in astrophysics. An example would be the Space-Probe Pioneer Anomaly [46]. Based on the charge-mass repulsive force, it is conjectured that the anomaly would be due to an effective charge-mass repulsive force from the sun,

$$F_{ps} = \frac{P_s m_p}{R^3}, \qquad (11)$$

where P_s is a parameter due to the sun, m_p is the mass of the Space-Probe, and R is the distance from the sun.

However, the charge term is not clear since for the sun we do not know what should correspond to the term q^2. Nevertheless, since such forces act essentially in the same direction, we could use a parameter P_s to represent the collective effect of the charges. The neutral sun has many locally charged particles, and thus P_s is not negligible. If the data fits well with an appropriate parameter P_s, then this is another confirmation of the charge-mass interaction.

Since this force is much smaller than the gravitational force from the sun, in practice the existence of such a repulsive force would result in a very slightly smaller mass M_s for the sun, i.e.

$$F = \frac{M_s m_p}{R^2} - \frac{P_s m_p}{R^3} \qquad (12a)$$

and

$$\frac{M_s m_p}{R_0{}^2} - \frac{P_s m_p}{R_0{}^3} = \frac{M_{ss} m_p}{R_0^2} \qquad (12b)$$

for R_0, which is the distance of the earth from the sun. Then, we have

$$F = \frac{M_{ss} m_p}{R^2} + \frac{P_s m_p}{R^2}\left(\frac{1}{R_0} - \frac{1}{R}\right). \qquad (12c)$$

Thus, there is an additional attractive force for $R > R_0$. This explains the unsolved puzzle of more than 15 years. Note that such a force would not be noticeable from a closed orbit since the variation of the distance from the sun is small.

Ref

46. Charles Q. Choi, NASA Baffled by Unexplained Force Acting on Space Probes, SPACE.com, 3 March 2008.

However, for open orbits of the pioneers, there are great variations. When the distance is very large, the repulsive force becomes negligible, and thus an additional attractive force would appear as the anomaly. Such a force would appear as a constant over a not too long distance. Thus, the force (11) satisfies the overall requirements [47]. Currently, the repulsive force (11) F_{ps} is a candidate that would give a qualitative explanation of the data [48, 49]. 15)

Therefore, there are two forces acting on a planet, one attractive and another repulsive with different strengths and distance dependences. It is possible that these forces would have an effect on the spins of the planets. Another speculation is that such a coupling would supply the energy that heats up planets internally. Current explanations for such heat that causes the explosion of the volcanoes, as being due to radiation decay are not satisfactory since there has been no radioactive material discovered from volcanoes. Thus, a new area for experimental and theoretical development of the charge-mass interaction and higher dimensional unification are opened for physicists to explore. Now, fundamental physics will be more alive again.

IX. Conclusions and Discussions

The bending of light marks the success of general relativity. However, such calculations also lead to discovering problems in general relativity. First, in such calculations, the gravitational effect of an electromagnetic wave is assumed to be negligible. However, there is no bounded solution for such a gravitational effect. Thus, it is necessary to modify the Einstein equation by adding the photonic energy-stress tensor with an anti-gravity coupling [31, 32]. Therefore, the notion of photons is actually a consequence of general relativity. This also solves a problem that the energy of photons can be equivalent to mass [42] although the electromagnetic energy cannot [2].

Moreover, this also means that the implicit assumption of Hawking and Penrose [50] on the unique sign for all the coupling constants is invalid. Since the unique sign was thought to be implied by $E = mc^2$, this formula of Einstein is now questionable. In fact, there are three types of experiments that shows $E = mc^2$ is not valid [3-5]. In particular the electromagnetic energy is not equivalent to mass [31, 32]. Theoretically, $E = mc^2$ is inconsistent with the Einstein equation [6]. Thus, the gravity generated by the electromagnetic energy should be different.

According to calculations of the bending of light, adaptation of the notion of distance in Riemannian is inconsistent [21], but a Euclidean-like theoretical framework is necessary. Thus, regarding the Hubble's redshifts as due to the receding velocities of the stars would be invalid [51], and then there is inadequate evidence for the expanding universe. Second, there is a need to add the gravitational radiation reaction force, which is absent from the geodesic equation [6], and thus gravity is clearly not just the Riemannian geometry.

Moreover, the charge-mass interaction (the fifth force 16)) is discovered, and this implies that the theoretical framework of general relativity must be extended to a five-dimensional relativity of Lo, Goldstein and Napier [27]. Moreover, since a capacitor does not generate repulsive gravitation in a normal situation, it is necessary to have an attractive current-mass interaction to cancel out the repulsive force generated by the charges. 9) Then, the repulsive force from a charged capacitor can be understood, and is definitely not due to experimental errors.

Now, because such a force can be explained in terms of the five-dimensional theory [27], Einstein's conjecture of unification of electromagnetism and gravitation is

Ref

42. A. Einstein, H. A. Lorentz, H. Minkowski, H. Weyl, ***The Principle of Relativity*** (Dover, New York, 1923).

proven necessary and valid. Consequently, new phenomena can be explained and long time errors can be identified.

It was a puzzle that a successful theory could be so difficult to understand. Now, we know that a successful theory may still have some errors. For, instance, a problem is Einstein's adaptation of the length measurement in Riemannian geometry. As Whitehead [52] pointed out, "By identifying the potential mass impetus of a kinematics element with a spatio-temporal measurement Einstein, in my opinion, leaves the whole antecedent theory of measurement in confusion, when it is confronted with the actual conditions of our perceptual knowledge." As Einstein pointed out, "Unthinking respect for authority is the greatest enemy of truth."

The existence of the repulsive gravitation implies that the physical picture provided by Galileo, Newton and Einstein is too simple for the complicated gravitation. Since gravitation is not always attractive to mass, the basic assumption for the simulation of Wheeler [53] that leads to the theory of black holes is not valid. Moreover, Einstein's covariance principle is invalid as Zhou [54] pointed out. In fact, there are explicit examples that illustrate the covariance principle to be invalid have been found [55], and thus Zhou's view is confirmed. [17)]

Due to inadequacy in mathematics, Einstein failed to see that his equation does not have any dynamic solution [15, 16] as Gullstrand, the Chairman (1922-1929) of the Nobel Prize Committee suspected. It is ironic that Einstein's confidence of his general relativity is based on his calculation result on the remaining perihelion of Mercury [56]. Einstein also did not see that linearization of his equation is invalid for the dynamic case [20]. Due to the general inadequacy of mathematics, physicists not only follow Einstein's errors, but also physicists such as Pauli [57], the Wheeler School, and Eric J. Weinberg, [18)] misinterpreted Einstein's equivalence principle to become impossible [19].

Since many physicists are incompetent in pure mathematics, [2)] D. Christodoulou had received many honors for his errors on general relativity [35, 36]. Moreover, errors in mathematics misled the physics community to the wrong direction. In addition, mathematicians who do not understand physics have made the situation worse. Thus, physicists must improve your mathematics that such errors of self-deception will not happen again.

An example is mathematician Roger Penrose. His inadequacy in physics misled him to believe that all the coupling of energy-momentum tensors must have the same sign. Then his talent in mathematic comes up with the space-time singularity theorems without realizing such an assumption is invalid in physics [17]. Worse, his victory over physicist Lifshitz on mathematical arguments had convinced many to believe that he was correct. Apparently, few realized the crucial fact is that the physical assumptions are invalid [17]. Thus, he has never looked for a dynamic solution, but simply believed the invalid claim of Einstein.

Yau [12] did not realize that the assumption of asymptotically flat implies that the solution is a stable solution such as the Schwarzschild and the Kerr solutions, etc. Therefore, Schoen and Yau actually prove a trivial result that the total mass of a stable solution is positive [13]. Since their misleading theorem is responsible for the false confidence on subsequent errors, the International Mathematics Union should rectify her awards to Yau and Witten [14].

Because of inadequacy in nonlinear mathematics, the top research institutes such as Princeton [18, 19], Harvard [12] and the Royal Society (London) [50] are the main sources of current errors [13, 36]. Moreover, because of the blind faith on Einstein, the mistakes are not discovered for a long time [19, 13, 41]. These lead to invalid

Ref

53. K. S. Thorne, *Black Holes and Time Warps* (Norton, New York, 1994).

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speculations and misinterpretations on experiments. However, in sciences errors cannot be covered up forever [10]. 19)

Gravitation was considered as producing only attractive force. The physical picture provided by Galileo, Newton and Einstein is just too simple for the complicated gravitation. As expected, Einstein does not fully understand general relativity. Here we promote a deeper understanding of gravitational phenomena, and in particular Einstein's unification, will find useful applications in various parts of physics, astrophysics in particular [3, 5].

Some physicists [4, 58] have mistaken the weight reduction from the charge-mass interaction as due to a mass reduction. However, this can be clarified by measuring the acceleration [8]. A myth generated by Einstein is that sciences can progress just by some ingenious imaginations without the assistance of experiments. Now, a thorough review in terms of experiments can find out what are invalid and what are needed to be completed. 20)

One may expect that the charge-mass interaction would be important in physics. Not only that it leads to the new repulsive gravitation, but also it would explain the space-probe pioneer anomaly. Moreover, it implies that current quantum theory is not a final theory since the charge-mass interaction is not included in quantum mechanics. This may also show the need of renormalization in Quantum field theories. A lesson to be learned is that experimentally partially supported unconditional $E = mc^2$ and the old notion of photon are actually incomplete.

Appendix A: Mathematical Foundation of Einstein's Equivalence Principle

Pauli's invalid version [57] has been mistaken as Einstein's equivalence principle although Einstein has made clear it is a misinterpretation [59]. In "Gravitation" [18] of Misner et al, there is no reference to Einstein's equivalence principle. Instead, they misleadingly refer to Einstein's invalid 1911 assumption [60] and Pauli's version [57]. In addition, in their Eq. (40.14) Misner et al. [18] even failed to understand the local time of a particle at free fall.

The mathematical theorems [61] related to Einstein's equivalence principle are as follows:

Theorem 1. Given any point P in any Lorentz manifold (whose metric signature is the same as a Minkowski space) there always exist coordinate systems (x^μ) in which $\partial g_{\mu\nu}/\partial x^\lambda = 0$ at P.

Theorem 2. Given any time-like geodesic curve Γ there always exists a coordinate system (the so-called Fermi coordinates) (x^μ) in which $\partial g_{\mu\nu}/\partial x^\lambda = 0$ along Γ.

In these theorems, the local space of a particle is locally constant, but not necessarily Minkowski.

However, after some algebra, a local Minkowski metric exists at any given point and along any time-like geodesic curve Γ. In a uniformly accelerated frame, the local space in a free fall is a Minkowski space according to special relativity. What Einstein added is that such a locally constant metric must be Minkowski. This is the basis of the Einstein-Minkowski condition that Einstein uses to derive the gravitational redshifts [42].

Note that, Pauli's version [57] is a simplified but corrupted version of these theorems as follows:

"For every infinitely small world region (i.e. a world region which is so small that the space- and time-variation of gravity can be neglected in it) there always exists a

Ref

8. C. Y. Lo, Could Galileo Be Wrong?, Phys. Essays, **24** (4), 477-482 (2011).

coordinate system K_0 (X_1, X_2, X_3, X_4) in which gravitation has no influence either in the motion of particles or any physical process."

Pauli regards the equivalence principle as merely the existence of locally constant spaces. Moreover, a local Minkowski space at a point does not mean the existence of local Minkowski spaces at a small world region.

An error is that Pauli extended the removal of uniform gravity to the removal of gravity in a small region. This becomes simply incorrect and even impossible in mathematics, but he does not see the difference because of inadequacy in mathematical analysis. He did not recognize that the removal of gravity in a small region, no matter how small, would be very different from a removal of gravity at one point. Apparently, Pauli [57], Witten [21)], the Wheeler School [18], and the British Encyclopedia did not understand the mathematics of the above theorems [61].

Appendix B: Some Remarks on Characteristics of the Current-Mass Interaction

The current-mass attractive interaction [19, 5] would be related to the velocity of the charge and sinθ where θ is the angle between a current element and the line joining the fixed mass point and current element. This attractive force is maximum when the angle is 90^0, but zero when the angle is 0^0 or 180^0.

Thus, the current-mass interact would be responsible for the weight changes of magnets. For instance, theoretically the weight of a magnetic rod would be maximum when the magnetic rod (in the direction of N-S) is perpendicular, and its weight would be minimum when the magnetic rod is horizontal. Moreover, the weight of a magnet changes when the angle of the magnet to earth changes. In the horizontal position of a magnet, its weight would be smaller than the weight before this piece of metal is magnetized. Thus, magnetism can increase or reduce weight. These can be checked with experiments.

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Endnotes

1. Einstein failed to prove $E = mc^2$ (1905-1909) [62], but his invalid speculation was spread by the media [28].
2. However, theorists such as Witten cannot see even errors of Wheeler [18] at the undergraduate level [19]. This is due to that most physicists do not have adequate training in pure mathematics.
3. Recently, Yau claimed that he can withstand all the attacks because he is a recipient of the Fields Medal. Thus, it is fortunate for Yau that those mathematicians do not understand general relativity.
4. An indirect proof has been given by Hu, Zhang, & Ding [63] that the radiation depends on the approach used.
5. The 1993 Nobel Committee for Physics even abandoned Einstein's equivalence principle [64].

Ref

18. C. W. Misner, K. S. Thorne, & J. A. Wheeler, ***Gravitation*** (W. H. Freeman, San Francisco, 1973).

6. t' Hooft [22] claimed, in violation of special relativity, that the electron inertial mass includes the electric energy.
7. However, when the charge of a ball is large, the repulsive force is observable [7, 65].
8. Many did not recognize that the observed repulsive force toward mass is related to general relativity [5, 23].
9. The current-mass interaction is also crucial for the unification. This interaction shows also [26] that electromagnetic energy does not necessarily lead to a reduction of weight as some believed [4, 58].
10. This formula is only approximately valid because gravity is temperature dependent.
11. The Chinese Physics B is also inadequate in pure mathematics, and thus failed to maintain the independent tradition of Zhou Pei-Yuan [54] and Hu Ning [63]. Instead, it accepted the invalid views advocated by British Encyclopedia. As Mao [66] pointed out, some Chinese have the tendency of believing more in non-Chinese.
12. For those who cannot argue rationally on scientific issues, what can be expected from them on other issues?
13. Their errors were not discovered because most relativists do not understand mathematics adequately. Moreover, without careful examination, many are very happy to see such a difficulty in general relativity was removed.
14. Einstein, nevertheless, discovered that his Einstein equation does not have a gravitational wave solution although the linearized equation does [67]. However, he did not see the root of his errors is due to his unverified speculation that $E = mc^2$ is generally valid [2]. A major problem of Einstein and his followers is that they do not have adequate background in mathematics [15], and consequently also made errors in physics.
15. Some claimed that there is no anomaly on the space-probe since the anomaly can be explained with a model of heat radiation. However, the discoverer of anomaly pointed out that such a model is so flexible that it can fit almost any situation and thus is not meaningful. Moreover, the question of flybys has not been able to explain.
16. Currently, there are four known forces. They are: 1) the gravitational force, 2) the electromagnetic force, 3) the strong force, and 4) the weak force. Thus, the new charge-mass interaction is called the fifth force [5, 68].
17. On the other hand, C. N. Yang incorrectly claimed that the covariance principle is valid because he misunderstood the notion of gauge invariance as Weinberg [69] pointed out.
18. Eric J. Weinberg, editor of Physical Review D, still does not accept the weight reduction of heat-up metal. Moreover, he considered Einstein's equivalence principle and Pauli's version are the same [16]. Weinberg believed [20] that the linearization would always produce an approximate solution for the Einstein equation. He is unable to understand the charge-mass interaction. He also accepts the unbounded solution because of inadequate understanding the principle of causality [15]. Eric J. Weinberg is probably responsible for erroneous papers published in the Physical Review D, because of his inadequacy in both mathematics and physics.
19. Prof. S. Weinberg taught us that general relativity must be understood in terms of physics. This MIT tradition has a long history, starting from Rosen and Einstein's paper of 1937, followed by Yilmaz, advocated by Weisskopf and Morrison, and so on. We believe that experiments will be properly understood at the end.
20. Although some journals disagree with this paper, they will change their mind after understanding the non-linear mathematics and the related experiments.

Ref

22. G. 't Hooft, "A Confrontation with Infinity", Nobel Lecture, December, 1999.

21. Witten was graduated in history, and his understanding of pure mathematics is at most half-baked. Witten has attended the Economic Dept., Applied Mathematics Dept. and Physics Dept. of Princeton University. However, he did not have any formal training in pure mathematics. Due to inadequacy in pure mathematics like many physicists such as Pauli [57], Witten also does not understand Einstein's equivalence principle, and thus agrees with the misinterpretation of Wheeler [18, 19]. He also does not know that the Einstein equation does not have any dynamic solution [15, 16, 70] because he believed incorrectly that linearization of the Einstein equation always produces an approximate solution for the Einstein equation [20]. Thus, he also failed to see that there is no bounded two-body solution in general relativity [71]. Unfortunately, the errors of Witten were over-looked because the non-linear mathematics are new to physicists and the blind faith on Einstein. To rectify this error, I have written a letter on his errors to the International Mathematics Union that issued the Fields Medal [14]. In my opinion, the award of the 2016 APS Medal for exceptional achievement in research to Witten is a good indication on the incompetence in pure mathematics of APS.

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爱因斯坦的一個主要错误是拒絶了加里略和牛顿所错过了的反引力。对一個带电粒子,反引力存在於爱因斯坦静态方程导出的度规中。但是爱因斯坦拒绝了反引力，因为他相信無條件的，但不正確的质能互换公式 $E = mc^2$。此外， 由於数学的不足， 爱因斯坦没有看到，光子也具有引力能， 但爱因斯坦方程却没有动力解。而且，偶合常数不能都是同符号。否则，动力性的爱因斯坦方程便会与光子概念产生矛盾， 而且也违反了因果原理。爱因斯坦另一个基本的错误是没有看到爱因斯坦方程和 $E = mc^2$之间的矛盾。现在，实验证明引力具有三种情况: 1) 质量与质量间的吸引力，2) 电荷与质量间的排斥力，3) 电流与质量间的吸引力。因此，引力与电磁力的统一是必要的， 而且这也将在物理学中产生革新。现在物理学上，一个主要的问题是美国物理学会普遍地不懂纯数学。

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Loss of Fitting and Distance Prediction for Fixed vs Updated ARIMA Models

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Abstract- In many cases, it might be advisable to keep an operational time series model fixed for a given span of time, instead of updating it as a new datum becomes available. One common case, is represented by model–based deseasonalization procedures, whose time series models are updated on a regular basis by National Statistical Offices. In fact, in order to minimize the extent of the revisions and grant a greater stability of the already released figures, the interval in between two updating processes is kept "reasonably" long (e.g. one year). Other cases can be found in many contexts, e.g. in engineering for structural reliability analysis or in all those cases where model re–estimation is not a practical or even a viable options, e.g. due to time constraints or computational issues. Clearly, the inevitable trade–off between a fixed models and its updated counterpart, e.g. in terms of fitting performances, out–of–sample prediction capabilities or dynamics explanation should be always accounted for.

Keywords: ARIMA models, model stability, model fitting, time series distances measure, time series prediction.

GJSFR-F Classification: MSC 2010: 97K80

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Loss of Fitting and Distance Prediction for Fixed vs Updated ARIMA Models

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Abstract- In many cases, it might be advisable to keep an operational time series model fixed for a given span of time, instead of updating it as a new datum becomes available. One common case, is represented by model–based deseasonalization procedures, whose time series models are updated on a regular basis by National Statistical Offices. In fact, in order to minimize the extent of the revisions and grant a greater stability of the already released figures, the interval in between two updating processes is kept "reasonably" long (e.g. one year). Other cases can be found in many contexts, e.g. in engineering for structural reliability analysis or in all those cases where model re–estimation is not a practical or even a viable options, e.g. due to time constraints or computational issues. Clearly, the inevitable trade–off between a fixed models and its updated counterpart, e.g. in terms of fitting performances, out–of–sample prediction capabilities or dynamics explanation should be always accounted for. This paper is devoted at presenting a procedure for the prediction of the loss in terms of fitting ability of a fixed model of the type autoregressive integrated moving average versus its updated version – according to a suitable quadratic cost function – and at giving a quantitative measure of the discrepancy between them. Being the updating frequency customizable, the presented approach can also be employed for simulations purposes, according to the updating intervals, the degree of complexity of the chosen model and the available computing resources. Finally, an empirical experiment involving both computer simulated and macroeconomic time series will be presented and the related outcomes discussed.

Keywords: ARIMA models, model stability, model fitting, time series distances measure, time series prediction.

I. Introduction

There are many reasons which might justify the choice of leaving a time series model – once correctly estimated and tested – unchanged for a certain time span, even when its performances, as expected, tend to deteriorate. The extent to which such a degradation can be considered acceptable, heavily depends on the specificity and the target a given model is built for. Under pre-specified regularity conditions, e.g. in terms of stability in the model's outcomes or of the underlying Data Generating Process (DGP), the benefits of using the same model for a given period of time are mainly related to two important factors: the need of a greater stability of the model outputs and to keep the computational time within "reasonable" limits and within the limits of the available computing resources. As for the first point, its relevance is evident in the case of statistical providers (e.g. national and supernational statistical offices), which constantly check past data for consistency with the most recent official releases. It is not uncommon, in fact, that in the attempt of capturing new features exhibited by the time series at hand (which might have had an irrelevant impact on past data or even

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gone undetected) the model is subjected to too frequent updating procedures involving, for example, the structure of the vector of parameters, the introduction of auxiliary variables (e.g. of the type dummy) or even the inference procedures. However, such interventions can jeopardize the coherence with data already released, validated and, therefore, employed in many type of official and unofficial analysis. This is, for example, the case of the model–based signal extraction techniques, which can be carried out by two widely employed deseasonalization methods, i.e. X-12-ARIMA [1] and TRAMO-SEATS [2]. As it is well known, they might generate, as a inevitable "byproduct", the undesirable phenomenon of the revisions, which is due to the inclusion in the data set of each and every new observation as it becomes available. In more details, at the current end of a time series, it is not possible to use symmetric filters to estimate the trend because of the end point problem. Instead, asymmetric filters are used to produce provisional trend estimates. However, as more data becomes available, it is possible to recalculate the trend using symmetric filters and improve the initial estimates. As expected, the impact of the revisions is more noticeable both in the period immediately preceding the inclusion of the new data and the corresponding period one seasonal lag prior. This problem has attracted a great number of researchers, triggering a still ongoing discussion on the different methods and procedure to deal with it. In particular, the problem has been discussed by[3], [4], [5] and, more recently, in [6]. Many other situations can require the use of a fixed model, e.g. when model's outputs must be provided under strict time limits – leaving not enough room for building and test a new model – or the nature of the Data Generating Process (DGP) under investigation suggests the changes in the model only reflect temporary phenomena, for instances related to outlier of the type temporary change, influential data, survey issues (e.g. unexpected amount of missing data). Another common scenario pertains the assessment of model lack of fitting, in order to monitor the stability of the underlying DGP. In this perspective, valuable insights can be gained in economics, e.g. to detect the changes occurring over time – as well as their starting points – in the case of key variable, such as the industrial production or the inflation indexes. Other important applications are related to on–line monitoring activities, e.g. for safety level assessment of structures – such as bridges, dams, TV towers – under standard as well as abnormal conditions, e.g. of the type of those induced by automotive traffic, temperature changes, wind, distant earthquakes, landslides (for a review of the most used methods the reader is referref to [7] [8]). For example, in [9] the modeling of the vibration signals originating from a bridge has been performed using a model of the class ARIMA, whereas mode-based damage identification techniques have been discussed in [10]. This framework identifies a class of problems of the type "inverse", as their design envisions a "baseline" model, whose structure identification and parameter inference procedures, however, usually inject a not negligible amount of uncertainty in the system under investigation [11]. In order to control for such a source of uncertainty, the input series has been modelled here assuming a DGP of the type autoregressive integrated moving average (ARIMA) [12], which in general can guarantee a good level of robustness and, unlike other methods, does not assume any particular pattern in the historical data. In addition, other being a plausible hypothesis satisfactorily adopted for many real-life phenomena (e.g. in economics, physics or engineering) this class of models enjoys a well established theoretical framework and that many routines are nowadays available free of charge for its efficient estimation. The proposed procedure uses an ad hoc distance function in conjunction with a suitable quadratic loss function and an extrapolation method. In

Ref

1. David F Findley, Brian Monsell, Mark Otto, William Bell, and Marian Pugh. Towards x12 arima. Technical report, mimeo, Bureau of the Census, 1992.

particular, in the Empirical Section two different distance metrics – i.e. the Complexity Invariant and the Normalized Integrated Periodogram distances – and two extrapolation methods – i.e. of the type polynomial regression and double exponential smoothing – will be considered.Clearly, the ARIMA assumption can be easily relaxed and a different type of model used, without changing the structure of the proposed framework, provided that a suitable metric for the estimation of the distance between models is correctly chosen. Consistently, in the empirical section, two model–free distances are applied. The proposed procedure might be also a useful tool for balancing model fitting, prediction performances and stability of the outcomes.

Ref

12. George EP Box, Gwilym M Jenkins, Gregory C Reinsel, and Greta M Ljung. *Time series analysis: forecasting and control.* John Wiley & Sons, 2015.

II. The Method

Throughout the paper, the time series of interest is intended to be a real–valued, uniformly sampled, sequence of data points of length T, denoted as

$$x_t := \{(x_t)_{t \in \mathbb{Z}^+}^{T}\}, \tag{1}$$

whereas its predicted values at horizon h are formalized as follows:

$$x_t(h) = \{(x_t)_{t \in \mathbb{Z}^+}^{T+h}; \qquad h = 1,2,\ldots,H\}. \tag{2}$$

An arbitrary, length $\mathcal{H} \in \mathbb{Z}^+$, windows is chosen as the time span in which a given model structure $M^\bullet$ estimated conditional to the full information available at the time $t-1$, i.e. $M^\bullet(t+h) = |\mathcal{I}_{t-1}$, is kept fixed for $\mathcal{H}$ times until an upper bound $\bar{\mathcal{H}}$ is reached, i.e. $t+1, t+2, \ldots, t+\bar{\mathcal{H}}$. This model is formalized as follows: $M^\circ_{\mathcal{H}}(t+h) = |\mathcal{I}_{t-1-\mathcal{H}} \quad \mathcal{H} = 1,2, \ldots \bar{\mathcal{H}}$.

Consistently, the predicted values obtained by $M^\circ(t+h)$ and $M^\bullet(t+h)$ are respectively denoted by $y^\circ(t+h)$ and $y^\bullet(t+h)$ therefore assuming i.e. $y_t^\bullet \sim ARIMA(p_0, d_0, q_0)$; $\mathcal{H} = 1$ and $y_t^\circ \sim ARIMA(p_0, d_0, q_0)$; $\mathcal{H} = 2,3 \ldots, \bar{\mathcal{H}}$, we will have that $y_t^\bullet(h) \equiv y_t^\circ(h) \Leftarrow \mathcal{H} = 1$ for each horizon considered $h = 1,2, \ldots, H$.

a) The underlying stochastic process and the distance measure adopted

The proposed procedure assumes the input time series (1) to be a realization of a DGP of the class ARIMA. Let x_t be a realization of a real 2^{nd} order stationary DGP, with mean μ. It is said [12] to admit a Autoregressive Moving Average representation of order p and q – i.e. $x_t \sim ARMA(p,q)$, with $(p,q) \in \mathbb{Z}^+$ – if for some constant $\phi_1 \ldots . \phi_p$, $\theta_1 \ldots \theta_q$, it is:

$$\sum_{j=0}^{p} \phi_j (X_{t-j} - \mu) = \sum_{j=0}^{q} \theta_j \alpha_{t-j} \tag{3}$$

Eqn. (3) is valid under the following assumptions: *a)* $\phi_0 = \theta_0 = 1$; *b)* $E\{\alpha(t)|\mathcal{S}_{t-1}\} = 0$; *c)* $E\{\alpha^2(t)|\mathcal{S}_{t-1}\} = \sigma^2$; *d)* $E\alpha^4(t) < \infty$; *e)* $\sum_{j=0}^{p} \phi_j z^j \neq 0$, $\sum_{j=0}^{p} \theta_j z^j \neq 0, |z| \leq 1$, where $\mathcal{S}_t$ denotes the sigma algebra induced by $\{\alpha(j), j \leq t\}$ and $\sum_{j=0}^{p} \phi_j z^j$ and $\sum_{j=0}^{p} \theta_j Z^j$ are assumed not to have common zeros. When needed, x_t can be transformed into a stationary process by differencing it $d \in \mathbb{Z}^+$ times. The order of integration, denoted as $I(d)$, enters formally in the ARIMA scheme, i.e. $x_t \sim ARIMA(p,d,q)$, so that using the back-shift operator L, i.e. $LX_t = X_{t-1}$ (therefore

$L^n X = X_{t-n}$) and the difference operator $\nabla^d X_t = (1-L)^d X_t d = 0,1, \dots D$, the ARIMA model can more synthetically be expressed as

$$\nabla^d (x_t - \mu) = \frac{\theta(L)}{\phi(L)} \alpha_t, \tag{4}$$

with $\phi_p(L) = 1 - \phi_1 L - \phi_2 L^2 - \dots - \phi_p L^p$; $\theta_q(L) = 1 - \theta_1 L - \theta_2 L^2 - \dots - \theta_q L^q$, and difference operator applied d times until stationarity is reached. Here ϕ, θ and α_t are, respectively, the autoregressive and moving average parameters. The term α_t is the white noise sequence with mean $\mu = 0$ and variance $\sigma^2 < \infty$. The estimation of (4) is possible only if the stationary and invertibility conditions are satisfied for both the autoregressive and moving average polynomials respectively, that is when $\phi_p(L)\theta_q(L) = 0$ has roots lying outside the unit circle. On the other hand, here the estimation of the ARIMA order $(\hat{p}, \hat{d}, \hat{q})$, is based on the Akaike Information Criterion (AIC) [13], which is defined as $-2\max\log(L(\widehat{\boldsymbol{\theta}}|y)) + 2K$, with K the model dimension and $(L(\widehat{\boldsymbol{\theta}}|y))$ the log–likelihood function. The related selection strategy adopted, called $MAICE$ (short for Minimum AIC Expectation) [14], is a procedure aimed at extracting, among the set of the candidate models, the order $(\hat{p}, \hat{d}, \hat{q})$ satisfying:

$$(\hat{p}, \hat{d}, \hat{q}) = \arg \min_{p \le p_0, d \le d_0, q \le q_0} AIC(p, d, q). \tag{5}$$

$MAICE$ procedure requires the definition of an upper bound for all the AR and MA parameters as well as for the difference operators, as a maximum order a given process can reach. This choice, unfortunately, is a priori and arbitrary. As already pointed out, two distance measures are considered in the present paper: the complexity invariant (CI) and the one based on the normalized integrated periodogram ($NIPER$). They are both model free and measure the distance between two series, say $\mathbf{Y}_t$ and $\mathbf{X_t}$ (1), the former exploiting a corrected version of the Euclidean distance whereas the latter on the basis of a normalized nonparametric spectral estimators.

The CI metric has been recently proposed in [15] and subsequently discussed in [16], as a correction factor of a given distance measure driven by the complexity difference between two time series. In this paper, the Euclidean Distance ED(x,y), between two time series x and y is considered. It is made invariant through the correction factor γ so that the distance is expressed as follows:

$$\delta^{ci}(x, y) = ED(x, y) \times \gamma(x, y).$$

Here, γ is expressed by $\gamma(x, y) = \frac{\max\{\widehat{\mathfrak{C}}(x), \widehat{\mathfrak{C}}(y)\}}{\min\{\widehat{\mathfrak{C}}(x), \widehat{\mathfrak{C}}(y)\}}$, with $\widehat{\mathfrak{C}}$ defining the series' complexity estimation, i.e.

$$\widehat{\mathfrak{C}} = \sqrt{\sum_{t=1}^{T-1} (x_t - x_{t+1})^2}. \tag{6}$$

Following [5], it has to be emphasized how the one formalized in (6) is only one of the possible complexity measures – as many others can be successfully employed – but nevertheless it is particularly suitable for the problem at hand being model–free, $\mathcal{O}(T)$ time complexity and $\mathcal{O}(1)$ space. The other distance measure considered, is the Normalized Cumulated Periodogram Based Dissimilarity which is based on the

Ref

15. Gustavo EAPA Batista, Xiaoyue Wang, and Eamonn J Keogh. A complexity-invariant distance measure for time series. In *SDM*, volume 11, pages 699–710. SIAM, 2011.

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cumulative periodogram of the series and has been proposed by [17]. Given the periodograms of $\mathbf{Y}$ and $\mathbf{X}$, respectively defined as $I_{X_t}(\mu_k) = \frac{1}{T}|\sum_1^T X_t e^{-i\mu t}|^2$ and $I_{Y_t}(\mu_k) = \frac{1}{T}|\sum_1^T Y_t e^{-i\mu t}|^2$, computed at frequencies $\mu_k = \frac{1}{T}2\pi k;\quad k = 1,2,\dots,\frac{T-1}{2}$, the Normalized Cumulated Periodogram Based Dissimilarity takes the form

$$\delta^{per}(\mathbf{Y}_t\mathbf{X_t}) = \int_{-\pi}^{\pi} |F_{X_t}(\mu) - F_{Y_t}(\mu)| d\mu, \tag{7}$$

being $F_{X_t}(\mu_j) = C_{X_T}^{-1}\sum_{i=1}^{j} I_{X_t}(\mu_i)$, $F_{Y_t}(\mu_j) = C_{Y_T}^{-1}\sum_{i=1}^{j} I_{Y_t}(\mu_i)$, with $C_{X_t} = \sum_i I_X(\mu_i)$ and $C_{Y_t} = \sum_i I_Y(\mu_i)$. Following ([9]) the normalized version of (7) has been adopted, as the two functions Fs in all the simulations conducted show a strong tendency to intersect. Finally, the adopted quadratic loss function is the $RMSFE$ (Root Mean Square Forecast Error), computed on the test set Ts. Based on the L_2 −norm, this metric is massively employed in the performance assessment stage of time series methods and, in general, takes the following form:

$$\mathfrak{L}(y_i, \hat{y}_i) = [R^{-1}\sum_{i=1}^{R} |e_i|^2]^{\frac{1}{2}}, \tag{8}$$

with y_i and $\hat{y}_i$ denoting the observed values and the predictions respectively, e their difference and R the sample size.

b) The extrapolation methods

Empirical evidences and the nature of the problem at hand have been led to discarding a pure standard regression scheme to make inferences on the bivariate vector $\mathcal{L}(\cdot)$ and $\delta(\cdot)$. In fact, the stochastic variability in the data plus the inevitable noise components embedded in the system make difficult to find a solid – statistically significant – relation between the two variables. In addition, as it is well known, being simple regression schemes not designed to take into account the correlation structures embedded in the data, memory information would be lost. This is not a negligible hurdle, as we want our estimations to be affected by the entire process' dynamic and possibly to take in greater account the most recent observations. However, in general modeling past data would require a "not small" number of observations available, especially in consideration of the fact that the proposed method uses block of data of length $\bar{\mathcal{H}}$. In order to satisfy these conditions, two different approaches have been considered, i.e. a polynomial regression ($POLY$) and a double exponential smoothing model (DES). An equation of the type $POLY$ tries to model the functional relationship between two variables by employing basis functions of the type $g(x) \in \mathbb{R}^{d_g}$, e.g. $[(1,x)] \xrightarrow{g} [1, x_i, x_i^2, \dots x_i^d]$. Its general expression, being y and x respectively the independent and the dependent variable, takes the form $\mathbb{E}[y] = \beta_0 + \beta_1 x + \cdots + \beta_d x^d$, which in matrix forms becomes $\mathbf{y} = \mathbf{X}a + \mathbf{e}$. In this framework, the problem is in general formalized by considering a model of the form $y_i = a_0 P_0(x_i) + a_1 P_1(x_i) + \cdots a_d P_d(x_i)\varepsilon_i,\quad i = 1,\dots,n$ which is to to be fitted. Notice that the estimation of the term a is done by ordinary least square, i.e. $a = (\mathbf{X}^T\mathbf{X})^{-1}\mathbf{X}^T\mathbf{y}$ which, for a_j take the form $[\hat{a}_j = \frac{\sum_{i=1}^{n} P_j(x_j)y_j}{\sum_{i=1}^{n} P_j^2(x_i)};\quad j = 1,2,\dots,d]$, whose variance is $V(\hat{a}_j) = \frac{\sigma^2}{\sum_{i=1}^{n}}[P_j(x_i)]^2$, being the

Ref

9. James MW Brownjohn. Structural health monitoring of civil infrastructure. *Philosophical Transactions of the Royal Society of London A: Mathematical, Physical and Engineering Sciences*, 365(1851):589–622, 2007.

generic term $P_r(x_i)$ the $r^{th} order$ orthogonal polynomial. This type of regression scheme has been considered here as it might allow meaningful interpretations of the extrapolation mechanism and can work satisfactorily with a (reasonably) small set of data. In addition, its estimation is in general easy given both the availability of fast and reliable routines and by design: in fact, due to the orthogonality of the polynomials involved, no recomputation of $(X^T X)^{-1}$ or of any other $a_j (j \neq k+1)$ is required, so that higher orders polynomial can be introduced at s small cost into the model, e.g. to attempt estimations on a trial and error basis. In this regard, it should be emphasized how the procedure can be easily iterated until a satisfactorily fitting is found. Finally, being technically a special case of multiple linear regression, $POLY$ shares with it the whole, well known, theoretical framework. However, its outcomes can be affected by the non-local nature of the polynomial basis functions, so that the fitted (as well as the extrapolated) values, depend on all the data set, regardless the location in time of the single observations. For the problem at hand, $POLY$ has been employed to model the non-linear relationship $\mathcal{L}(\cdot)$–time and $\delta(\cdot)$–time and the polynomial degree $d = 3$ seemed to yield acceptable predictions. While in $POLY$ the past observations are processed being assigned equal weights, in the second model considered (DES) more recent observations are given higher weights than the older ones, so that the forecast is generated accordingly. In particular, DES is generally represented by the following set of equations:

1. $C_t = \alpha y_t + (1-\alpha)(C_{t-1} + T_{t-1})$
2. $T_t = \beta(C_t - C_{t-1}) + (1-\beta)T_{T-1})$
3. $F_{T+1} = C_t + T_t$,

being: β = trend-smoothing constant, C_t = smoothed constant-process value for period t, T_t = smoothed trend value for period t, F_{t+1}= forecast value for period $t+1$. The use of such an approach is justified by the fact that – as expected – in the empirical experiment always linear memory structures have been always found in the δ and $\mathcal{L}$ sequences. Regarding the parameters estimation procedure, it is based on the minimization of the in sample Mean Square Error. However, a drawback of the DES approach is that in our simulations it has proved to yield more unstable predictions with smaller sample sizes than POLY.

c) The algorithm

Without loss of generality, in what follows it is assumed that:

1. Assumptions:
   (a) $h \equiv H = 1, \ (h, H) \in \mathbb{Z}^+$;
   (b) $\mathcal{H} \equiv \bar{\mathcal{H}} \geq 2, \ (\mathcal{H}, \bar{\mathcal{H}}) \in \mathbb{Z}^+$ (in the empirical experiment it will be set to 4);
   (c) $\frac{T}{\mathcal{H}} = k, \ k \in \mathbb{Z}^+$;
2. Time Series Segmentation:
   (a) the training set $\mathcal{X}_t$, with length N_{tr} , is defined ;
   (b) the test set $\mathcal{Y}_t$ with length N_{ts} , is defined ;
3. Forecast Generation:
   (a) a maximum ARIMA order $(p_0, d_0, q_0, P_0, D_0, Q_0)$, likely to encompass the true model order, is arbitrarily chosen;

Notes

(b) optimal MAICE–wise (5) ARIMA model is fitted to the time series at hand (1) conditioned to Tr, i.e. $M^{\bullet}|\mathcal{I}_{Tr} \equiv M^{\circ}|\mathcal{I}_{Tr}$;

(c) ITERATE (3b) $[Nts - 1]$ times, i.e. every $x_t \forall t = x_{Nts}, \ldots, x_T$ s.t. the OSH predicted values are stored in the vector conditioned to the last available datum is generated, i.e.

$$\mathbf{y}^{\bullet} \equiv (y^{\bullet}_{(Tr+1)}|\mathcal{I}_{Tr}), \quad (y^{\bullet}_{(Tr+2)}|\mathcal{I}_{Tr+1}), \quad \ldots, \quad (y^{\bullet}_{(Ts)}|\mathcal{I}_{Ts-1}); \tag{9}$$

Notes

(d) ITERATE (3b) k times, i.e. every $\bar{\mathcal{H}}$ observations s.t. the OSH predicted values vector y° conditioned to the model fixed every $\bar{\mathcal{H}}$ observations, is generated, i.e.

$$\mathbf{y}^{\circ} \equiv (y^{\circ}_{(Tr+1)}|\mathcal{I}_{Tr}), (y^{\circ}_{(Tr+2)}|\mathcal{I}_{Tr}), \ldots, (y^{\circ}_{(Tr+\bar{\mathcal{H}}-1)}|\mathcal{I}_{Tr}),$$

$$(y^{\circ}_{(Tr+\bar{\mathcal{H}})}|\mathcal{I}_{Tr+\bar{\mathcal{H}}-1}), \ldots, (y^{\circ}_{(Ts-k\bar{\mathcal{H}})}|\mathcal{I}_{Ts-k\bar{\mathcal{H}}-1}), \ldots, (y^{\circ}_{Ts}|\mathcal{I}_{Ts-k\bar{\mathcal{H}}-1}); \tag{10}$$

4. Distance and Loss of Fitting Prediction

(a) The distance measure is sequentially computed on window of length $(\bar{\mathcal{H}})$ of y° and $y^{\bullet}$, i.e. $\delta(y^{\circ}, y^{\bullet})_{Tr+a\bar{\mathcal{H}}}$; $a = 1,2, \ldots k$;

(b) The loss function is sequentially computed on window of length $(\bar{\mathcal{L}})$ of y° and $y^{\bullet}$, i.e. $\mathcal{L}(y^{\circ}, y^{\bullet})_{Tr+a\bar{\mathcal{H}}}$; $a = 1,2, \ldots k$;

(c) Standard polynomial regression–based extrapolation scheme is applied to both the functions $\mathcal{L}(\cdot)$ and $\delta(\cdot)$ for the $Nts + \bar{\mathcal{H}}$ period i.e. $\hat{\mathcal{L}}(\bar{\mathcal{H}}) = \mathbf{P}[\mathcal{L}(y^{\circ}, y^{\bullet})]_{Nts+1,\ldots,Nts+\bar{\mathcal{H}}}$ and $\hat{\delta}(\bar{\mathcal{H}}) = \mathbf{P}[\delta(y^{\circ}, y^{\bullet})]_{Nts+1,\ldots,Nts+\bar{\mathcal{H}}}$;

(d) The related expected values are taken, i.e. $\tilde{\mathcal{L}} = \mathbf{E}[\mathcal{L}(y^{\circ}, y^{\bullet})]_{Nts+1,\ldots,Nts+\bar{\mathcal{H}}}$ and $\tilde{\delta} = \mathbf{E}[\delta(y^{\circ}, y^{\bullet})]_{Nts+1,\ldots,Nts+\bar{\mathcal{H}}}$, i.e. $\hat{\mathcal{L}}(\bar{\mathcal{H}}) = \frac{1}{\bar{\mathcal{H}}}\sum_{j=1}^{\bar{\mathcal{H}}} \mathbf{P}[\mathcal{L}(y^{\circ}, y^{\bullet})]_{Nts+j}$ and $\hat{\delta}(\bar{\mathcal{H}}) = \frac{1}{\bar{\mathcal{H}}}\sum_{j=1}^{\bar{\mathcal{H}}} \mathbf{P}[\mathcal{L}(y^{\circ}, y^{\bullet})]_{Nts+j}$.

d) Empirical Experiment

This section is devoted to the empirical experiment which has been designed and caried outin order to test the validity of the proposed procedure. It consists of two parts: a Monte Carlo experiment, based on computer generated time series and an analysis of four real-life time series, two of the type Macroeconomic and two related to tourism variables. Regarding the Monte Carlo experiment, four different DGPs – whose parametrization is given in Tab.1 along with the codification used for brevity and reported in the column labeled "DGP" – have been employed to generate 1000 realizations (250 realizations for each model), with sample size $t = 300$. The main reason behind the choice of series showing such a limited sample size is that instabilities in the ARIMA parameters are more likely to occur under small sample sizes and therefore greater uncertainty is expected in terms of both $\delta(y^{\circ}, y^{\bullet})$ and $\mathcal{L}(y^{\circ}, y^{\bullet})$. In addition, such a situation is common in economic time series but also in all the cases where only a small set of past data is subjected to investigation, e.g. due to computational reasons. In order to mimic reality, realizations of DGP 1–4 are corrupted with short bursts of noise (iid shocks) in the form of outliers of the type additive (AO). Such a sequence of isolated spikes have been introduced to represent those noticeable departures – consistently found across the empirical experiment – that sporadically might take place in the series $\delta(\cdot)$ and $\mathcal{L}(\cdot)$, as a result of the effect of sudden changes on the models. To do so, $\mathbf{O} = 3$ Additive Outliers have been embedded in the test set $\mathcal{Y}_t$, so that the resulting set up can be formalized as follows:

$$\mathcal{Y}_t^* = \sum_{j=1}^{\mathbf{O}} \xi_j(B)\gamma_j I_t^{(\psi_j)} + \mathcal{Y}_t \,, \tag{11}$$

being $\mathcal{Y}_t^*$ the stretch of data corrupted by the outliers, $\mathcal{Y}_t$ its outlier-free, unobservable, counterpart (3) and γ_j represents the outlier's impact at ψ_j and I_t is a switching variable allowing the system to (not) include the outlier in $t = \psi_j$ when $I = 1(0)$. Training and Test sets' sample sizes have been set respectively at nTs =180 and nTr =120 whereas the outliers have been embedded in the test set at observations $t = Nts/4, Nts/3, Nts/2$. Their values have been kept fixed and set to 6 σ^2, being $\sigma^2 = 1\ \forall\ DGPs$.

Table 1: Parametrization of the simulated DGPs

DGP number	ARIMA order	ϕ	ϕ
DGP1	(0,1,1)	–	-.6
DGP2	(1,1,2)	-.65	.6; -.45
DGP3	(2,0,1)	.7; -.5	-.5
DGP4	(1,0,2)	-.6;	.5; -.4

Table 2: Actual vs predicted distances and loss functions in the simulated time series case: percentage difference

DGP	$\widehat{\mathfrak{L}}_{\%}(y^{\bullet}, y^{\circ})$ Poly	DES	$\widehat{\delta^{CI}}_{\%}(y^{\bullet}, y^{\circ})$ Poly	DES	$\widehat{\delta^{NIPER}}_{\%}(y^{\bullet}, y^{\circ})$ Poly	DES	Ntr	Nts
DGP1	10.2	11.6	10.5	11.9	11.1	12.2	220	80
DGP2	12.4	14.3	10.4	11.2	12.6	10.9	220	80
DGP3	8.0	7.2	9.4	4.7	8	6.3	100	200
DGP4	6.2	5.8	9.5	5.4	8.2	7.5	100	200

Table 3: Actual vs predicted distances and loss functions in the real time series case: percentage difference

DGP	$\widehat{\mathfrak{L}}_{\%}(y^{\bullet}, y^{\circ})$ Poly	DES	$\widehat{\delta^{CI}}_{\%}(y^{\bullet}, y^{\circ})$ Poly	DES	$\widehat{\delta^{NIPER}}_{\%}(y^{\bullet}, y^{\circ})$ Poly	DES	Ntr	Nts
DGP1	15.3	18.9	16.5	19.9	22.1	19.6	300	56
DGP2	15.4	10.1	14.4	12.5	22.6	20.1	300	120
DGP3	8.9	9.5	15.6	7.3	10.7	10.7	219	120
DGP4	9.7	8.6	10.5	6.8	8.7	8.7	219	120

Table 4: Real time series employed in the empirical section: sources and main details

Code	Variable	Source	Seas	Units	Data range (Number of obs)
X1	Housing: mortgage interest payments	Data Set MM23 (San Louis Fed)	No	Index, base 1987 = 100	1987-02 to 2016-09(356)

Notes

X2	Consumer Price Index for All Urban Consumers: All Items	US. Bureau of Labor Statistics	No	Index, base 1984 = 100	1981-10 to 2016-09(420)
X3	OS visits to UK: Earnings: Θ Millions	U.K. Office for National Statistics	YES	Θ Millions	1980-01 to 2016-07 (439)
X4	OS visits to UK: All visits	U.K. Office for National Statistics	YES	Thousands of visitors	1980-01 to 2016-07 (439)

Regarding the second part of the experiment, in Table 4, the four time series employed in the empirical study are detailed along with their conventional name, in the sequel adopted for brevity, stored in the column labeled "Code". Series X1 – X2 are of the type macroeconomic, whereas the remaining ones refer to tourism-related variables. All the time series are characterized by a limited sample sizes (not too far from the one of the computer generated time series), the presence of outliers – e.g. of the type additive, as clearly noticeable in the series X4 (May 2013 2006) and X3 (July 2007) – and, to a different extent, non stationary behaviors. All the series have not been adjusted for seasonality nor corrected for outliers. Finally, the variable "seas" in Table 4 indicates the presence of a significant seasonal component in the series, which has been properly captured by the seasonal parameters of the seasonal version of the ARIMA model.

i. *Experiment's outcomes*

Regarding the Monte Carlo experiment, the mean values of the loss function and the distance metrics have been computed over each set (250 series), i.e. $\hat{\delta}_{mc}(\bar{\mathcal{H}}) = \frac{1}{250}\sum_{1=1}^{250}(\sum_{j=1}^{4}\hat{\delta}(\mathcal{H}_j))$ and $\hat{\mathcal{L}}_{mc}(\bar{\mathcal{H}}) = \frac{1}{250}\sum_{1=1}^{250}(\sum_{j=1}^{4}\hat{\mathcal{L}}(\mathcal{H}_j))$, with $\bar{\mathcal{H}} = 4$ and the subscript "mc" standing for Monte Carlo. In Tables 2 and 3 – where the results of the empirical experiment are reported – the following two indicators are employed to evaluate the usefulness of the proposed procedure, i.e. the Loss function discrepancy percentage change and the the Distance Discrepancy percentage, respectively defined as follows: $\widehat{\mathfrak{L}}_{\%}(y^{\bullet}, y^{\circ}) = 100\frac{\widehat{\mathfrak{L}}_{mc}(\bar{\mathcal{H}})-\mathfrak{L}_{mc}(\bar{\mathcal{H}})}{\widehat{\mathfrak{L}}_{mc}(\bar{\mathcal{H}})}$ and $\hat{\delta}_{\%}(y^{\bullet}, y^{\circ}) = 100\frac{\hat{\delta}_{mc}(\bar{\mathcal{H}})-\delta_{mc}(\bar{\mathcal{H}})}{\hat{\delta}_{mc}(\bar{\mathcal{H}})}$.

The results obtained indicate the interesting prediction capabilities provided by the proposed procedure, which can be considered adequate to gain valuable insights on the discrepancies resulting from the use of a fixed ARIMA model instead of its updated version. With both artificially generated and real time series, the best performances are obtained – under the condition of a test set of "sufficient" length – by using the exponential smoothing extrapolation technique in conjunction with a distance metric of the type CI. On the other hand, less impressive outcomes are obtained with small test sets. In this case the polynomial regression has yielded slightly better outcomes than the exponential smoothing scheme. However, even for small values of Nts, the approach still seems to provide useful information, especially in terms of expected loss function, where the percentage difference under polynomial regression recorded is around 10.2% and 11.6% in the case of the artificial time series DGP1 and DGP2 respectively and slightly higher (15.3%) for the real time series TS1. For larger test sets the DES extrapolation technique does a better job than the regression–based technique: the recorded value for

$\mathcal{L}_{\%}(y^{\bullet}, y^{\circ})$ and $\delta_{\%}^{CI}(y^{\bullet}, y^{\circ})$ is always less than approx 10% and 12.5% respectively. In the set of the real time series, the best performances have been obtained in the case of TS4, where an error of 6.8% and 8.6% have been recorded for the distance CI and the RMSE values respectively, computed via DES equations. Throughout the empirical experiment, the values recorded for δ^{NPER} has been consistently less remarkable results. A possible explanation is related to the sensitivity of the periodogram towards aberrant observations, so that bias components might have been introduced into its estimation as a result.

Notes

III. Conclusion

In this paper, it has been illustrated a procedure for the prediction of the lack of fit and the distance between the outcomes of two models, when one of them is re–estimated at the highest possible frequency (i.e. the sample frequency of the time series under investigation) and the other one is left unchanged for a certain span of time. This technique has been presented using time series models belonging to the class ARIMA, however, such a conditions can be easily relaxed and basically left to be decided on a case-by-case basis. All the simulations have been carried out having in mind a short span of time, set to 4, between two updating processes and the results turned out to be encouraging. In particular, consistency in terms of empirical outcomes has been found across the statistical tools employed and the time series used. Finally, out of the sets of the available extrapolation techniques and distances measures, only two pair of them have been here considered, so that future directions will include the analysis of a larger portfolio of these tools.

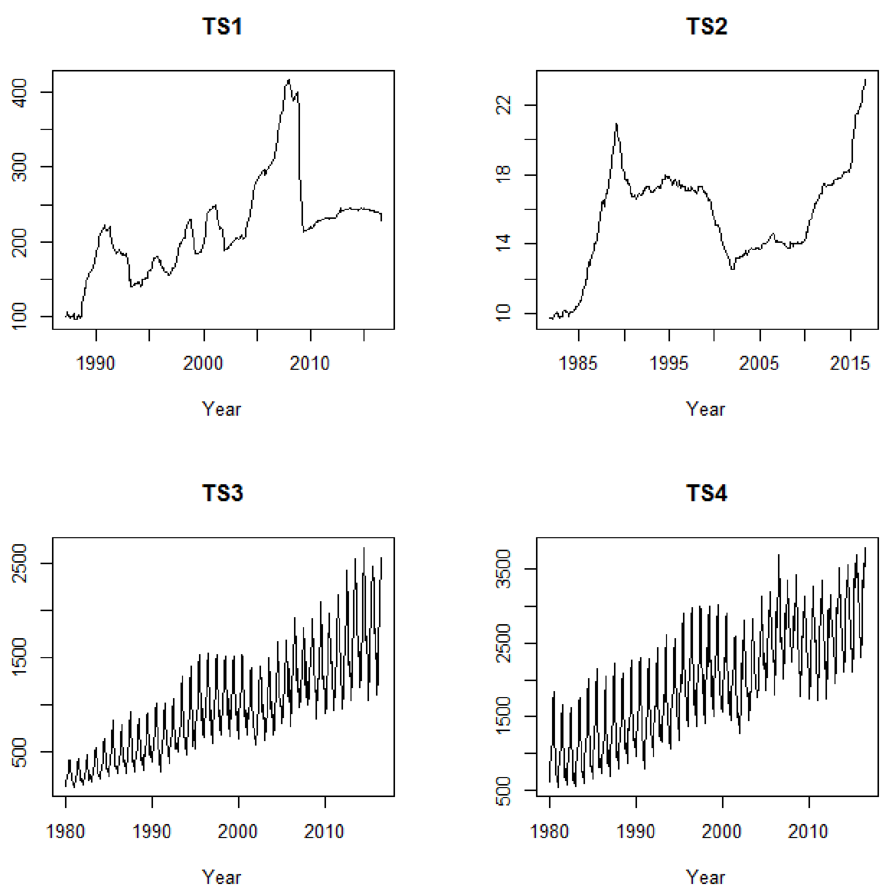

Figure 1: Actual Time Series

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On Characterizing Generalized Cambanis Family of Bivariate Distributions

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GJSFR-F Classification: MSC 2010: 62H10

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On Characterizing Generalized Cambanis Family of Bivariate Distributions

N. Unnikrishnan Nair [α], Johny Scaria [σ] & Sithara Mohan [ρ]

Abstract- In this work we present characterizations of a generalized version of Cambanis family of bivariate distributions. This family contains extensions of the Farlie-Gumbel-Morgenstern system as special cases. The characterizations are by properties of P(X>Y), regression functions and E(XjX > Y) which were found to be useful in many applications.

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I. Introduction

In the present work we consider a generalized version of a family of bivariate distributions specified by an absolutely continuous distribution function of the form

$$F(x,y) = F_X(x)F_Y(y)[1+\alpha_1 A(F_X(x)) + \alpha_2 B(F_Y(y)) + \alpha_3 A(F_X(x))B(F_Y(y))], \quad (1.1)$$

of a random vector (X, Y). The kernels $A(.)$ and $B(.)$ in the model are differentiable over [0,1], satisfies the conditions

$$A(1) = 0 = B(1) \quad \text{and} \quad A(0) = 1 = B(0)$$

and are chosen in such a way that (1.1) is a distribution function with absolutely continuous marginal distributions. The family subsumes several distributions of potential interest in distribution theory as well as in modelling problems associated with other disciplines. These include the extended Farlie-Gumbel-Morgenstern (FGM) system

$$F_1(x,y) = F_X(x)F_Y(y)[1+\alpha_3 A(F_X(x))B(F_Y(y))] \quad (1.2)$$

considered in Bairamov and Kotz (2002) and several particular cases obtained by giving different forms for $A(.)$ and $B(.)$ like the classical FGM when $A(F)$=1-$F_X(x)$ and $B(F)$=1-$F_Y(y)$ and others discussed in Huang and Kotz (1984, 1999), Bairamov et al. (2001), Amblard and Girard (2009) and Carles et al. (2012) and the references therein.

A somewhat different special case of (1.1) is the Cambanis (1977) model specified by

$$\begin{aligned} F_2(x,y) &= F_X(x)F_Y(y)[1+\alpha_1(1-F_X(x)) + \alpha_2(1-F_Y(y)) \\ &+ \alpha_3(1-F_X(x))(1-F_Y(y))], \end{aligned} \quad (1.3)$$

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$-\infty < x, y < \infty$, $(1 + \alpha_1 + \alpha_2 + \alpha_3) \geq 0$, $(1 + \alpha_1 - \alpha_2 - \alpha_3) \geq 0$, $(1 - \alpha_1 + \alpha_2 - \alpha_3) \geq 0$ and $(1 - \alpha_1 - \alpha_2 + \alpha_3) \geq 0$.

The major difference here is that unlike the FGM, the marginals of (1.3) are not $F_X(x)$ and $F_Y(y)$ but they are uniquely determined by $F_X(x)$ and $F_Y(y)$. The distributional aspects, dependence structure and applications of (1.3) are discussed in Nair et al. (2016). Various forms of $A(.)$ and $B(.)$ used to extend the FGM can also be applied in (1.1) to generate new families of bivariate models. In view of the wide variety of distributions generated from (1.1), it is important to study its properties.

The objective of the present work is to attempt characterizations of $F(x,y)$ through properties of $P(X < Y)$, $E(X|X > Y)$ and the regressions functions of (X, Y). The former is well known in stress-strength modelling. When X represents the stress and Y, the strength, $P(X < Y)$ indicates the reliability of the material, while the latter is the average stress at which it exceeds the strength. More details about these aspects are discussed in the next section where the characterizations are considered.

II. Characterizations

First we consider $P(X < Y)$ when (X, Y) follows the distribution (1.1). Apart from the stress-strength interpretation $P(X < Y)$ is suited to other variables in different fields of study such as quality control, genetics, psychology, economics and clinical trial. For details we refer to Kotz et al. (2003).

When bivariate distributions are used to model stress-strength data some sort of dependence is assumed between X and Y. Among various bivariate cases considered in literature in this context, one of particular interest to the present work is Domma and Giordano (2013) in which the FGM copula is considered.

Let $f(x,y)$, $f_X(x)$ and $f_Y(y)$ denote the probability density functions of (X, Y), X and Y respectively. Then

$$\alpha = P(X < Y) = \int_{-\infty}^{\infty} P(X < y|Y = y) f_Y(y) dy$$

$$= \int_{-\infty}^{\infty} \int_{0}^{y} f(\nu, y) d\nu dy. \tag{2.1}$$

Since $P(X < Y)$=$P(F_X(x) < F_Y(y))$, for calculation purposes it is enough to consider the uniform distribution in (1.1),

$$F_4(x, y) = xy[1 + \alpha_1 A(x) + \alpha_2 B(y) + \alpha_3 A(x)B(y)],$$

and the corresponding probability density function

$$f_4(x, y) = 1 + \alpha_1 \frac{d}{dx} xA(x) + \alpha_2 \frac{d}{dy} yB(y) + \alpha_3 \frac{d}{dx} xA(x) \frac{d}{dy} yB(y). \tag{2.2}$$

In that case

$$\alpha = \int_{0}^{1} \int_{0}^{y} f_4(\nu, y) d\nu dy. \tag{2.3}$$

Notes

Following Bairamov and Kotz (2002), we have the first theorem concerning the nature of $P(X<Y)$ in the model (1.1).

Theorem 2.1

Let (X,Y) be a continuous random variable with distribution function (1.1). Then $P(X<Y)$ is independent of α_3 if and only if $A(x){=}B(x)$ for all x in [0,1] provided that

Notes

$$A(x)B^{'}(x)-A^{'}(x)B(x) \ \text{ is } \ \geq 0 \ \text{ or } \ \leq 0 \ \text{ for all } \ x. \tag{2.4}$$

In this case,

$$P(X<Y)=\frac{1}{2}+(\alpha_1-\alpha_2)\int_0^1 xA(x)dx. \tag{2.5}$$

Proof: From (2.2) and (2.3) using $A(1){=}0{=}B(1)$,

$$\begin{aligned}\alpha &= \int_0^1 [y+\alpha_1 yA(y)+\alpha_2 y\frac{d}{dy}yB(y)+\alpha_3 yA(y)\{B(y)+yB^{'}(y)\}]dy \\ &= \frac{1}{2}+\alpha_1\int_0^1 yA(y)dy-\alpha_2\int_0^1 yB(y)dy+\alpha_3\int_0^1\{yA(y)B(y)+y^2A(y)B^{'}(y)\}dy.\end{aligned} \tag{2.6}$$

Since

$$\frac{d}{dy}y^2A(y)B(y)=2yA(y)B(y)+y^2\{A(y)B^{'}(y)+A^{'}(y)B(y)\}$$

(2.6) takes the form,

$$\begin{aligned}\alpha &= \frac{1}{2}+\alpha_1\int_0^1 yA(y)dy-\alpha_2\int_0^1 yB(y)dy+\frac{\alpha_3}{2}\int_0^1\frac{d}{dy}y^2A(y)B(y)dy \\ &+ \frac{\alpha_3}{2}\int_0^1 y^2\{A(y)B^{'}(y)-A^{'}(y)B(y)\}dy.\end{aligned} \tag{2.7}$$

Since α is independent of α_3 and $\int_0^1\frac{d}{dy}y^2A(y)B(y)dy{=}0$, one must have

$$\int_0^1 y^2\{A(y)B^{'}(y)-A^{'}(y)B(y)\}dy=0,$$

which means that $A(y)B^{'}(y){-}A^{'}(y)B(y){=}0$ by virtue of (2.4). Hence $A(y){=}C\ B(y)$ in which $C{=}1$ from $A(0){=}B(0){=}1$. Thus $A(x)=B(x)$ and (2.5) holds. Conversely if $A(x)=B(x)$, (2.7) shows that α does not contain α_3.

Remark 2.1

For the theorem to be true, the representation (1.1) must yield a distribution function for some $A(.)$ and $B(.)$. In the case of the Cambanis family (1.3), $A(x)=1-x$, $B(y)=1-y$ so that we have a distribution function belonging to (1.1) satisfying (2.4). Further, $A(x)=B(x)$ and so

$$\begin{aligned} P(X<Y) &= \frac{1}{2} + (\alpha_1 - \alpha_2)\int_0^1 x(1-x)dx \\ &= \frac{1}{2} + \frac{\alpha_1 - \alpha_2}{6}. \end{aligned}$$

Remark 2.2

When α_3=0, the conditions on the parameters α_1 and α_2 are satisfied by a convex set containing $|\alpha_i| \leq \frac{1}{3}$, i=2. Thus $P(X<Y)$ lies in the range $(\frac{7}{18}, \frac{11}{18})$ which is more flexible than that of FGM for which $P(X<Y) = \frac{1}{2}$. The flexibility can be further increased with other choices of $A(x)$, for example $A(x) = 1-x^2 = B(x)$ as in the Huang-Kotz modification.

From Theorem 2.1, a modification of Theorem in Bairamov and Kotz (2002) is evident.

Theorem 2.2

Let *(X, Y)* be a continuous random vector with distribution function (1.1) with α_1=α_2. Then $P(X<Y) = \frac{1}{2}$ if and only if $A(x) = B(x)$ for all x, provided that (2.4) is satisfied.

Our second characterization is based on the conditional expectations $E(X|X>Y)$ and $E(Y|Y>X)$. In a reliability frame work these have interpretations and applications. Suppose that *(X, Y)* represents the lifetimes of a two-component system. Then $E(X|X>Y)$ and $E(Y|Y>X)$ denotes the average lifetime of the longest living component and is an important information about the system. The probability density function of X given $X>Y$ is

$$f(x|X>Y) = \frac{1}{P(X>Y)}\int_{-\infty}^{x} f(x,\nu)d\nu$$

and hence

$$P(X>Y) \;\; E(X|X>Y) = \int_{-\infty}^{\infty}\int_{-\infty}^{x} xf(x,\nu)d\nu dx.$$

Specializing to the uniform case

$$P(X>Y) \;\; E(X|X>Y) = \int_0^1\int_0^x xf_4(x,\nu)d\nu dx. \tag{2.8}$$

Similarly

$$P(Y>X) \;\; E(Y|Y>X) = \int_0^1\int_0^y yf_4(\nu,y)d\nu dy. \tag{2.9}$$

Theorem 2.3

Let *(X, Y)* be a random vector specified by $f_4(x,y)$ satisfying $A(1) = 0 = B(1)$ and $A(0) = 1 = B(0)$. Then $P(X>Y)$ $E(X|X>Y)$ - $P(Y>X)$ $E(Y|Y>X)$ is independent of α_3 if and only if $A(x) = B(x)$ for all x provided that (2.4) is satisfied.

Proof: From equations (2.8) and (2.2),

$$P(X>Y)E(X|X>Y) = \int_0^1\int_0^x x[1+\alpha_1\frac{d}{dx}xA(x)+\alpha_2\frac{d}{d\nu}\nu B(\nu)+\alpha_3\frac{d}{dx}xA(x)\frac{d}{d\nu}\nu B(\nu)]d\nu dx$$

Notes

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Notes

$$= \int_0^1 x[x+\alpha_1 x\frac{d}{dx}xA(x)+\alpha_2 xB(x)+\alpha_3(\frac{d}{dx}xA(x))(xB(x))]dx$$

$$= \frac{1}{3}-2\alpha_1\int_0^1 x^2A(x)dx+\alpha_2\int_0^1 x^2B(x)dx$$

$$- \alpha_3\int_0^1 [2x^2A(x)B(x)+x^3A(x)B^{'}(x)]dx.$$

Similarly from (2.9),

$$P(Y>X)E(Y|Y>X) = \frac{1}{3}+\alpha_1\int_0^1 x^2A(x)dx-2\alpha_2\int_0^1 x^2B(x)dx$$

$$- \alpha_3\int_0^1 [2x^2A(x)B(x)+x^3A^{'}(x)B(x)]dx.$$

Thus

$$P(X>Y)E(X|X>Y)-P(Y>X)E(Y|Y>X)=-3\alpha_1\int_0^1 x^2A(x)dx+3\alpha_2\int_0^1 x^2B(x)dx$$

$$- \alpha_3\int_0^1 x^3(A(x)B^{'}(x)-A^{'}(x)B(x))dx. \quad (2.10)$$

Now assume that $A(x)$=$B(x)$. Then obviously (2.10) is independent of α_3. Conversely (2.10) is independent of α_3, then $A(x)$=$B(x)$ using the arguments in Theorem 2.1 and the proof is complete.

Notice that in the above case,

$$P(X>Y)E(X|X>Y) = \frac{1}{3}-2\alpha_1\int_0^1 x^2A(x)dx+\alpha_2\int_0^1 x^2A(x)dx$$

$$- \alpha_3\int_0^1 x^2A(x)[xA^{'}(x)+2A(x)]dx.$$

The last integral is

$$\int_0^1 [x^3A(x)A^{'}(x)+2x^2A^2(x)]dx = \int_0^1 [2x^2A^2(x)+\frac{1}{2}x^3\frac{d}{dx}A^2(x)-\frac{3}{2}x^2A^2(x)]dx$$

$$= \frac{1}{2}\int_0^1 x^2A^2(x)dx.$$

Thus

$$P(X>Y)E(X|X>Y)=\frac{1}{3}+(\alpha_2-2\alpha_1)\int_0^1 x^2A(x)dx-\frac{\alpha_3}{2}\int_0^1 x^2A^2(x)dx.$$

and finally

$$E(X|X>Y)=\frac{\frac{1}{3}+(\alpha_2-2\alpha_1)\int_0^1 x^2A(x)dx-\frac{\alpha_3}{2}\int_0^1 x^2A^2(x)dx}{\frac{1}{2}-(\alpha_1-\alpha_2)\int_0^1 xA(x)dx}$$

using (2.5). As an example, for the Cambanis family, with uniform marginals,

$$F(x,y)=xy[1+\alpha_1(1-x)+\alpha_2(1-y)+\alpha_3(1-x)(1-y)], \qquad 0\le x,y\le 1,$$

the conditions of the Theorem 2.3 are satisfied. Accordingly

$$P(X>Y)=\frac{1}{2}+\frac{\alpha_2-\alpha_1}{6}$$

and

$$E(X|X>Y)=\frac{20+5(\alpha_2-2\alpha_1)-\alpha_3}{30+10(\alpha_2-\alpha_1)}.$$

Further in the light of the above discussions Theorem 2 in Bairamov and Kotz (2002) can be modified as follows.

Theorem 2.4

Let (X,Y) be a bivariate random vector with distribution function

$$F(x,y)=xy[1+\alpha_1A(x)+\alpha_2B(y)+\alpha_3A(x)B(y)] \tag{2.11}$$

satisfying $A(1)=0=B(1)$, $A(0)=1=B(0)$ and $A(x)B'(x)-A'(x)B(x)\ge 0$ or ≤ 0 for all x in [0,1], Then

$$P(X>Y)E(X|X>Y)=P(Y>X)E(Y|X>Y)$$

if and only if α_1=α_2 and $A(x)=B(x)$ for all x.

Proof: The result follows from the fact that for (2.11)

$$\begin{aligned}P(X>Y)E(X|X>Y) &= \frac{1}{3}-\alpha_1\int_0^1 x^2A(x)dx-\frac{\alpha_3}{2}\int_0^1 x^2A^2(x)dx\\ &= P(Y>X)E(Y|X>Y)\end{aligned}$$

and Theorem 2.3.

The problem of characterizing bivariate distributions through their regression functions have received considerable attention, see for example, Rao and Sinha (1988), Bryc (2012). A traditional approach in statistical modelling is to select a flexible family of distributions and then to find a member of the family that is appropriate for the given data. One characteristic of the family amenable to easy verification is the regression function. The forms of the regression functions $b_1(x)=E(Y|X=x)$ and $b_2(y)=E(X|Y=y)$ can be detected from the observations and the model that conforms with it is a reasonable choice for the data.

Notes

We show that $(b_1(x), b_2(y))$ determines the model (2.2) uniquely and provide example of members that have simple functional forms for them.

Theorem 2.5

Let *(X, Y)* be continuous random vector with distribution specified by (2.2). Then the regression functions $b_1(x)$ and $b_2(y)$ uniquely determine the distribution of *(X, Y)*.

Notes

Proof: For the distribution (2.2), the conditional distribution of Y given $X{=}x$ is

$$f(y|x) = \frac{1 + \alpha_1 \frac{d}{dx}xA(x) + \alpha_2 \frac{d}{dy}yB(y) + \alpha_3(\frac{d}{dx}xA(x))(\frac{d}{dy}yB(y))}{1 + \alpha_1 \frac{d}{dx}xA(x)}.$$

Some direct calculations give

$$\begin{aligned} b_1(x) &= \int_0^1 y f(y|x)dy \\ &= \frac{1}{2} - \frac{[\alpha_2 + \alpha_3 \frac{d}{dx}xA(x)]\int_0^1 yB(y)dy}{1 + \alpha_1 \frac{d}{dx}xA(x)} \end{aligned}$$

Solving

$$\frac{d}{dx}xA(x) = \frac{d_1(x) - \alpha_2}{\alpha_3 - \alpha_1 d_1(x)}, \quad d_1(x) = \frac{\frac{1}{2} - b_1(x)}{\int_0^1 yB(y)dy}$$

and hence

$$A(x) = \frac{1}{x}\int_0^x \frac{d_1(t) - \alpha_2}{\alpha_3 - \alpha_1 d_1(t)}dt. \tag{2.12}$$

Similarly

$$B(y) = \frac{1}{y}\int_0^y \frac{d_2(t) - \alpha_1}{\alpha_3 - \alpha_2 d_2(t)}dt, \quad d_2(y) = \frac{\frac{1}{2} - b_2(y)}{\int_0^1 xA(x)dx}. \tag{2.13}$$

Equations (2.12) and (2.13) determine the distribution (2.2).

Example 2.1

$$\text{Let} \quad d_1(x) = \frac{\alpha_2 + \alpha_3(1 - 2x)}{1 + \alpha_1(1 - 2x)} \quad \text{and} \quad d_2(y) = \frac{\alpha_1 + \alpha_3(1 - 2y)}{1 + \alpha_2(1 - 2y)}$$

Then from (2.12),

$$A(x) = \frac{1}{x}\int_0^x (1 - 2t)dt = 1 - x,$$

and similarly $A(y) = 1 - y$. Thus the distribution is given by

$$F(x, y) = xy[1 + \alpha_1(1 - x) + \alpha_2(1 - y) + \alpha_3(1 - x)(1 - y)], \quad 0 \le x, y \le 1.$$

Example 2.2

Let $$d_1(x) = \frac{\alpha_2 + \alpha_3(1-x)(1-3x)}{1+\alpha_1(1-x)(1-3x)} \quad \text{and} \quad d_2(y) = \frac{\alpha_1 + \alpha_3(1-y)(1-3y)}{1+\alpha_2(1-y)(1-3y)}$$

Then

$$A(x) = \frac{1}{x}\int_0^x (1-t)(1-3t)dt = (1-x)^2,$$

and similarly $A(y) = (1-y)^2$, giving

$$F(x,y) = xy[1+\alpha_1(1-x)^2 + \alpha_2(1-y)^2 + \alpha_3(1-x)^2(1-y)^2], \quad 0 \le x, y \le 1.$$

We conclude this work by noting that Theorems 2.1 through 2.4 extends the work of Bairamov and Kotz (2002) to a more general family of bivariate distributions and Theorem 2.5 provides a new result that helps in identifying a distribution belonging to the general family we have presented.

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Notes

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Role of Banks and Financial Institutions in Export Finance of Bangladesh

By Syed Tanimul Haque, Faijun Nahar Mim & Md. Soyebur Rahman
Jahangirnagar University

Abstract- With a view to find out the role of banks and financial institutions in export finance of Bangladesh, a questionnaire survey was done on commercial banks and exporters. Besides, reading materials and secondary data on export financing from various sources were analyzed.

As an apex body in the financial system, Bangladesh Bank plays an important role in export financing through its policy formulation and refinancing facilities. Commercial banks are dealing with export financing directly.

Keywords: *banks and financial institutions, banks, commercial banks, exporters, export.*

GJSFR-F Classification: *MSC 2010: 97K80*

ROLEOFBANKSANDFINANCIALINSTITUTIONSINEXPORTFINANCEOFBANGLADESH

Strictly as per the compliance and regulations of :

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Abstract- With a view to find out the role of banks and financial institutions in export finance of Bangladesh, a questionnaire survey was done on commercial banks and exporters. Besides, reading materials and secondary data on export financing from various sources were analyzed.

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I. Background of Export Financing in Bangladesh

Bangladesh economy is characterized by major structural problems and as a result it is exceptionally dependent on external assistance for financing development activities and for bridging its sizable fiscal and external deficits. An alternative to overcome the excessive dependence on external assistance is export-led growth strategy. Recent success story of export-led growth in some Asian economies like the Republic of Korea, Taiwan, Hong Kong, Malaysia, Indonesia, Singapore, and the Philippines have laid sufficient ground to believe in the idea of export-led growth strategy for economic development. Furthermore better export performance of the country in recent years especially in garments sector and other nontraditional sectors has also brought about some hope of success in economic development through export-led strategy.

Export finance system of the country could play a significant role in pursuance of Government's export-led growth strategy. With this view in mind Government introduced several financial incentives for increasing export of our country over past several years.

Export Performance Benefit (EPB) scheme, Duty Draw Back System, Bonded Warehouse System, Export Credit Guarantee Scheme, Preferential Interest Rates, Income Tax Rebate, Travel Quota Retention, Convertibility of Taka on Current Account and so on. An export development fund has been maintained with Bangladesh Bank with a view to refinancing the commercial banks engaged in export financing, Sadharan Bima Corporation (SBC) has also been playing a significant role in export financing through export credit guarantee schemes. Other general insurance companies also have been involved in export financing through their insurance policy coverage for exporters.

A high level committee to review monthly export performance of the country has been set up which chaired by the Finance Minister himself. Despite high priority given

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to export financing, academicians or government officials have done little research work on the issue relating to export financing except some statistical works on export performance either. For this the present study on export financing problems of Bangladesh has been attempted to cover some of the questions related to this field.

a) Research objectives

This study examines the Export Finance scenario in the line with export promotion policies and programs of Bangladesh with special emphasis on Export Finance activities of Banks and financial institutions. More specifically, it attempts:

1. To review the export promotion policies of the country,
2. To analyze the county's export structure,
3. To analyze the role of banks and financial institutions in export financing
4. To describe and evaluate the existing export financing system, recommend policy and institutional reforms that can further strengthen the export sector.

b) Lists of Hypotheses

The list of hypotheses for the study is as follows:

1. Inadequate equity capital or inadequate collateral or insufficient insurance cover is the problem for export finance.
2. Interest rate control by Bangladesh Bank has reduced the profit of commercial banks in export finance.
3. Improved customer service is necessary for banks to overcome the present problems in export finance.
4. Loan terms should be easier to boost up export credit.

c) Scope of the study

This study gives an overview of our financial system, which can be helpful to our exporters. Furthermore, results of questionnaire survey on banks and exporters may be informative to our export credit monitoring committee headed by the Governor, Bangladesh Bank. Evaluation of export finance system of the country may set ground for more comprehensive study and evaluation in this field. Foreign trade financing of Islamic Banking System has been kept outside the preview of this study.

d) Methodology

Methodology of research for this study includes-

Primary data collection:

A questionnaire survey on selected banks and exporters.
Discussion with several bank officials and exporters.

Secondary data collection:

Study of journals, newspapers, periodicals and other reading materials.
Informal talks with officials of Bangladesh Bank, Export Promotion Bureau, Sadharan
Bima Corporation, Duty Exemption & Draw Back Office (DEDO) and commercial banks.

Data Analysis:

A Trend analysis technique of Time series analysis has been used to compare and evaluate the data.
Ten years data of banks and financial institutions has been used to find out the current trend and situation of export financing.

Notes

e) Limitations

Limitations of the study are as follows-

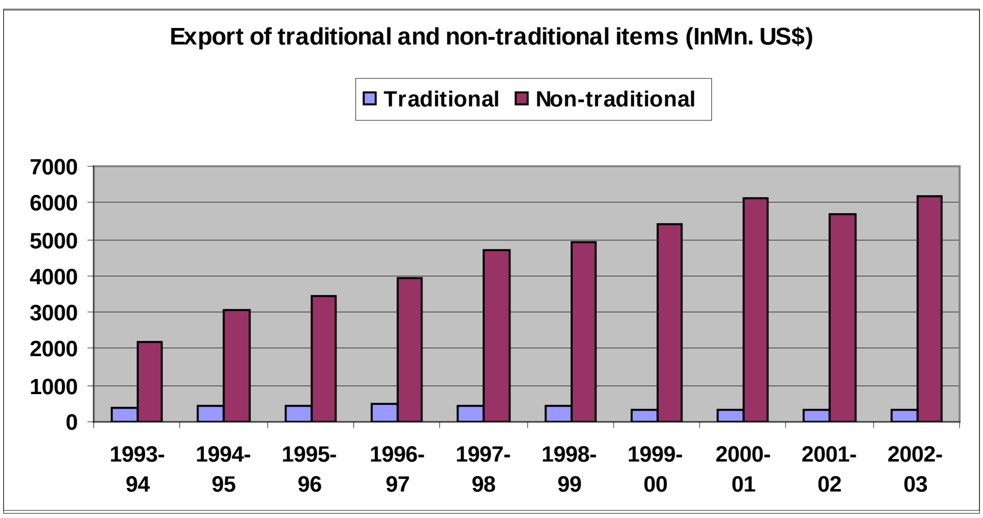
1. Lack of financial data of commercial banks.
2. Time constraint of related persons in replying to the questionnaire.
3. Reluctance of some officials to respond at the time of interview.
4. Lack of cooperation in providing data by primary sources.
5. Since some of the sources of information were personal interviews, this tool is vulnerable to personal bias and distortions.

Notes

II. Traditional and Non- Traditional Export of Bangladesh

Bangladesh export can be divided into traditional and non- traditional exports. Export items like raw jute, jute goods, tea etc. are traditional items and items like garments, shrimps, frozen fish, leather and leather products, fruits, specialized textiles, handicrafts, engineering goods, consultancy service etc. are non-traditional items.

We started calculation of data from FY 1993. In 1993 share of traditional items in total export was 85.51% where share of non-traditional items in total export was 14.49%. This trend is still in succession; moreover, with passage of time, share of traditional items in total export is increasing. As in FY 2002-03 share of traditional items in total export is 94.59% where share of non-traditional items in total export was 5.41%. Following figure of Export of traditional and non-traditional items gives us clearer picture of this tradition.



Source: Export Statistics by EPB Bangladesh

Figure 2.1: Export of traditional and non-traditional items

From the above figure-2.1 it is observed that share of traditional items in our export earnings reduce from a14.49% to 4.95% during 1994-2003. On the other hand, that of non- traditional items increased from 85.51% to 95.05% during the same period.

a) Share of major export commodities In Bangladesh export:

A couple of commodities have always been the principle in the export scenario from FY 72-73 to mid 80s. Items principally contributing to the export earnings were jute, jute goods, leather and tea of which jute and jute goods were the main export earners.

In FY 72-73 jute and jute goods along contributed 90% of the total earnings and leather and tea to these two, raising their contribution to 97.4pc. This situation continued up to mid 80s when the scenario started changing with appearance of new products, specially RMG (woven garments & knitwear), shrimp, frozen foods, chemical and agricultural products.

During 90-91 FY, RMG including hosiery jute and jute goods, leather, frozen foods and chemical products contributed 92.1pc to the total export earnings. RMG alone earn more than 50pc. If Tea is added to these 6 products, the contribution of 6 products in FY 90-91 comes to 94.6pc out of approximately 114 exportable items.

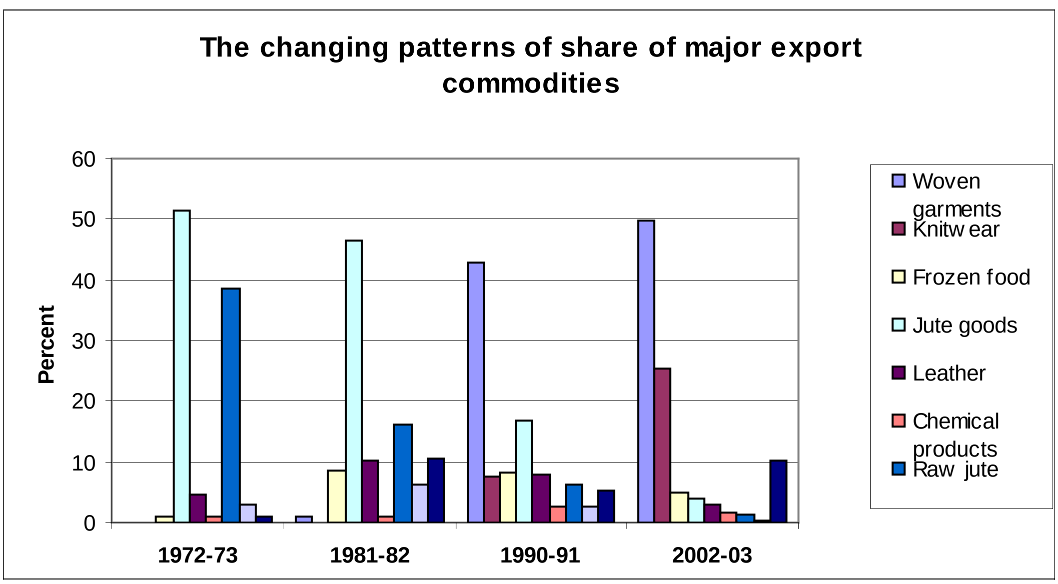
Table-2.1 shows the changing pattern of share of major export commodities in export of Bangladesh.

Table 2.1: The changing patterns of share of major export commodities in last four decades

Products	1972-73	1981-82	1990-91	2002-03
Woven garments	-	1.1	42.8	49.8
Knitwear	-	-	7.6	25.3
Frozen food	0.9	8.5	8.3	4.9
Jute goods	51.4	46.5	16.9	3.9
Leather	4.6	10.1	7.8	2.9
Chemical products	0.9	1.1	2.6	1.5
Raw jute	38.5	16.3	6.1	1.3
Tea	2.9	6.1	2.5	0.2
Others	0.9	10.4	5.4	10.2
Total:	100	100	100	100

Source: Annual Report of Export Promotion Bureau.

Following Bar chart will help us more to understand the situation clearly.



Source: Annual Report of Export Promotion Bureau.

Figure-2.2: The changing patterns of share of major export commodities in last four decades

During FY 2002-03 RMG alone earn nearly 80%and raw jute and jute goods earn only 5%. Leather, frozen foods and chemical products contributed 9.3pc. Tea earns record lowest 0.2% and other all products earn 10.2pc.

Notes

b) Major commodity wise export earnings in recent years

The principal commodities of which export earning has increased during the financial year under review in comparison with the previous year are: Agricultural products (12.96%), Jute goods (5.61%), Raw jute (34.89%), frozen shrimp and fish (16.55%), petroleum by product (215.45%), chemical product (50.95%), knitwear (13.34%), woven garments (4.28%). The commodities, which registered decline in exports earnings, are Tea (10.99%), Leather (7.77%), and Handicrafts (2.78%). Following Table shows the comparative export earnings of major commodities between FY98 to FY04.

Notes

Table-2.3: Major Commodity wise export earnings (Value in million US dollar)

Year	RMG	Raw jute	Jute goods	Frozen shrimps & Fish	Knitwear & hosiery products	Fertilizer	Leather
FY98	2843.30	107.80	278.60	293.80	940.30	58.70	190.30
FY99	2984.74	71.75	301.91	274.32	1035.36	58.67	168.24
FY01	3082.56	71.62	262.70	343.82	1269.83	59.88	195.05
FY02	3363.89	67.18	229.11	363.23	1496.23	68.17	253.93
FY03	3124.56	61.13	241.61	276.11	1459.24	47.93	207.33
FY04	3258.27	82.40	256.54	321.81	1653.83	78.62	191.23

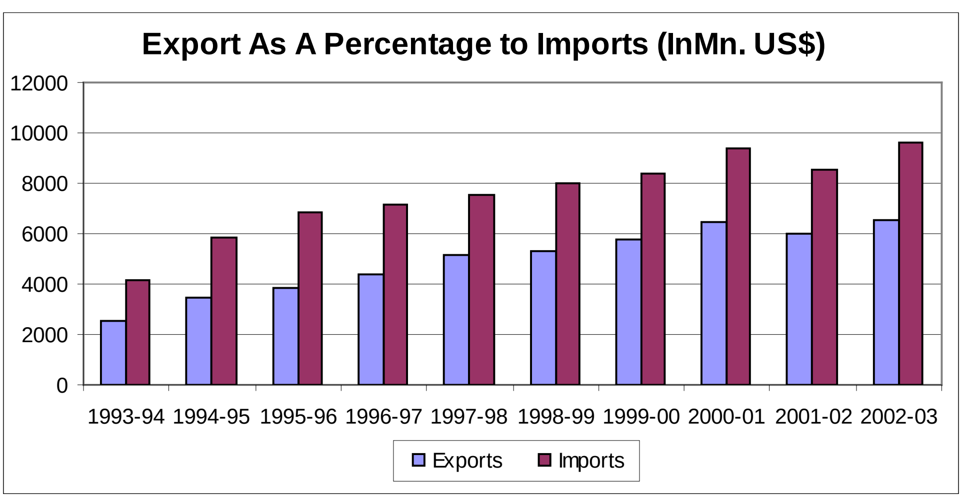
Source: Bangladesh Bank Annual Report

Above table-2.3 reveals that among the major export commodities RMG achieved the most impressive average earnings follows by Knitwear and hosiery. Raw jute and jute goods shows a meager of 2.2% and 3.31% average annual growth rate over the year 2000 to 2003. Frozen shrimps & Fish also lost their average earnings over the period of 1998 to 2001.Fertilizer have the lowest export earnings among stated commodities.

c) Export as a percentage of imports

Export as a percentage of import show a country's ability to meet the requirements of its import payment from internal resources. The greater the percentage, the greater the country's ability to pay import bill from internal resources, meaning lesser dependence on external aid and grant.

Figure 2.2 below shows the share of export earnings as a percentage of import payment from 1993-1994 to 2002-2003.



Source: Bangladesh Export Statistics

Figure 2.3: Export As A Percentage to Imports

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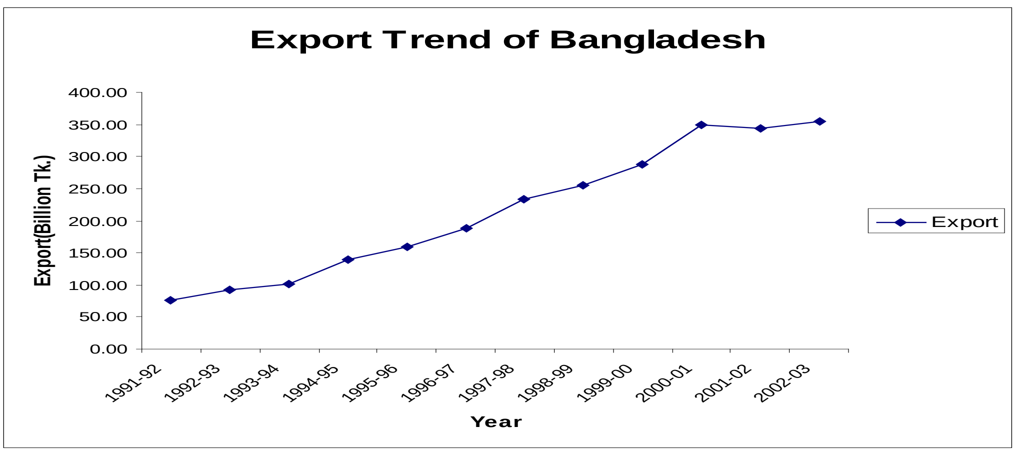
Figure 2.3 it is observed that share of export increased from 60.46% in 1993-94 to 70.09 % in 2001-2002. This indicates that our performance in export sector has been improved remarkably. During 2001-2002 total export was for 6548 million US $. Stated data shows that export is consistently increasing except FY 2001-02. And our export is always is from nearly 60% to 70% of import. This is partly attributable to export promotion policies of the government over the past decade, despite various setbacks.

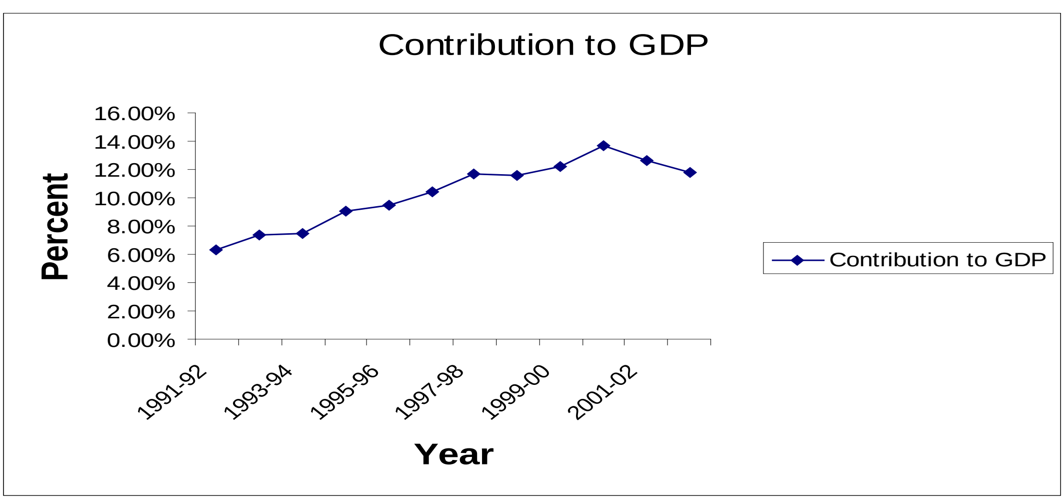
d) Export Trend and its contribution to GDP

Openness in trade and expansionary export policy help export sector of Bangladesh to show a steady growth over the years. Though September 11, crisis shrink the world trade and Bangladesh was not out of that crisis. Consequently on 2001-2002 fiscal year export of Bangladesh showed negative growth. Analyzing the Table A.1 in annexure it is observed that from 1991-92 to 2002-03 average growth in export is 15.07% and export grew at highest rate 20.96% in 2000-01 fiscal year. Contribution of export sector in GDP in this time frame on an average 10.50% and growth rate is 5.87%. Export trend of Bangladesh and its contribution in GDP presented graphically in Figure 4.4 & 4.5.



Source: Bangladesh Economic Review

Figure 2.4: Export trend of Bangladesh (1991-2003)



Source: Bangladesh Economic Review

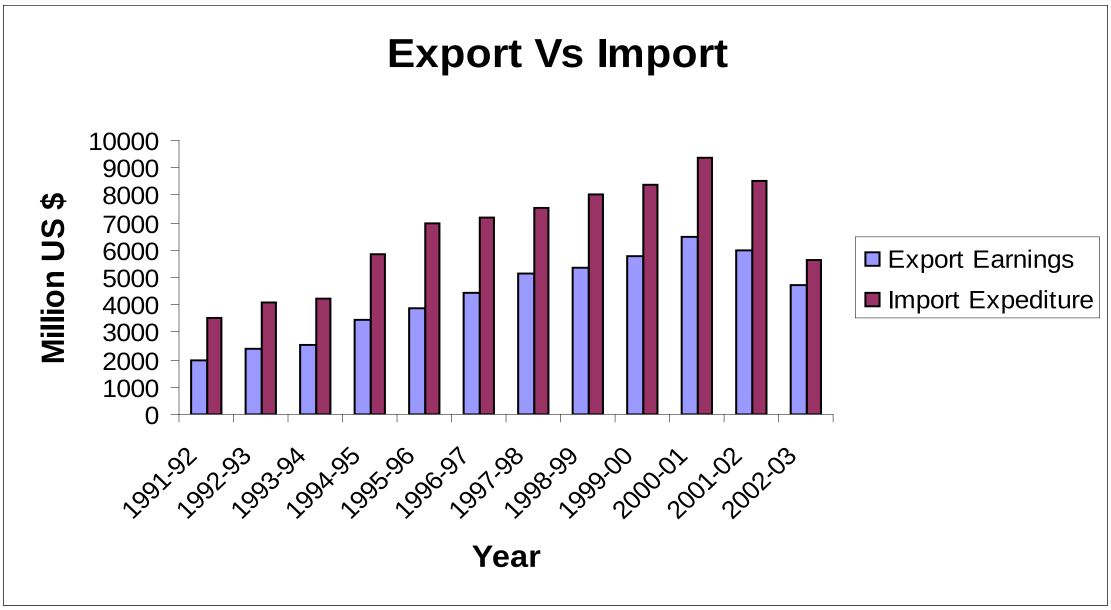
Figure 2.5: Contribution of Export to GDP (1991-2003)

Notes

Figure 2.4 & 2.5 it is clear that though recently export earnings and import expenditure is showing decreasing trend but export earning shows higher growth rate than that of growth in import expenditure. Average growth in export earnings is 8.15% and import expenditure is 4.39% during 1991 to 2003. Which indicate a positive economic development of the country.

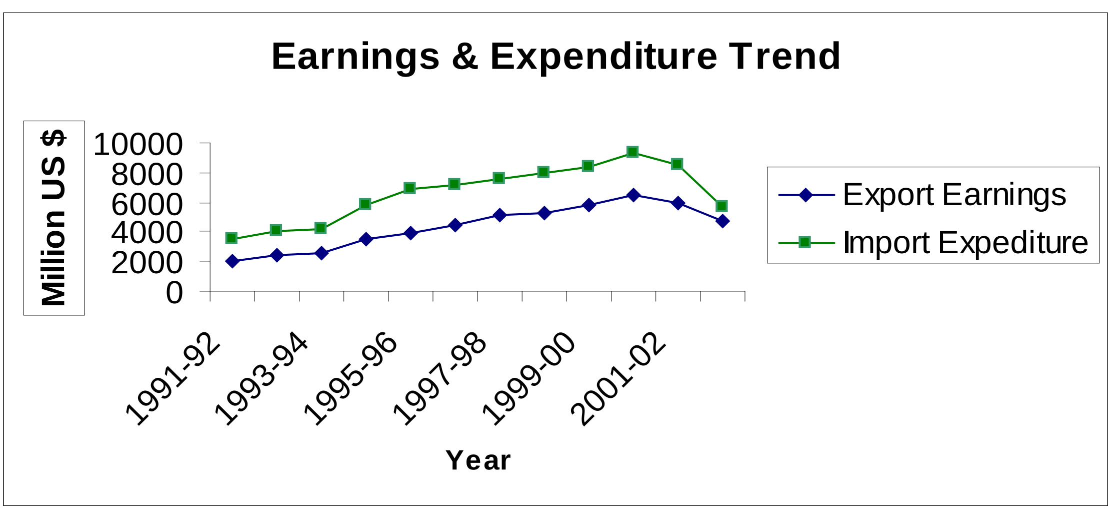
e) Export Earnings and Import Expenditure

Export earnings and import expenditure is an important factor for the balance of payment (BOP) of a country. Our export is always far behind from our import. Following two figures give us the latest information about the relationship of our export earnings and import expenditure.



Source: Bangladesh Economic Review

Figure 2.6: Export earnings and Import expenditure of Bangladesh (1991-2003)



Source: Bangladesh Economic Review

Figure 2.7: Trend of Export earnings and Import expenditure of Bangladesh (1991-2003)

Notes

From the above two figures we can easily understand that our export is lower than our import. But for a developing country it is always necessary that export is greater than import. During FY 2000-01 and 2001-02 our export receipt was far bellow than our import payments. But in FY 2003 this situation improved little bit.

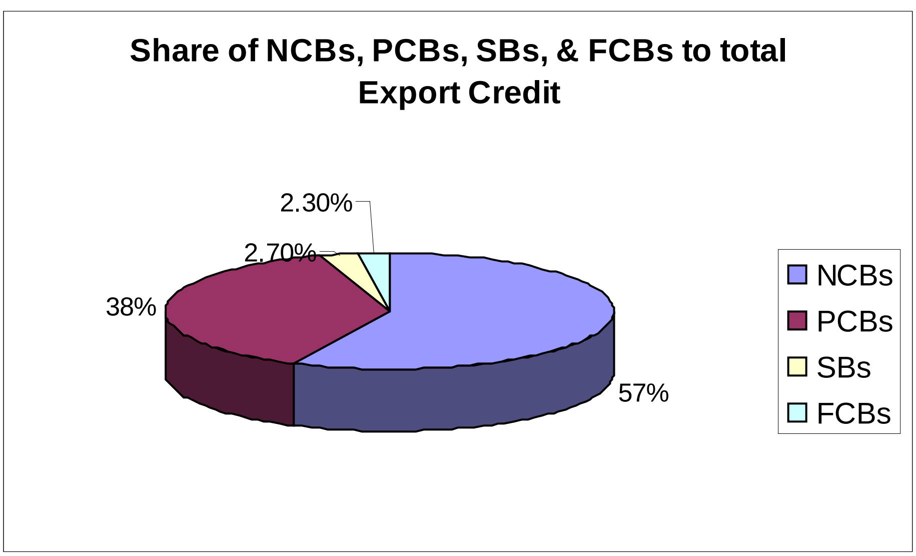
III. Comparative Performance of Total Banking System

During year 2003 all Scheduled banks as NCBs, PCBs, SBs, and FCBs perform total export financing of 8953670lacs Taka. Where Nationalized Commercial Banks disburse 57% export credit to total export credit of 2oo3. Then private Commercial Banks disburse 38% and Specialized Banks perform 2.7% export credit to total export credit of 2oo3. Foreign Commercial Banks disburse lowest 2.3% export credit. On the bank wise export credit to total credit, NCBs perform highest 7.38% export credit to their total credit of 3616846lacs Taka. PCBS, SBs, and FCBs disburse 4.82%, 1.16% and 1.56% export credit respectively to their total credit of the year 2003. Following table-3.1 and figure-3.2 shows the detail condition of export financing by banking system in 2003.

Table 3.1: Export finance by all banks during year 2003 (Value in lac Taka)

Banks	Total credit	Export credit (EC)	% Export credit to total credit	% Of bank wise EC to total EC
NCBs	3616846	266792	7.38	57
PCBs	3724150	179447	4.82	38
SBs	926297	11514	1.16	2.7
FCBs	616377	9639	1.56	2.3
Total	8953670	467392	5.22	100

Source: Schedule Bank Statistics



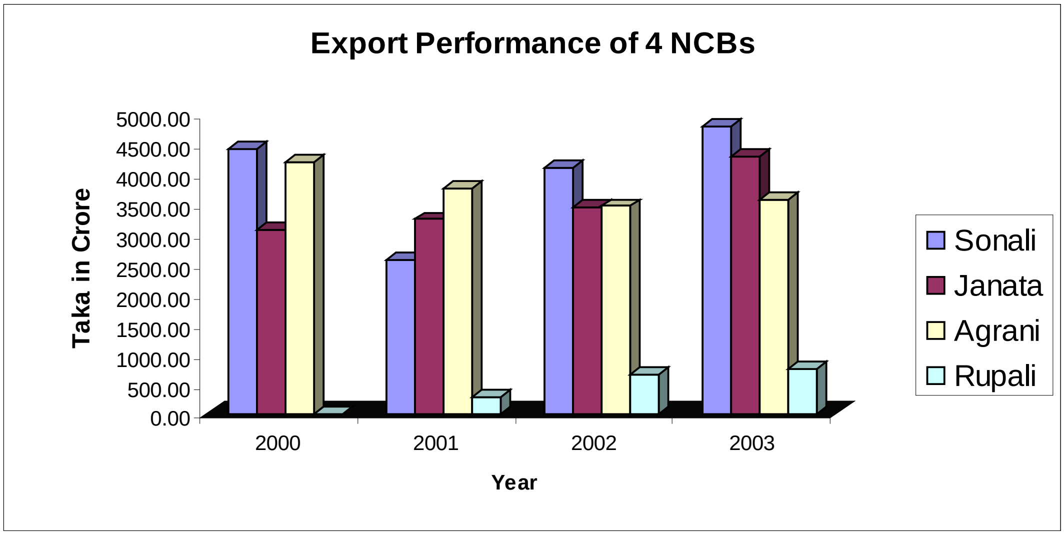
Source: Schedule Bank Statistics

Figure 3.1: Export performance of 4 NCBs (2000-2003)

Notes

Notes

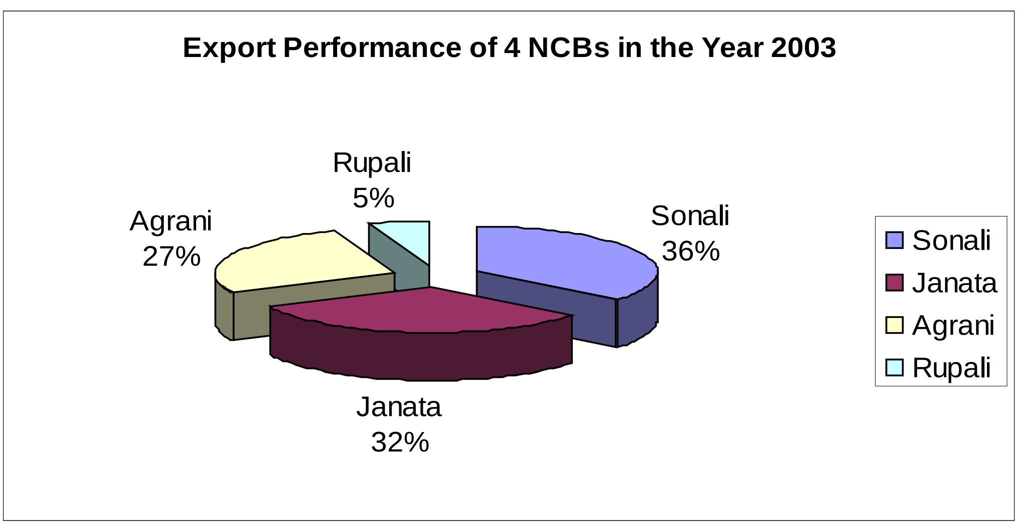
a) Comparative performance of NCBs



Source: International division (Export) Janata Bank, Head office.

Figure 3.2: Export performance of 4 NCBs (2000-2003)

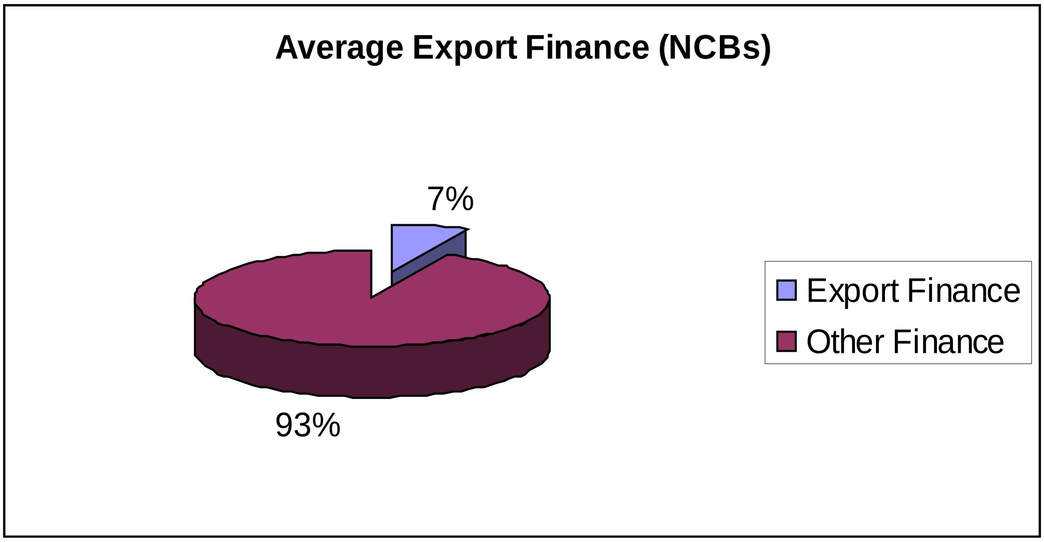
As NCBs perform highest export credit in export of Bangladesh, so we will focus on details performance NCBs. Among 4 NCBs at present Sonali Bank has secured 1st position. It is observed from Table A.6 and Figure 5.3 that among them Janata Bank and Rupali Bank has shown steady growth during 2000 to 2003. In 2003 contribution of Sonali Bank in the total export performance of four NCBs was 36%, which reflected in Figure 3.2



Source: International division (Export) Janata Bank, Head office.

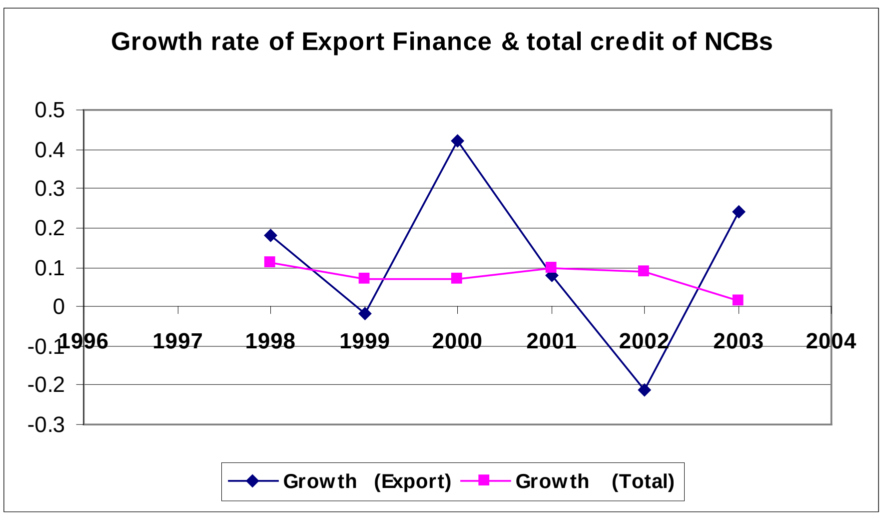
Figure 3.3: Share of Export performance of 4 NCBs in the year 2003

Total credit disbursed by Nationalized Commercial Banks grown at an average rate of 9% and export finance at a rate of 7% during the observed period (1997 to 2003). Growth of export finance by NCBs also deflects a rough fluctuating trend. Export finance comprise about 7% out of total disbursement by NCBs during 1997 to 2003.



Source: Schedule Bank Statistics

Figure 3.4: Share of Export Finance to total credit disbursed by NCBs (1997-2003)



Source: Schedule Bank Statistics

Figure 3.5: Growth rate of Export Finance & total credit of NCBs (1997-2003)

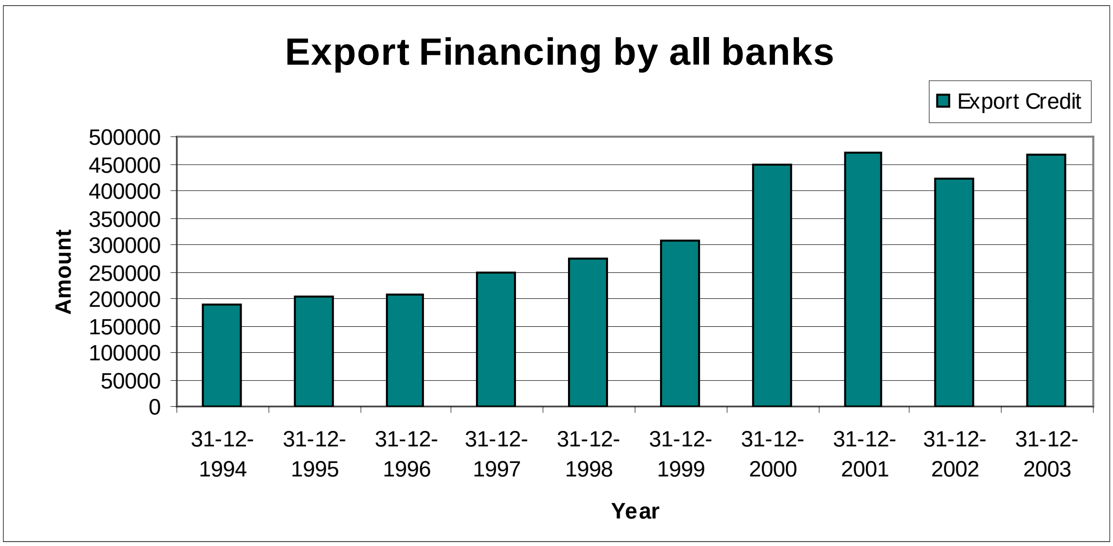
IV. Total Export Financing by Commercial Banks

A table of data reeling number of accounts and total export financing by the banking system from 1994 to 2003 is presented bellow to have a look over this. Share of export credit to total credit of the banking system is also given in the table.

Table-4.1: Export Financing by all banks (Taka in lacs)

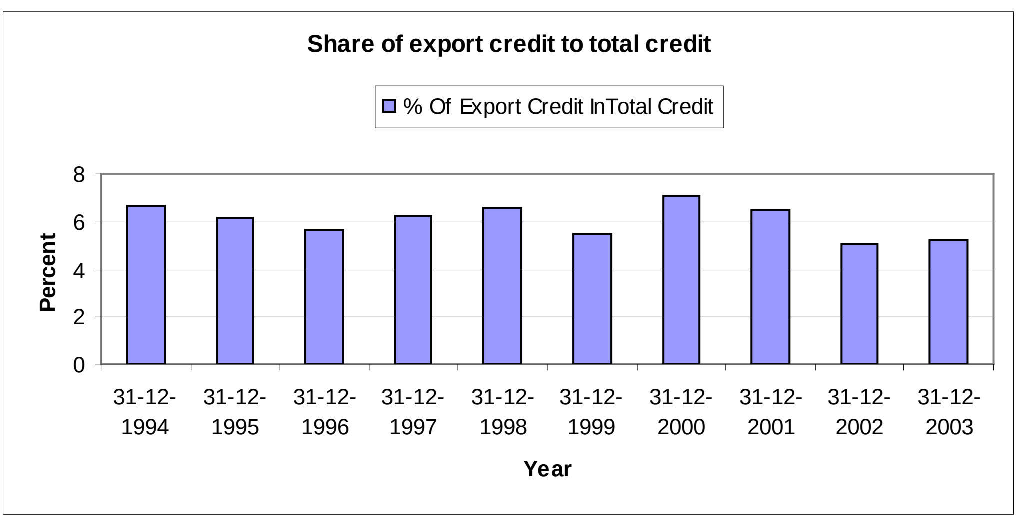
Year	No of A/Cs	Export Credit	% Of Total Credit
31-12-1994	13326	187843	6.63
31-12-1995	11067	202638	6.14
31-12-1996	16874	208402	5.61
31-12-1997	16709	246579	6.20
31-12-1998	18899	275636	6.60
31-12-1999	13001	309076	5.48
31-12-2000	18170	446451	7.07
31-12-2001	19721	471420	6.48
31-12-2002	15982	422630	5.09
31-12-2003	2623	467392	5.22

Source: Schedule Bank Statistics



Source: Schedule Bank Statistics

Figure 4.1: Total export financing by all banks



Source: Schedule Bank Statistics

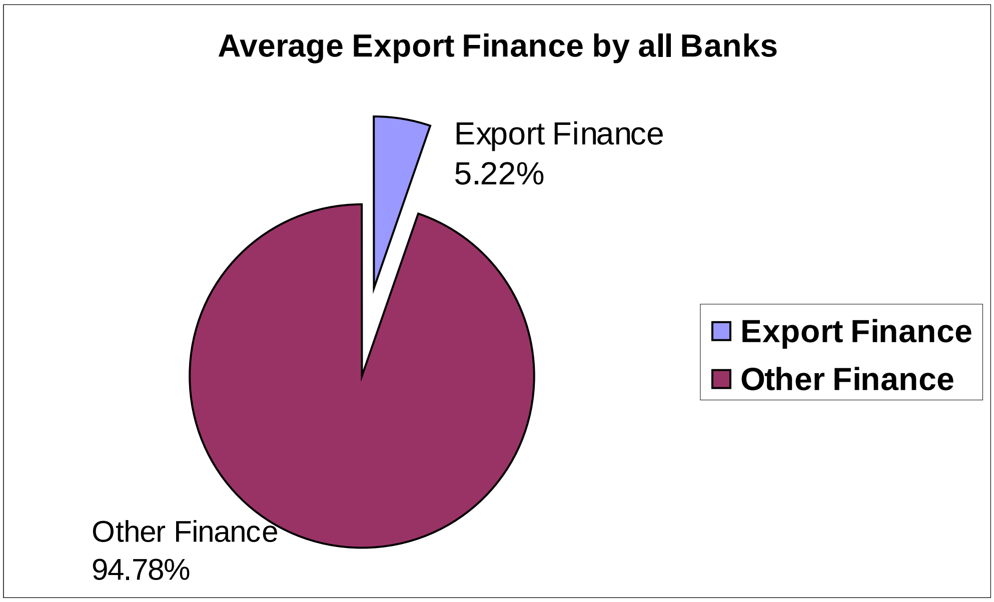
Figure 4.2: Share of export credit to total credit of the banking system

Notes

Above figure-4.1 and figure-4.2 shows that from 1994 to 2001 export credit by al banks has been increasing at an increasing rate but at 2002 it was decreased. At 2003 export financing regain its rate and roughly touch previously highest amount.

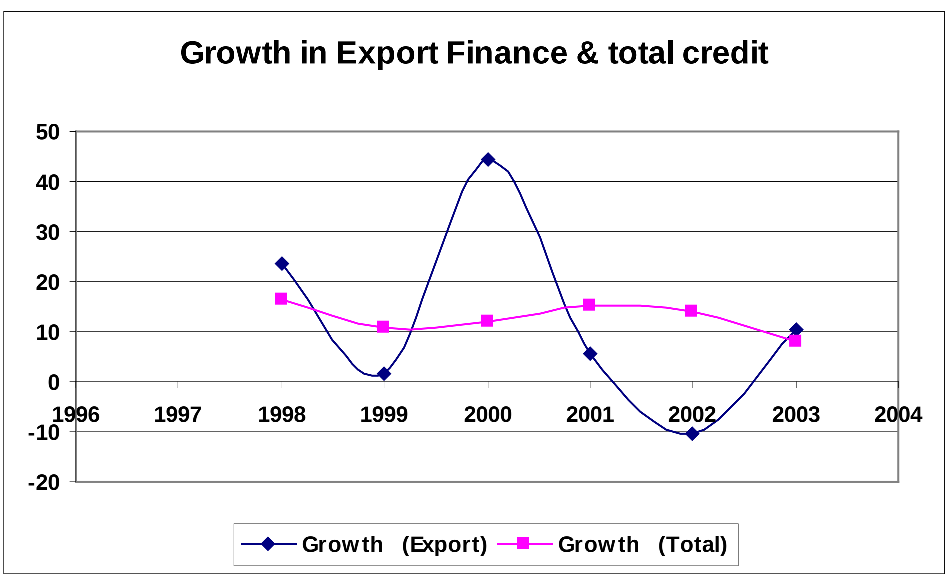
It is also observed that export finance shows 10% negative growth in the year 2002 though it achieved highest growth 44% in the year 2000. But in 2003 export finance shows 10% positive growth. Trend in export finance is very much fluctuating steady one. On an average 5.92% of total credit is shared by export finance during the observed period.

Notes



Source: Schedule Bank Statistics

Figure 4.3: Average Export Finance by all banks of Bangladesh



Source: Schedule Bank Statistics

Figure 4.4: Growth in Export Finance & total credit of Bangladesh (1997-2002)

Notes

a) A brief picture of export financing in export of Bangladesh

When growth of total export financing by all banks is presented against that of our export, it is observed that export grew over the years with an average annual rate of 14.79% from 1992 to 2004 and export finance grew at a rate of 14.39% during the same tenure. Moreover contribution of export to GDP is 10.46% where as export finance comprises only 5.82% of total credit. Which means that export and export finance is not at par, there is a considerable degree of latitude for improving export finance.

Table-5.1: Export Finance By all Banks & Export performance of Bangladesh

As on	Export Finance (Lac Taka)	Percentage of Total Credit	Growth in Export Finance	Year	Export (Billion Taka)	Contribution to GDP	Growth in Export
31-12-1991	101,716	4.64		1991-92	75.90	6.30%	
31-12-1992	132,176	5.31	29.95	1992-93	92.60	7.40%	22.00
31-12-1993	158,017	6.40	19.55	1993-94	101.00	7.50%	9.07
31-12-1994	187,843	6.63	18.88	1994-95	139.30	9.10%	37.92
31-12-1995	202,638	6.14	7.88	1995-96	158.80	9.50%	14.00
31-12-1996	208,402	5.61	2.84	1996-97	188.10	10.40%	18.45
31-12-1997	246,579	5.63	18.32	1997-98	234.20	11.70%	24.51
31-12-1998	304,596	5.98	23.53	1998-99	254.90	11.60%	8.84
31-12-1999	309,076	5.48	1.47	1999-00	288.20	12.20%	13.06
31-12-2000	446,491	7.07	44.46	2000-01	348.60	13.70%	20.96
31-12-2001	471,420	6.48	5.58	2001-02	343.70	12.60%	-1.41
31-12-2002	422,630	5.09	-10.35	2002-03	355.40	11.80%	3.40
31-12-2003	467,392	5.22	10.59	2003-04	379.14	12.30%	6.67
Average		**5.82**	**14.39**			**10.46%**	**14.79**

Source: Schedule Bank Statistics

Analyzing information and presented data it is established that growth in export finance reflects poorer performance in respect to the growth of export. Moreover export finance is not proportionate against its contribution to GDP. A gap between policy and practice is observed. Being treated most favored sector it is still lagging behind and suffering from different set back.

V. Summary and Conclusion

Bangladesh gradually started to shift from its earlier economic development policy of import substitution to export-led growth strategy since 1982. Bangladesh is still striving hard through adopting various policies and strategies but achievement is much below expectations. This suggests that the country has yet to develop a suitable policy package for sustained growth and development. In this connection it may be mentioned that "Export or perish" now a day's become a very popular slogan among the development economists and policy makers. In today's world almost all developing countries have been adopted various reform measures in order to institute open market economy. Current export policies and promotional measures are much more realistic than that of previous years. But there has been always a wide gap between policies and implementations, so benefits of policies could not be reaped properly before.

Questionnaire survey and secondary data analysis on commercial banks reveals interest rate and inadequate collateral security as the main difficulties in extending export finance. Further, Export Development Fund (EDF) is not so attractive to commercial banks due to complications in the procedure. On the other hand, exporters surveyed mark export financing services of the commercial banks as inadequate. Besides, either exporter is not aware of the export credit guarantee or simply they do avoid complications. Exporters also observed bribery by customs officials, loan terms and lack of knowledge about market as number one problem in the growth of export. It is also observed that more finance is needed to plug the gaps between export finance and export. However, based on the findings of survey and evaluation of export finance data, important point that comes out is procedural simplification of EDF, extension of cash assistance, publicity of ECG, training of employees of commercial banks and good governance; not only economic but also political and social. Few reforms and lucrative incentive packages could not improve the situation. To chase the chiming challenge of globalization we need to integrate policy formulation, its implementation and have to improve law and order situation, appropriate judicial system.

Notes

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General Coordinate Formula of Strain (Skew Reflection) of $\mathbb{R}^2$ onto $\mathbb{R}^2$

By Gedefa Negassa Feyissa & M.P. Chaudhary
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Abstract- The authors establish a set of presumably new results, which provide general coordinate formula of strain(skew reflection) of $\mathbb{R}^2$ onto $\mathbb{R}^2$. Several closely related results are also considered.

Keywords: *coordinate formula, skew reflection.*

GJSFR-F Classification: *MSC 2010: 12E15*

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General Coordinate Formula of Strain (Skew Reflection) of $\mathbb{R}^2$ onto $\mathbb{R}^2$

Gedefa Negassa Feyissa [α] & M.P. Chaudhary [σ]

Abstract- The authors establish a set of presumably new results, which provide general coordinate formula of strain(skew reflection) of $\mathbb{R}^2$ onto $\mathbb{R}^2$. Several closely related results are also considered.

Keywords and Phrases: coordinate formula, skew reflection.

I. Introduction

1.1. ***Definition:*** Let $0 \neq k \neq 1$, and l be a line. A strain (skew reflection) with the axis l and coefficient k denoted by $T_{l,k}$, keep l pointwise invariant and maps every other point P to a point P' so that the line $\overline{PP'}$ is perpendicular to l.

Equation of strain with X-axis and coefficient k is $T_{y=0,k}((p_1, p_2)) = (p_1, kp_2)$. Equation of strain with Y-axis and coefficient k is $T_{x=0,k}((p_1, p_2)) = (kp_1, p_2)$.

1.2. ***Definition:*** Rotation about a fixed point C through a directed anggle θ is a transformation $\rho_{c,\theta}$, which fixes C and sends P to a point P' such that $CP = CP'$, and θ is the measure of directed andgle from $\overline{CP}$ to $\overline{CP'}$.

II. Rotation about Origin $O = (0, 0)$ and its Coordinate Equations

Let us consider in XY-plane, rotation from positive X-axis towards anticlockwise direction, after rotation of angle β it reaches at any point $P = (x, y)$ which has distance r from origin O. Further, the point P reached to another poinr $P' = (x', y')$in the similar direction by rotation of angle θ. Then we have following elementary results;

$$cos\beta = \frac{x}{r} \implies x = rcos\beta \tag{2.1}$$

$$sin\beta = \frac{y}{r} \implies y = rsin\beta \tag{2.2}$$

similarly, we have

$$cos(\theta + \beta) = \frac{x'}{r} \implies x' = rcos(\theta + \beta)$$

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$$\implies x' = rcos\theta\cos\beta - rsin\theta sin\beta = xcos\theta - ysin\theta \quad (2.3)$$

$$sin(\theta+\beta) = \frac{y'}{r} \implies y' = rsin(\theta+\beta)$$

$$\implies y' = rsin\theta\cos\beta + rcos\theta sin\beta = xsin\theta + ycos\theta \quad (2.4)$$

Therefore, we have

$$\rho_{O,\theta}((x,y)) = (xcos\theta - ysin\theta, xsin\theta + ycos\theta) \quad (2.5)$$

III. Rotation about Arbitrary Centre $C = (c_1, c_2)$ and its Coordinate Equations

Let us consider an arbitrary centre $C = (c_1, c_2)$ in XY-plane, rotation from positive X-axis towards anticlockwise direction, after rotation of angle θ it reaches at any point $P = (x, y)$, which has distance r from origin $O = (0, 0)$. Then we have following elementary results;

$$\rho_{C,\theta} = \tau_{O,C} \times \rho_{O,\theta} \times \tau_{C,O} \quad (3.1)$$

$$\implies \rho_{(c_1,c_2),\theta}((x,y)) = \tau_{(O,O),(c_1,c_2)}\big(\rho_{(O,O),\theta}\big(\tau_{(c_1,c_2),(O,O)}((x,y))\big)\big) \quad (3.2)$$

$$= \tau_{(O,O),(c_1,c_2)}\big(\rho_{(O,O),\theta}((x-c_1, y-c_2))\big) \quad (3.3)$$

$$= \tau_{(O,O),(c_1,c_2)}\big(((x-c_1)cos\theta - (y-c_2)sin\theta, (x-c_1)sin\theta + (y-c_2)cos\theta)\big) \quad (3.4)$$

$$= \big((x-c_1)cos\theta - (y-c_2)sin\theta + c_1, (x-c_1)sin\theta + (y-c_2)cos\theta + c_2\big) \quad (3.5)$$

IV. Derivation of the General Coordinate Formula of Strain (Skew Reflection) of $\mathbb{R}^2$ onto $\mathbb{R}^2$

Let us assume

$$l : y = mx + b, m \neq 0 \ \text{ and } \ \beta = arctan(m) \quad (4.1)$$

. Conider

$$T_{l,k}((p_1,p_2)) = \rho_{(\frac{-b}{m},0),\beta}(T_{y=0,k}(\rho_{(\frac{-b}{m},0),-\beta}((p_1,p_2)))) \quad (4.2)$$

$$= \rho_{(\frac{-b}{m},0),\beta}\Bigg(T_{y=0,k}\Bigg(\Bigg(\Bigg(p_1 + \frac{b}{m}\Bigg)cos(-\beta) - p_2 sin(-\beta)$$

$$-\frac{b}{m} + c_1, \Bigg(p_1 + \frac{b}{m}\Bigg)sin(-\beta) + p_2 cos(-\beta)\Bigg)\Bigg)\Bigg) \quad (4.3)$$

$$= \rho_{(\frac{-b}{m},0),\beta}\Bigg(\Bigg(\Bigg(p_1 + \frac{b}{m}\Bigg)cos(-\beta) - p_2 sin(-\beta)$$

$$-\frac{b}{m} + c_1, k\Bigg\{\Bigg(p_1 + \frac{b}{m}\Bigg)sin(-\beta) + p_2 cos(-\beta)\Bigg\}\Bigg)\Bigg) \quad (4.4)$$

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$$= \left(\left(\left(\left(p_1 + \frac{b}{m} \right) cos(-\beta) - p_2 sin(-\beta) \right) cos\beta \right.\right.$$

$$- \left(k \left\{ \left(p_1 + \frac{b}{m} \right) sin(-\beta) + p_2 cos(-\beta) \right\} \right) sin\beta - \frac{b}{m},$$

$$\left(\left(p_1 + \frac{b}{m} \right) cos(-\beta) - p_2 sin(-\beta) \right) sin\beta$$

$$\left. + \left(k \left\{ \left(p_1 + \frac{b}{m} \right) sin(-\beta) + p_2 cos(-\beta) \right\} \right) cos\beta \right) \tag{4.5}$$

$$= \left(\left(p_1 + \frac{b}{m} \right) cos^2\beta + p_2 sin\beta cos\beta + k \left(p_1 + \frac{b}{m} \right) sin^2\beta - kp_2 sin\beta cos\beta - \frac{b}{m}, \right.$$

$$\left. \left(p_1 + \frac{b}{m} \right) sin\beta cos\beta + p_2 sin^2\beta - k \left(p_1 + \frac{b}{m} \right) sin\beta cos\beta + kp_2 cos^2\beta \right) \tag{4.6}$$

$$= \left(\left(p_1 + \frac{b}{m} \right) cos^2\beta + mp_2 cos^2\beta + k \left(p_1 + \frac{b}{m} \right) sin^2\beta - mkp_2 cos^2\beta - \frac{b}{m}, \right.$$

$$\left. m \left(p_1 + \frac{b}{m} \right) cos^2\beta + p_2 sin^2\beta - mk \left(p_1 + \frac{b}{m} \right) cos^2\beta + kp_2 cos^2\beta \right) \tag{4.7}$$

V. Justification of General Formula

Let us consider $(p_1, p_2) \in l$, then we have

$$T_{l.k}((p_1, p_2)) = \left(\left(p_1 + \frac{b}{m} \right) cos^2\beta + mp_2 cos^2\beta + k \left(p_1 + \frac{b}{m} \right) sin^2\beta - mkp_2 cos^2\beta \right.$$

$$\left. - \frac{b}{m}, m \left(p_1 + \frac{b}{m} \right) cos^2\beta + p_2 sin^2\beta - mk \left(p_1 + \frac{b}{m} \right) cos^2\beta + kp_2 cos^2\beta \right)$$

$$= \left(\left(\frac{p_2}{m} \right) cos^2\beta + mp_2 cos^2\beta + k \left(\frac{p_2}{m} \right) sin^2\beta - mkp_2 cos^2\beta \right.$$

$$\left. - \frac{b}{m}, m \left(\frac{p_2}{m} \right) cos^2\beta + p_2 sin^2\beta - mk \left(\frac{p_2}{m} \right) cos^2\beta + kp_2 cos^2\beta \right)$$

$$= \left(\left(\frac{p_2}{m} \right) cos^2\beta + mp_2 cos^2\beta + k \left(\frac{p_2}{m} \right) sin^2\beta - mkp_2 cos^2\beta \right.$$

$$\left. - \frac{b}{m}, p_2 cos^2\beta + p_2 sin^2\beta - kp_2 cos^2\beta + kp_2 cos^2\beta \right)$$

$$= \left(\left(\frac{p_2}{m} \right) cos^2\beta + mp_2 cos^2\beta + k \left(\frac{p_2}{m} \right) sin^2\beta - mkp_2 cos^2\beta - \frac{b}{m}, p_2 (cos^2\beta + sin^2\beta) \right)$$

$$= \left(\left(\frac{p_2}{m}\right)cos^2\beta + mp_2cos^2\beta + k\left(\frac{p_2}{m}\right)sin^2\beta - mkp_2cos^2\beta - \frac{b}{m}, p_2\right)$$

$$= \left(\left(\frac{p_2}{m}\right)(1 - sin^2\beta) + mp_2cos^2\beta + k\left(\frac{p_2}{m}\right)sin^2\beta - mkp_2cos^2\beta - \frac{b}{m}, p_2\right)$$

$$= \left(\left(\frac{p_2}{m}\right) - \left(\frac{p_2}{m}\right)sin^2\beta + mp_2cos^2\beta + k\left(\frac{p_2}{m}\right)sin^2\beta - mkp_2cos^2\beta - \frac{b}{m}, p_2\right)$$

$$= \left(\left(\frac{p_2}{m}\right) - \left(\frac{p_2}{m}\right)sin^2\beta + m^2\frac{p_2}{m}cos^2\beta + k\left(\frac{p_2}{m}\right)sin^2\beta - mkp_2cos^2\beta - \frac{b}{m}, p_2\right)$$

$$= \left(\left(\frac{p_2}{m}\right) - \left(\frac{p_2}{m}\right)sin^2\beta + \frac{p_2}{m}tan^2\beta cos^2\beta + k\left(\frac{p_2}{m}\right)sin^2\beta - mkp_2cos^2\beta - \frac{b}{m}, p_2\right)$$

$$= \left(\left(\frac{p_2}{m}\right) - \left(\frac{p_2}{m}\right)sin^2\beta + \frac{p_2}{m}sin^2\beta + k\left(\frac{p_2}{m}\right)sin^2\beta - mkp_2cos^2\beta - \frac{b}{m}, p_2\right)$$

$$= \left(p_1 + \frac{b}{m} + k\left(\frac{p_2}{m}\right)sin^2\beta - mkp_2cos^2\beta - \frac{b}{m}, p_2\right)$$

$$= \left(p_1 + \frac{b}{m} + k\left(\frac{p_2}{m}\right)sin^2\beta - m^2k\left(\frac{p_2}{m}\right)cos^2\beta - \frac{b}{m}, p_2\right)$$

$$= \left(p_1 + \frac{b}{m} + k\left(\frac{p_2}{m}\right)sin^2\beta - k\left(\frac{p_2}{m}\right)tan^2\beta cos^2\beta - \frac{b}{m}, p_2\right)$$

$$= \left(p_1 + \frac{b}{m} + k\left(\frac{p_2}{m}\right)sin^2\beta - k\left(\frac{p_2}{m}\right)sin^2\beta - \frac{b}{m}, p_2\right)$$

$$= (p_1, p_2)$$

$$\implies T_{l.k}((p_1, p_2)) = (p_1, p_2)$$

Hence, it keeps l pointwise invariant.

Further, let $T_{l.k}((p_1, p_2)) = (p_1', p_2')$, then the slop of the line between two points $P = (p_1, p_2)$ and $P' = (p_1', p_2')$ is given as;

$$\frac{(p_2' - p_2)}{(p_1' - p_1)} = \frac{m\left(p_1 + \frac{b}{m}\right)cos^2\beta + p_2sin^2\beta - mk\left(p_1 + \frac{b}{m}\right)cos^2\beta + kp_2cos^2\beta - p_2}{\left(p_1 + \frac{b}{m}\right)cos^2\beta + mp_2cos^2\beta + k\left(p_2 + \frac{b}{m}\right)sin^2\beta - mkp_2cos^2\beta - \frac{b}{m} - p_1}$$

$$= \frac{m(1-k)\left(p_1 + \frac{b}{m}\right)\cos^2\beta + (k-1)p_2cos^2\beta}{(k-1)\left(p_1 + \frac{b}{m}\right)\sin^2\beta + m(1-k)p_2cos^2\beta} = \frac{\left\{\frac{m(1-k)\left(p_1+\frac{b}{m}\right)\cos^2\beta+(k-1)p_2cos^2\beta}{cos^2\beta}\right\}}{\left\{\frac{(k-1)\left(p_1+\frac{b}{m}\right)\sin^2\beta+m(1-k)p_2cos^2\beta}{cos^2\beta}\right\}}$$

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$$= \frac{m(1-k)\left(p_1+\frac{b}{m}\right)+(k-1)p_2}{m^2(k-1)\left(p_1+\frac{b}{m}\right)+m(1-k)p_2} = \frac{m(1-k)\left(p_1+\frac{b}{m}\right)+(k-1)p_2}{m\left\{m(k-1)\left(p_1+\frac{b}{m}\right)+(1-k)p_2\right\}}$$

Notes

$$= \frac{m\{-(k-1)\}\left(p_1+\frac{b}{m}\right)+(p_2\{-(1-k)\}}{m\left\{m(k-1)\left(p_1+\frac{b}{m}\right)+(1-k)p_2\right\}} = \frac{-\left\{m(k-1)\left(p_1+\frac{b}{m}\right)+(1-k)p_2\right\}}{m\left\{m(k-1)\left(p_1+\frac{b}{m}\right)+(1-k)p_2\right\}}$$

$$= \frac{-1}{m}$$

$$\Longrightarrow \frac{(p_2'-p_2)}{(p_1'-p_1)} = \frac{-1}{m}$$

Hence, line passing through two point $P=(p_1,p_2)$ and $P'=(p_1',p_2')$ i.e line $\overline{PP'}$ is perpendicular to l.

VI. Conclusion

The results on general coordinate formula of strain (skew reflection) of $\mathbb{R}^2$ onto $\mathbb{R}^2$ are summarized as follows;

1. Equation of strain with X-axis and coefficient k is

$$T_{y=0,k}((p_1,p_2)) = (p_1, kp_2)$$

2. Equation of strain with Y-axis and coefficient k is

$$T_{x=0,k}((p_1,p_2)) = (kp_1, p_2)$$

3. If, $l: y = mx+b, m \neq 0$ and $\beta = arctan(m)$; then

$$T_{l.k}((p_1,p_2)) = \left(\left(p_1+\frac{b}{m}\right)cos^2\beta + mp_2cos^2\beta + k\left(p_1+\frac{b}{m}\right)sin^2\beta\right.$$

$$\left.-mkp_2cos^2\beta - \frac{b}{m}, m\left(p_1+\frac{b}{m}\right)cos^2\beta + p_2sin^2\beta - mk\left(p_1+\frac{b}{m}\right)cos^2\beta + kp_2cos^2\beta\right).$$

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Testing Restricted Mean Vector under Alternatives Hypothesis

By F. Mim & A. K. Majumder
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Abstract- In most of the statistical models, the sign of the parameters are known is advance. In order to test the validity of the model, estimation and testing parameters to be done at the initial stage. In this case, usual unrestricted estimation and testing procedures may result in incorrect solutions. Usually, two-sided F or χ^2 testing are not suitable as well as unconstraint optimization solutions can give wrong estimate. In multivariate analysis, we usually apply two-sided Hotelling's $-T^2$ for testing mean vector. This test may not be appropriate for testing when an order restriction is imposed among several p-variate normal mean vector. The main objective of this paper is for a given a multivariate normal population with unknown covariance matrix to develop a new testing procedure when the mean vector slipped to the right or to the left or both. So, we proposed a new distance based one sided and partially one sided Hotelling's $-T^2$ to test restricted mean vectors. Monte Carlo simulations are conducted to compare power properties of the proposed DT^2 along with their respective conventional counterparts.

Keywords: distance–based test, weighted mixture distribution, simulation, one-sided and partially one-sided hotelling's-T^2, power.

GJSFR-F Classification: MSC 2010: 97G70

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Testing Restricted Mean Vector under Alternatives Hypothesis

F. Mim [α] & A. K. Majumder [σ]

Abstract- In most of the statistical models, the sign of the parameters are known is advance. In order to test the validity of the model, estimation and testing parameters to be done at the initial stage. In this case, usual unrestricted estimation and testing procedures may result in incorrect solutions. Usually, two-sided F or χ^2 testing are not suitable as well as unconstraint optimization solutions can give wrong estimate. In multivariate analysis, we usually apply two-sided Hotelling's -T^2 for testing mean vector. This test may not be appropriate for testing when an order restriction is imposed among several p-variate normal mean vector. The main objective of this paper is for a given a multivariate normal population with unknown covariance matrix to develop a new testing procedure when the mean vector slipped to the right or to the left or both. So, we proposed a new distance based one sided and partially one sided Hotelling's -T^2 to test restricted mean vectors. Monte Carlo simulations are conducted to compare power properties of the proposed DT^2 along with their respective conventional counterparts. It is found that our proposed DT^2 test shows substantially improved power than the usual two-sided test in all situations.

Keywords: distance–based test, weighted mixture distribution, simulation, one-sided and partially one-sided hotelling's-T^2*, power.*

I. Introduction

Multivariate analysis considers joint effect of a set of variables simultannously. It can be applied in different ares of scientific research viz, Medical, Zoological, Botanical etc. In medical science, diagnosis of diseases of patients are based on several physical or clinical conditions. Simultaneous physical or clinical conditions of patients with interaction can be very useful to correctly diagnose diseases of patients. Statistical multivariate analysis such as multivariate mean vector, cluster analysis, factor analysis etc. can be very useful to diagnosis or identify factors of diseases. In recent year there has been a significant amount of interest in developing tests that incorporate one sided information. For example, in the case of ordered treatment means or the testing in which a treatment is better than the control when the responses are ordinal. The application of restricted hypothesis can be found in clinical trials design to test superiority of a combination therapy (Laska and Meisner, 1989and Sarka et al.,1995). The extensive literature concerning this problem has been appeared by Barlow et al.(1972),Robertson et al. (1988) and Silvapulle and Sen (2005). Bartholomew (1959a,b)derived a likelihood ratio test for homogeneity of k univariate normal means against ordered alternatives. The problems with ordered parameters have been studied to some extents by Chacko (1963) and Shorack (1967). Kudo (1963) considered a p - dimensional normal distribution with unknown mean $\mu = (\mu_1, \mu_2, ..., \mu_p)$ and known covariance matrix Σ. The problem of testing was $H_o : \mu = 0$ against the restricted

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alternative $H_a : \mu_i \geq 0(i = 1,2,......., p)$, where the inequality is strict for at least one value of i. He obtained the test statistic based on the likelihood ratio criterion and discussed its existence and geometric nature and also gave a scheme for its computation. Perlman (1969) studied this problem assuming that $\sum$ is completely unknown. Tang et al. (1989) proposed a new multivariate statistic for this problem of testing with known covariance matrix and investigated its null distribution. Robertson and Wegman (1978) obtained the likelihood ratio test statistic for testing the isotonicness of several univariate normal means against all alternative hypotheses. They calculated its exact critical values at different significance levels for some of the normal distributions and simulated the power by Monte Carlo experiment. Also they considered the test of trend for an exponential class of distributions.

Hotelling's T^2 is a very versatile test statistic to test the homogeneity of several multivariate normal means against the unrestricted alternative hypothesis. In this paper, our main objective is to develop one-sided and partially one-sided testing approach for testing restricted multivariate mean vector using Hotelling's T^2 type test along with Distance-Based estimation technique (See for example, Majumder and King (1999)) and make a comparative study between the usual two-sided Hotelling's T^2 and distance-based Hotelling's T^2 (DT^2) tests.

The paper is organized as follows. In Section 2, we represent the hypothesis used to develop the test. Our proposed DT^2 along with usual T^2 test are discussed in Section 3. Calculation of weights and Monte Carlo simulation are given in Section 4 and 5. In Section 6, we introduce the design matrix. A comparison is made between the powers of two-sided T^2 and DT^2 tests in Section 7. Finally, Section 8 contains concluding remarks.

II. Hypothesis

Multivariate one-sided hypothesis-testing problems are very common in real life. The likelihood ratio test (LRT) and union intersection test (UIT) are widely used for testing such problems. It is argued that, for many important multivariate one-sided testing problems, the LRT and UIT fail to adapt to the presence of sub-regions of varying dimensionalities on the boundary of the null parameter space and thus give undesirable results. Several improved tests are proposed that do adapt to the varying dimensionalities and hence reflect the evidence provided by the data more accurately than the LRT and UIT (See Perlman, Lang). Suppose that $X_{i1}, X_{i2},........., X_{ini}$ are random vectors from a p - dimensional normal distribution $Np(\mu_i, \sum)$ with unknown mean vector μ_i and nonsingular covariance matrix $\sum_i, i = 1,2,......, k$. We assume that $\sum$ is unknown. In order to test the mean vector we consider the following hypotheses

$$\text{H1} \quad H_0^1 : \mu = 0 \quad \text{vs} \quad H_a^1 : \mu > 0,$$

$$\text{H2} \quad H_0^2 : \mu = 0 \quad \text{vs} \quad H_a^2 : \mu < 0,$$

$$\text{H3} \quad H_0^3 : \mu = 0 \quad \text{vs} \quad H_a^3 : \mu_k > 0, \mu_l \neq 0, \mu_m < 0.$$

where, $k \neq l \neq m$, $\mu = (\mu_1, \mu_2, \ldots, \mu_p)'$ *is a* $(p \times 1)$ matrix.

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III. Distance-Based One-Sided Tests

Notes

Distance-based approach suggests that we have to determine whether the estimated parameters under test likely to be closer to null hypothesis or to alternative hypothesis. For testing two or more parameters, we can use the normal Euclidean measure of distance to determine closest point in the maintained hypothesis parameter space to the unconstrained estimate. But, in the case of a non-orthogonal design matrix, we use a transformation of the original model to understand the incorporation variance-covariance or information matrix to measure the distance in general situations. It is also worth noting that Shapiro (1988, p.50) used the variance-covariance matrix in a metric to determine the closest point in maintained hypothesis from the estimated value of the parameter. Also, Kodde and Palm (1986) used a distance function and metric spaces to develop a test based on their distance function. Majumder (1999) utilizes these ideas to develop distance-based approach for testing one-sided or partially one-sided hypothesis of any parametric model. In this paper, we apply Majumder and King's (1999) distance based approach. Majumder's (1999) approach is outlined below for general testing problem: suppose, we are interested in testing a hypothesis of a parametric model in which the parameter of interest, θ, is restricted under the alternative hypothesis. More specifically, we wish to test

$$H_0 : \theta = 0 \qquad \text{versus} \qquad H_a : \theta \in B$$

based on the $n \times 1$ random vector y whose distribution has probability density function $f(y, \theta)$ where $\theta \in R^p$ is a subvector of an unknown parameter $\Theta \in R^s$ and B is a subset of R^p. Let $\hat{\theta}$ be a suitable estimate of θ such that $\hat{\theta}$ is asymptotically distributed as normal with variance-covariance matrix $cI^{-1}(\theta)$ where c is a constant and $I(\theta)$ is the information matrix. As θ is an element of B, and B is a subset of R^p, elements of the parameter vector θ can be either positive, negative or both. Therefore, a test under this hypothesis is either one-sided when all values of θ are positive (or more accurately constrained to have a particular sign-positive or negative) or partially one-sided when some of the values are positive and some are unconstrained. Following Shapiro (1988, eq.21, p.50), Kodde and Palm's (1986) Majumder (1999) suggest that we should determine the closest point in the maintained hypothesis from the unconstrained point. This closest point is the solution of the following distance function or optimal function in the metric $cI^{-1}(\theta)$ of the parameter vector $\hat{\theta}$

$$\left\| \breve{\theta} - \hat{\theta} \right\|^2 = (\breve{\theta} - \hat{\theta})' I(\theta)(\breve{\theta} - \hat{\theta})$$

subject to $\breve{\theta} \in B$.

The closest point or optimized $\breve{\theta}$ can be used in any appropriate two-sided tests to obtain the corresponding distance-based one-sided and partially one-sided tests. The asymptotic null hypothesis distribution generally follows a mixture of the corresponding two-sided distributions.

a) Distance-Based One-Sided LR test

The Likelihood ratio (LR) test requires calculation of both restricted and unrestricted estimators. If both are simple to compute, this will be a convenient way to proceed.

The general form of two-sided LR statistic is,

$$LR = 2\left(l(\hat{\theta}_a) - l(\hat{\theta}_0)\right), \qquad (3.1.1)$$

where, $l(\hat{\theta}_0)$ and $l(\hat{\theta}_a)$ are the unrestricted and restricted maximized log-likelihood functions, respectively. The asymptotic null hypothesis distribution of (4.1.1) follows a central chi-square distribution with k degrees of freedom. But the two-sided LR test is not appropriate when the alternative hypothesis becomes strictly one-sided. In our distance-based LR test we have to estimate the optimum values of $l(\hat{\theta}_0)$ and $l(\hat{\theta}_a)$ according to the general formulation of distance-based approach (see for example, Majumder (1999), Basak, T. (2004), Rois etl. (2008)), subject to the restrictions $\mathrm{H1}$ and $\mathrm{H2}$, discussed in section 2. Then the statistic becomes,

$$DLR = L\breve{R} = 2\left(l(\breve{\theta}_a) - l(\breve{\theta}_0)\right), \qquad (3.1.2)$$

where, $l(\breve{\theta}_0)$ is the unrestricted optimized value and $l(\breve{\theta}_a)$ is the optimized value subject to the restrictions, $\mathrm{H1}$ and $\mathrm{H2}$.

Under the null hypothesis the distribution of the statistic (3.1.2) follows asymptotically weighted mixture of chi-square distribution with p degrees of freedom (see for example, Kodde and Palm (1986), Shaprio (1988), Majumder (1999)).

b) Distance-Based One-Sided Hotelling T^2 (DT^2) Test

In this testing procedure we wish to maximize

$$L(\theta, \Sigma) = \frac{1}{(2\pi)^{np/2} |\Sigma|^{n/2}} \exp\left[-\frac{1}{2}\sum_{i=1}^{n}(x_i - \mu)' \Sigma^{-1}(x_i - \mu)\right], \qquad (3.1.3)$$

with respect to μ, Σ and subject to the restrictions : $\mu > 0 \; or \; \mu < 0 \; or \; \mu_k < 0, \mu_l \neq 0, \mu_m > 0$ where, $k \neq l \neq m$.

In our DT^2 we have to estimate the optimum values of μ under the above restrictions according to the general formulation of distance-based approach (See for example, Majumder (1999), Basak, T. (2004), Rois etl. (2008)). Replacing the usual maximum likelihood estimate of μ in two-sided T^2 by the optimal value we get the following one-sided or partially one-sided T^2 statistic,

$$T^2 = n(\breve{\mu} - \mu_0)' S^{-1}(\breve{\mu} - \mu_0) \qquad (3.1.4)$$

where, $\breve{\mu}$ is the optimized value . Under the null hypothesis the distribution of the test statistic (3.4) follows weighted mixture of $\frac{(n-1)p}{n-p} \times F_{p,(n-p)}$ distribution.

IV. Determination of Weights

Weights of DT^2 can be calculated from likelihood ratio test. Monfort's (1980) one-sided LR test statistic is given below:

$$S_{LR} = 2(L(\tilde{\mu}, \Sigma) - L(\hat{\mu}, \Sigma) = L(\tilde{w}) \text{-} L(\hat{w}_0) \qquad (4.1)$$

where, $\tilde{w} = (\tilde{\mu}', \tilde{\Sigma}')'$, $\hat{w}_0 = (\hat{\mu}', \hat{\Sigma}_0')'$

Notes

The asymptotic null hypothesis distribution of (4.1) is a probability mixture of independent chi-squared distributions with different degrees of freedom and is given by,

$$\Pr(S_{LR} < c) = \sum_{i=1}^{n} w(p,i)\Pr(F < c), \text{ for } c \in R, \tag{4.2}$$

where, F denotes a random variable having F distribution with i degrees of freedom and R is the two sided LR statistic defined as,

Notes

$$R = \operatorname{sgn}(\hat{\mu} - \mu_0)\sqrt{2\{L(\hat{\mu}, \Sigma) - L(\tilde{\mu}_0, \Sigma)\}}\,. \tag{4.3}$$

The weight, $w(p, i)$, $i = 1, 2, \cdots, p$ denote the power function of times any i elements of $\tilde{\mu}$ are strictly positive and the remaining $p - i$ elements are zero under the null hypothesis.

V. Monte Carlo Simulation

Monte Carlo simulations are carried out to compare the powers of the usual T^2 and DT^2 for testing restricted multivariate mean vector. The powers were estimated by calculating the percentage of times the test statistics exceeded the appropriate 5% critical values. Here each entry is based on at least 5000 runs.

a) Experimental design

In order to compare the power properties of proposed DT^2 test with usual T^2, we use artificially generated data. Since Hotelling T^2 statistic is a generalization of Student's t statistic and Student's t statistic follows normal distribution, we generate data of size 100 from Multivariate Normal distribution by Spectral decomposotion with mean vector assumed in hypothesises and covarinaces Σ_1 and Σ_2. To make the comparison appropriate, we consider hypothetical covariance matrices

$$\Sigma_1 = \begin{bmatrix} 20 & -5 \\ -5 & 13 \end{bmatrix}, \quad \Sigma_2 = \begin{bmatrix} 23.65 & 18.43 & 13.78 \\ 8.43 & 32.28 & 25.18 \\ 13.78 & 25.18 & 42.53 \end{bmatrix}.$$

We perform our experiment for different values of the parameters $\mu = (\mu_1, \mu_2, \mu_3)'$ ($\mu = 0,.3,\ .5,.7,1$). On the basis of the above covariance matrix we estimate simulated powers of all the considerate tests for testing strictly one-sided and partially one-sided hypothesis.

For testing, H1, H2 and H3 we use, $\mu = (0, 0.3, 0.5, 0{\cdot}7, 1)'$, $\mu = (0, -0.3, -0.5, -0.7, -1)'$ and $\mu = (0, 0.3, -0.5, 0.7, 1)'$, respectively, for each design matrix.

VI. Results

This section compares the power of the existing Hotelling's T^2 and proposed DT^2 for testing H1, H2, H3 for different design matrices defined in Section 6.The estimated simulated powers of these tests are presented in Tables 1-2 with figures 1-2 for the defined design matrixes Σ_1 and Σ_2 .

For the design matrix Σ_1 and $\mu = (\mu_1, \mu_2)'$, simulated powers of DT^2 test and the usual T^2 test when the alternative hypothesis is of the form H_a^1, H_a^2 are presented in Table 1.

Table 1: Simulated power comparisons of the DT^2 and T^2 statistics for hypothesis H1 when covariance matrix Σ_1

μ_1	μ_2	DT^2	T^2
0	0	0.05	0.05
	0.3	0.209	0.1036
	0.7	0.934	0.5819
	1	0.998	0.7352
0	0	0.092	0.0854
	0.3	0.387	0.1881
	0.7	0.972	0.7433
	1	0.999	0.8173
1	0	0.850	0.2841
	0.3	0.954	0.4418
	0.7	0.999	0.763
	1	1	0.9251
1	0	0.994	0.5371
	0.3	0.999	0.6867
	.5	1	0.7914
	0.7	1	.8942

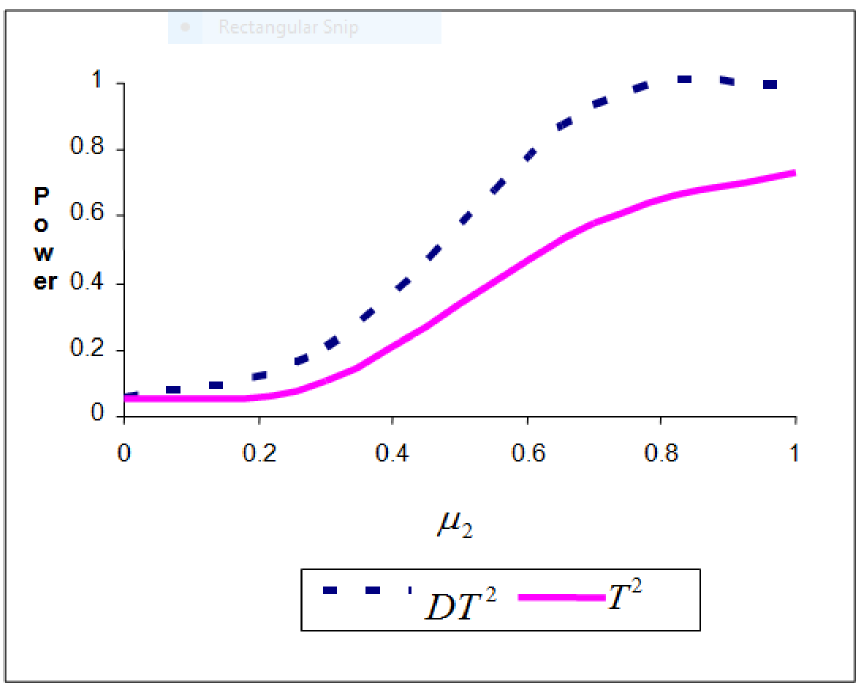

Figure 1: Power curves of DT^2 *and* T^2 *tests of hypothesis,* H1, *for* $p = 2$ *and fixed* $\mu_1 = 0$

Table 1 reveals the estimated powers of Hotelling's T^2 and our proposed distance based Hotelling's T^2 for the design matrix Σ_1 and $\mu = (\mu_1, \mu_2)'$, when the alternative hypothesis is of the form H_a^1, H_a^2. We observe that the power of the DT^2 test is higher than the usual T^2 test in all cases. For example, the powers of the DT^2 and T^2 tests are 0.2099 and 0.1036, respectively, for $\mu_1 = 0, \mu_2 = 0.3$.

Notes

Table 2 shows, simulated powers for testing H_a^3 when the mean vector and design matrix is of the form $\mu = (\mu_1, \mu_2, \mu_3)'$ and Σ_2, respectively. Also, we observe that the powers of the DT^2 and T^2 test when $\mu_1 = 0, \mu_2 = 0.5, \mu_3 = 0.3$ are 0.912, 0.341, respectively, for the design matrix Σ_2. Figure 1 and 2 explore that powers of all tests are increases as increases.

Notes

Table 1: Simulated power comparisons of the DT^2 and T^2 statistic for hypothesis H3 when covariance matrix Σ_2

μ_1	μ_2	μ_3	DT^2	T^2
		0	0.05	0.05
		0.3	0.219	0.09
0	0	0.5	0.568	0.141
		0.7	0.911	0.281
		1	0.998	0.472
		0	0.773	0.23
		0.3	0.912	0.341
0	.5	0.5	0.901	0.253
		0.7	0.996	0.601
		1	1	0.485
		0	0.5	0.159
		0.3	0.795	0.239
	0	0.5	0.854	0.219
.3		0.7	0.988	0.468
		1	1	0.49
		0	0.979	0.454
		0.3	0.993	0.576
0.5	. 5	0.5	0.997	0.401
		0.7	0.999	0.787
		1	1	0.597

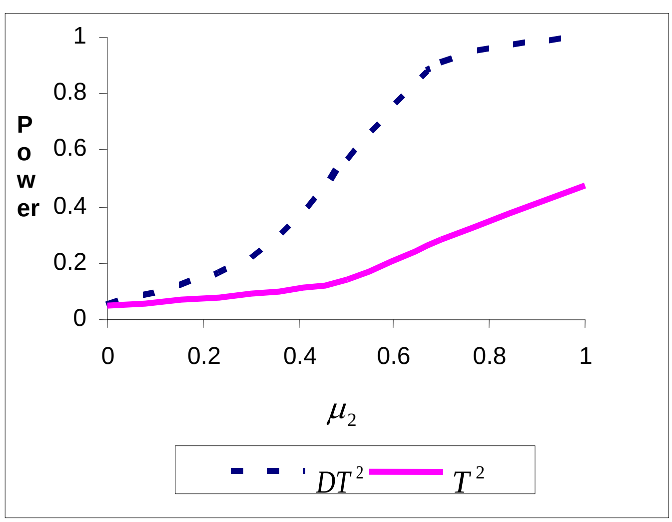

Figure 2: Power curves of DT^2 and T^2 tests of hypothesis H1, for $p = 3$, Σ_2 and fixed $\mu_1 = 0, \mu_2 = 0$.

We observe from Monte Carlo simulation study that in all cases our proposed DT^2 test gives higher power than two-sided T^2 test. All the figures and tables represent that the simulated power of all one-sided T^2test is always superior to its usual two-sided counterpart.

VII. Conclusions

This paper develops distance based one-sided and partially one-sided testing approach for testing multivariate mean vector under considered restricted alternative hypothesis. We observe from Monte Carlo simulation studies in different cases. All the figures and tables represent that the simulated power of one-sided and partially one-sided test is always superior to the usual two-sided test. Monte Carlo results show that the power of the proposed DT^2 test is better than that of the usual test based on the adjusted F distribution. Therefore, we advocate the use of D T^2test to test the multivariate mean vector when the alternative hypothesis is strictly one-sided or partially one-sided.

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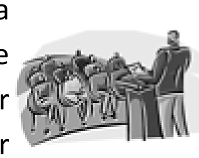

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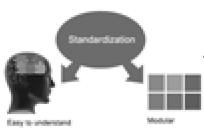

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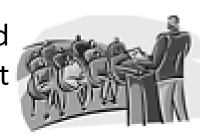

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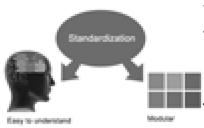

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- In case, the chairperson needs to be replaced then consent of 2/3rd board members are required and they are also required to jointly pass the resolution copy of which should be sent to us. In such case, it will be compulsory to obtain our approval before replacement.
- In case of "Difference of Opinion [if any]" among the Board members, our decision will be final and binding to everyone.

"

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1. General,

2. Ethical Guidelines,

3. Submission of Manuscripts,

4. Manuscript’s Category,

5. Structure and Format of Manuscript,

6. After Acceptance.

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The **Introduction** should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- Explain the value (significance) of the study
- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from a abstract point of vision as well as point out sensible reasons for using it.
- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

Approach:

- Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done.
- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.

- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
- Shape the theory/purpose specifically - do not take a broad view.
- As always, give awareness to spelling, simplicity and correctness of sentences and phrases.

Procedures (Methods and Materials):

This part is supposed to be the easiest to carve if you have good skills. A sound written Procedures segment allows a capable scientist to replacement your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt for the least amount of information that would permit another capable scientist to spare your outcome but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section. When a technique is used that has been well described in another object, mention the specific item describing a way but draw the basic principle while stating the situation. The purpose is to text all particular resources and broad procedures, so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step by step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

- Explain materials individually only if the study is so complex that it saves liberty this way.
- Embrace particular materials, and any tools or provisions that are not frequently found in laboratories.
- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

Methods:

- Report the method (not particulars of each process that engaged the same methodology)
- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

What to keep away from

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.
- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
- All figure and table must be adequately complete that it could situate on its own, divide from text

Discussion:

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a argument should be. Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly described. Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved with prospect, and let it drop at that.

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

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Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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