Analyzing Pakistan Textile and Clothing Export trade dynamics- A comprehensive Study from 2003 to 2021 Using Statistical Model

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Abstract: Pakistan's textile industry is the core of the nation's economy, employing over 15 million people and contributing over 60% of all export earnings. The research work done in this paper includes the collection of yearly data (2003-2021) of textile exports of Pakistan with other countries. By using MINITAB software Moving Average Model and Residual Plots has been obtained 100% throughout model and it gives appropriate forecast values. This statistical model provides the expected value for the prediction of future textile export data. The main aim of the manuscript is to throw light on dynamic performance of exports of textiles of Pakistan in the perspective of various countries like Afghanistan, Bangladesh, Turkey, Germany, Australia, Sri Lanka, China, India and Qatar.

Keywords: Textile exports, Statistical models, forecast

1. Introduction

Pakistan's export business is undeniably supported by its textile industry. Pakistan is one of the most capable in textile-producing among different Asian countries. It contributes 8.5 % in GDP and provides 15 million employments, which is 30% of total work force of 49 million in Pakistan. More than 2500 textile-producing businesses use more than 440 mills in Pakistan [15, 16]. As a result, Pakistani industrial goods focused on cotton, such as yarn, knitted clothing and woven goods, were able to full fill the demand of overseas markets. As per the Finance Division's (2021) [1] report, the textile industry's share of overall exports in 2018–2019 was around 58.30 percent, or $13,396.074 million, however the total exports amounted to approximately $22,979.325 million. The two categories of textiles that provide the least to textile exports are woolen and synthetic, with cotton and cotton-based textiles meeting up the majority of the total. Around $13,031 million is made up of textiles made of cotton, whereas synthetic and woolen textiles contribute another $297.809 and $67.265 million respectively [1-4].

Over the next 50 years production dynamics are predicted to positively affect economic growth in Pakistan and India [2]. The quick consequences of exchange liberalization can be absorbed by forming a buffer zone [3]. In order to improve national benefits, further credits to the export sectors may be conferred [4].

2. Methodology

In this research paper some statistical tools were incorporated like Minitab software to determine the significant model of textile exports and forecasts for various countries selected export data from 2003 to 2021. Click the stats option Minitab software and then. Next open the time series tab and then go to moving average model then selected the exports variable and select the forecast and then go to time option to select the yearly data of different countries. Finally, determined the results by Moving average plot and residual plot graphs [6-8].

The moving-average model (MA), often recognizes as the moving-average process, is a famous technique for modeling univariate time series data [1, 2 & 14]. Time series is defined as data that is acquired in chronological order. Observing time series data reveals insights into how much the data changes over time, as well as underlying trends that can aid in problem solving across multiple disciplines. The analysis of the time series can also help estimate future values based on historical recorded data, resulting in increased productivity, earnings, policy planning, risk management and other profits. As a result, time series data analysis has emerged as a critical component of data science. The moving-average technique describes that the output variable is associated with a random variable that is not itself identical [9-12].

Like the autoregressive (AR) model, moving-average is a subset and important component of the more generic ARMA and ARIMA time series methods [13 & 3], which contains more complex stochastic structure. Unlike the AR model, the finite MA model is always stationary [17].

$$X_t = \mu + \varepsilon_t + \theta_1 \varepsilon_{t-1} + \cdots + \theta_q \varepsilon_{t-q} = \mu + \sum_{i=1}^{q} \theta_i \varepsilon_{t-i} + \varepsilon_t,$$

These values depict the export data of different countries such as Afghanistan, Bangladesh, China, Srilanka, India, Australia, Turkey, Germany and Pakistan from 2003 to 2021, whereas prediction was done for future exports by using Moving Average to selected countries data.

3. Results and Discussion

These numbers represent the export data of various countries such as Afghanistan, Bangladesh, China, Sri Lanka, India, Australia, Turkey and Germany to Pakistan from 2003 to 2021 while forecast predicts the future exports by using Moving Average to these nations.

Time	Export (US$ Thousand)	MA	Predict	Error
2003	12781.8	12781.8	*	*
2004	14125.1	14125.1	12781.8	1343.3
2005	22105.6	22105.6	14125.1	7980.6
2006	7844.1	7844.1	22105.6	-14261.6
2007	3140.1	3140.1	7844.1	-4704.0
2008	7957.1	7957.1	3140.1	4817.1
2009	9091.1	9091.1	7957.1	1133.9
2010	6627.2	6627.2	9091.1	-2463.9
2011	23965.8	23965.8	6627.2	17338.7
2012	29857.3	29857.3	23965.8	5891.5
2013	11465.6	11465.6	29857.3	-18391.8
2014	23337.5	23337.5	11465.6	11871.9
2015	10162.9	10162.9	23337.5	-13174.6
2016	17226.7	17226.7	10162.9	7063.7
2017	11653.7	11653.7	17226.7	-5573.0
2018	22969.0	22969.0	11653.7	11315.4
2019	22155.1	22155.1	22969.0	-813.9
2020	15339.7	15339.7	22155.1	-6815.4

2021	12278.9	12278.9	15339.7	-3060.8

Table 1: Moving Average values of textile exports to Afghanistan from 2003 to 2021

Period	Forecast	Lower	Upper
2022	15339.7	-2994.98	33674.4
2023	15339.7	-2994.98	33674.4
2024	15339.7	-2994.98	33674.4
2025	15339.7	-2994.98	33674.4
2026	15339.7	-2994.98	33674.4

Table 2 Forecast of textile exports to Afghanistan from 2022 to 2026

The textile data of export to Afghanistan (2003-2021) indicates extreme volatility, with values swinging from 3.1million (2007) to3.1 million (2007) to 29.9 million (2012). The moving average predicts for 2022-2026 simply recall the 2021 value of 15.3 million with idealistically wide confidence intervals (−15.3 million with unrealistically wide confidence intervals (−3M to $33.7M), indicating poor model reliability. Given the limitations, more sophisticated forecast methods including economic trends and trade policies would better predict future export patterns. The data clearly shows the need for moderate analytical approaches to adopt strategic trade decisions.

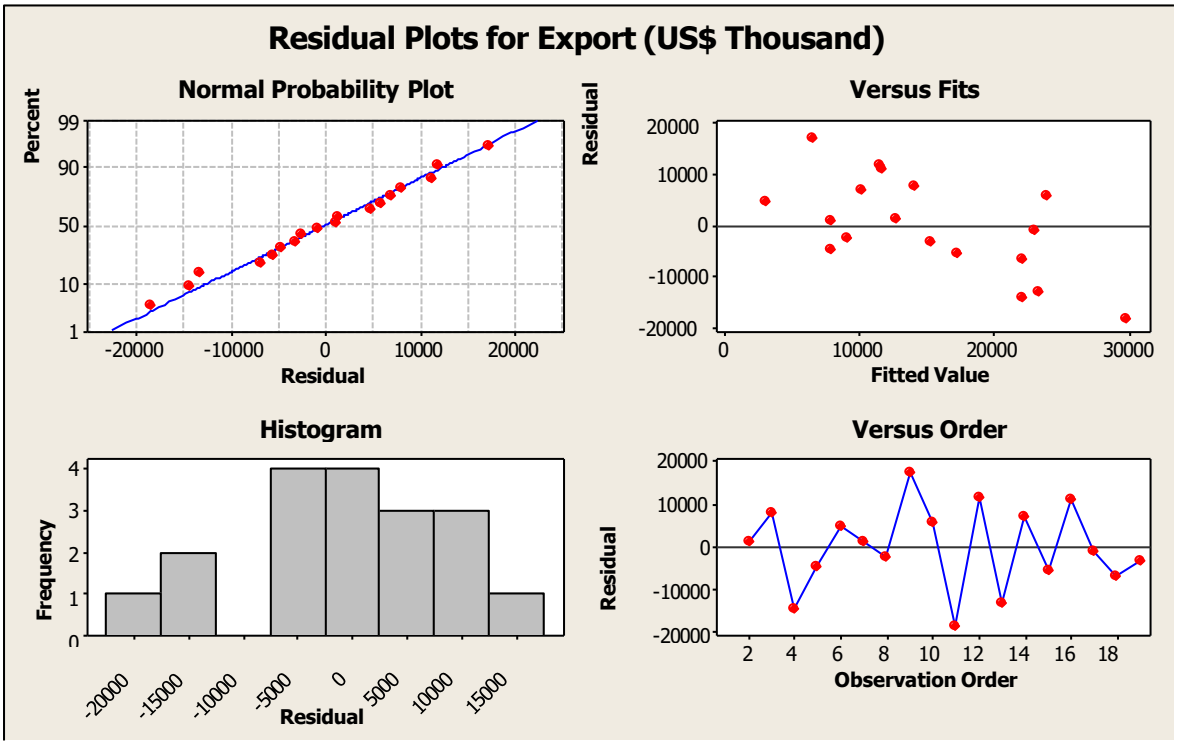


Figure 1 Residual plots of exports to Afghanistan

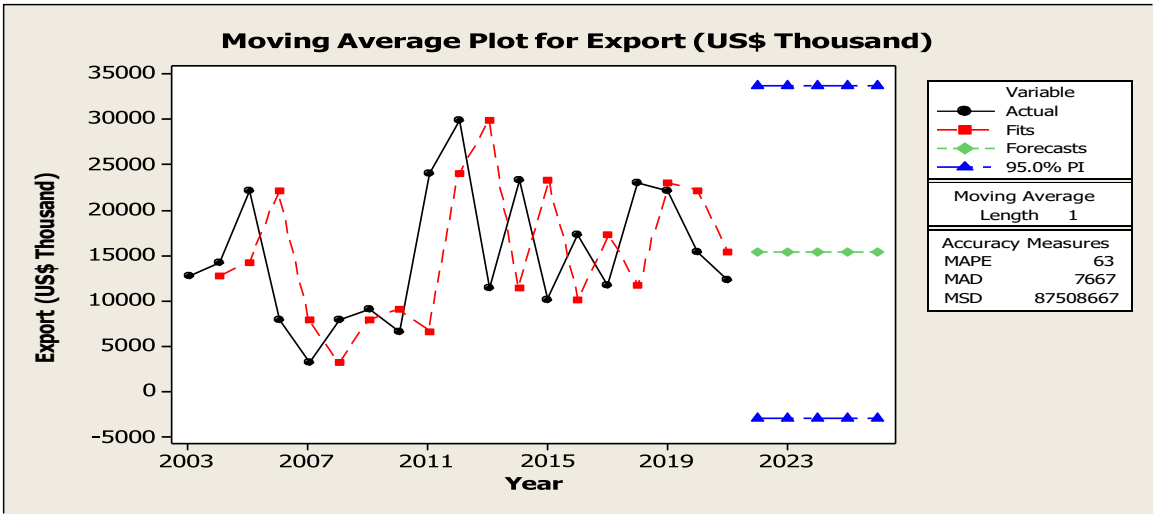


Figure 2 Textile Exports of Pakistan to Afghanistan from 2003 to 2021

Graph expressed that textile exports to Afghanistan are rapidly increase in 2012. Between 2013 to 2020 there are some ups and downs in textile exports.

Time	Export (US$ Thousand)	MA	Predict	Error
2003	124693	124693	*	*
2004	152031	152031	124693	27338
2005	195960	195960	152031	43928
2006	232581	232581	195960	36621
2007	225244	225244	232581	-7337
2008	336687	336687	225244	111442
2009	310659	310659	336687	-26028
2010	467040	467040	310659	156381
2011	584057	584057	467040	117017
2012	591898	591898	584057	7841
2013	628520	628520	591898	36622
2014	608822	608822	628520	-19699
2015	617674	617674	608822	8852
2016	583505	583505	617674	-34168
2017	563066	563066	583505	-20439
2018	591166	591166	563066	28100
2019	591772	591772	591166	605

2020	438768	438768	591772	-153004
2021	678938	678938	438768	240170

Table 3: Moving Average values of textile exports to Bangladesh from 2003 to 2021

Period	Forecast	Lower	Upper
2022	438768	265512	612023
2023	438768	265512	612023
2024	438768	265512	612023
2025	438768	265512	612023
2026	438768	265512	612023

Table 4 Forecast of textile exports to Bangladesh from 2022 to 2026

The textile exports of Bangladesh grew steadily from 124.7 million (2003) to 124.7 million (2003) to 678.9 million (2021), with big surges in 2008, 2010, and 2021. However, the MA model shows large prediction residuals, especially in volatile years like 2020 (-153M) and 2021 (+153M) and 2021 (+240M). The 2022-2026 forecast recalls 2020's dip value (438.8M) with a spread confidence range (438.8M) with a wide confidence range (265.5M-$612M), refusing to reflect the strong recovery of 2021. These simplistic methodology overlooks upward trend of Bangladesh, suggesting advanced technique (e.g., ARIMA, exponential smoothing) would better grip the growth patterns and enhance forecast accuracy for trade planning.

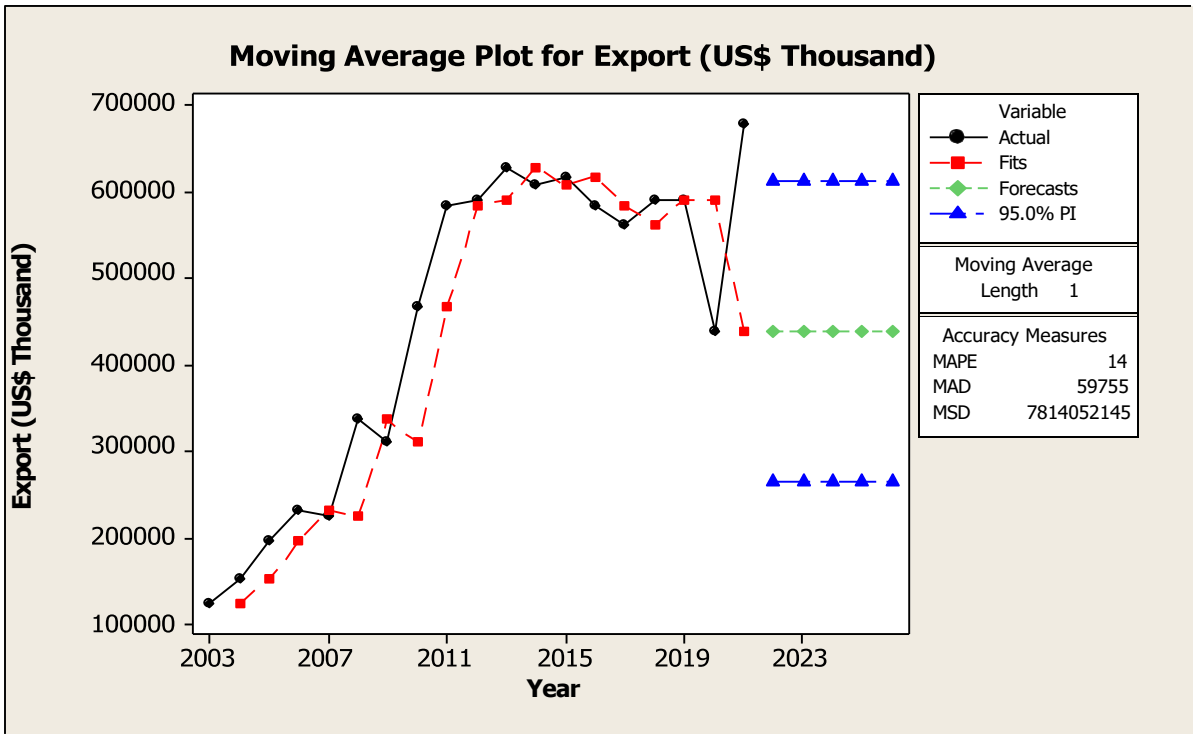


Figure 3 Textile Exports of Pakistan to Bangladesh from 2003 to 2021

This graph indicates that exports of Pakistan to Bangladesh in 2020 decreased fastly and rapidly increase in 2021.

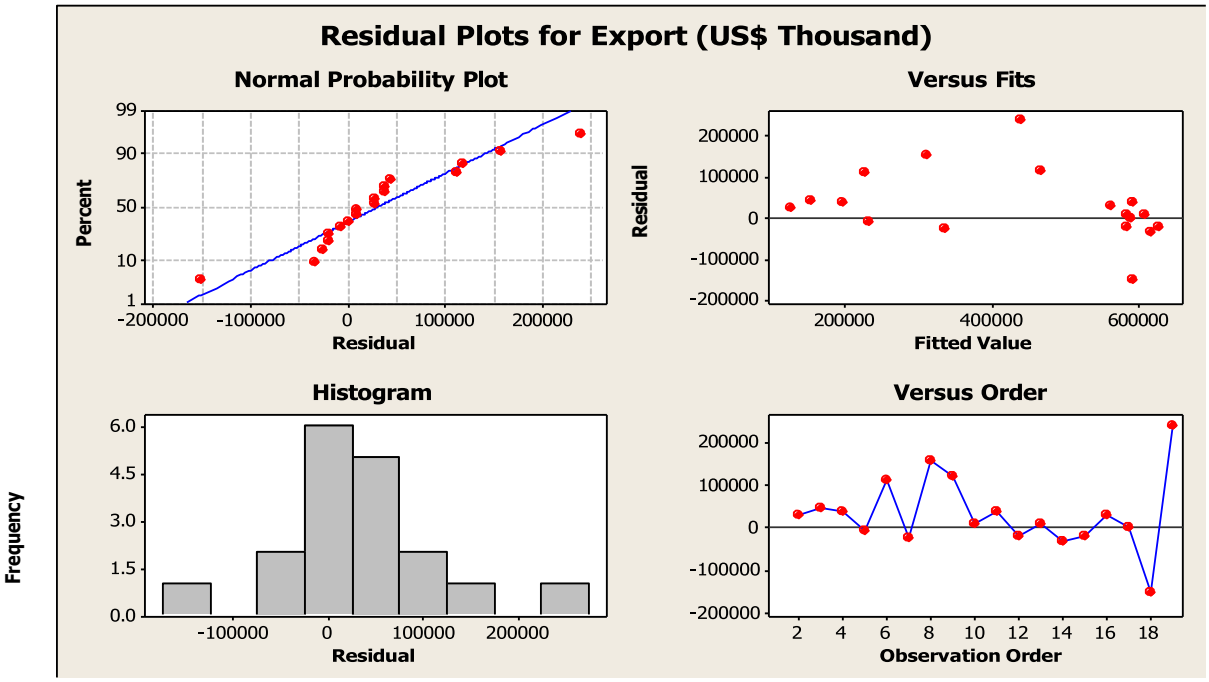


Figure 4 Residual plots of exports to Bangladesh

Time	Export (US$ Thousand)	MA	Predict	Error
2003	47428	47428	*	*
2004	59539	59539	47428	12111
2005	195960	195960	59539	136420
2006	125242	125242	195960	-70717
2007	129468	129468	125242	4226
2008	127389	127389	129468	-2079
2009	107453	107453	127389	-19936
2010	126021	126021	107453	18568
2011	131973	131973	126021	5952
2012	115096	115096	131973	-16877
2013	115300	115300	115096	204
2014	113732	113732	115300	-1567
2015	115466	115466	113732	1733
2016	101933	101933	115466	-13533
2017	112395	112395	101933	10463
2018	133343	133343	112395	20948
2019	138725	138725	133343	5383
2020	98012	98012	138725	-40713
2021	146390	146390	98012	48378

Table 5: Moving Average values of textile exports to Sri Lanka from 2003 to 2021

Period	Forecast	Lower	Upper
2022	98012.4	18523.6	177501
2023	98012.4	18523.6	177501
2024	98012.4	18523.6	177501
2025	98012.4	18523.6	177501
2026	98012.4	18523.6	177501

Table 6 Forecast of textile exports to Sri Lanka from 2022 to 2026

Sri Lanka's textile exports from 2003 to 2021 show significant fluctuations, ranging from 47.4 million to 47.4 million to 146.4 million annually. The MA model reveals substantial predictions errors, specifically during volatile periods - underestimating 2005 exports by 136.4 million while over estimating 2020 by136.4 million while over estimating 2020 by 40.7 million. The 2022-2026 projections, based on 2020's depressed 98 million value, fail to account for the 4898 million value, fail to account for the 4818.5M-$177.5M). This easiest approach cannot describe Sri Lanka's characteristic boom-and-rebound patterns, indicating the need for more sophisticated prediction methods that incorporate financial cycles and recovery trends to better inform trade strategies. The data clearly indicates that advanced analytical techniques would provide more reliable guidance for export planning in this volatile market.

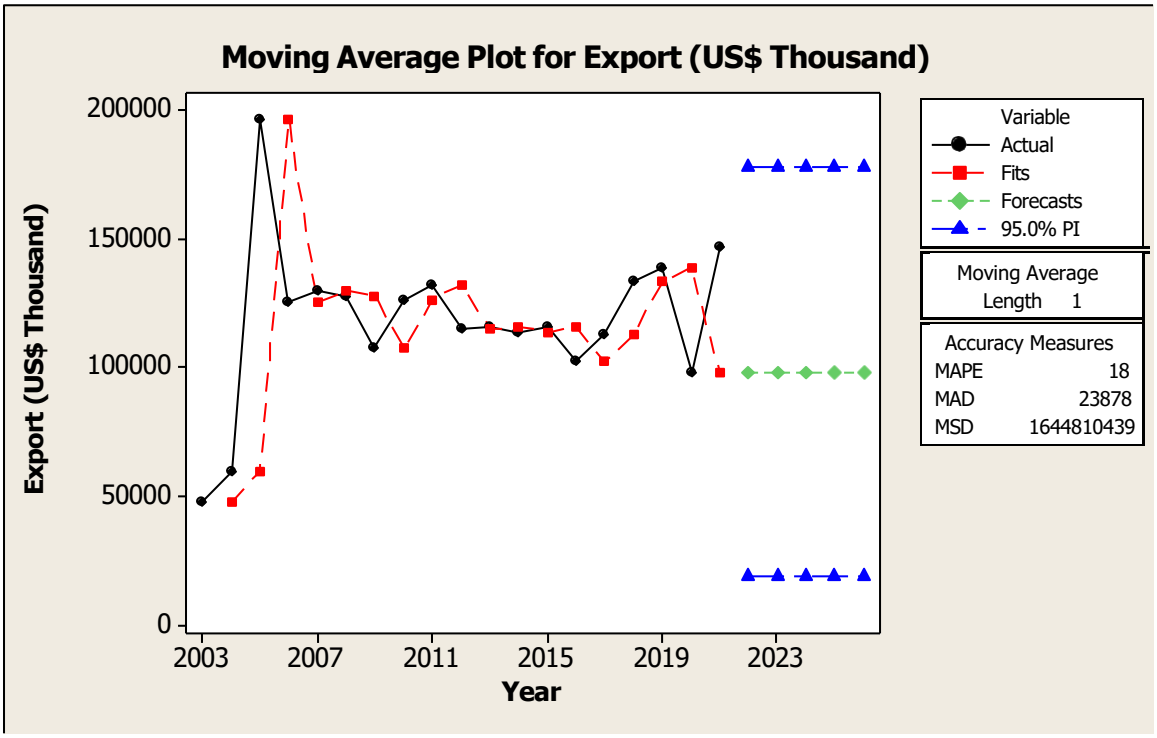


Figure 5 Textile Exports of Pakistan to Sri Lanka from 2003 to 2021

Graph expressed that textile exports to Sri Lanka are rapidly increase in 2004. Between 2005 to 2020 there are some ups and downs in textile exports.

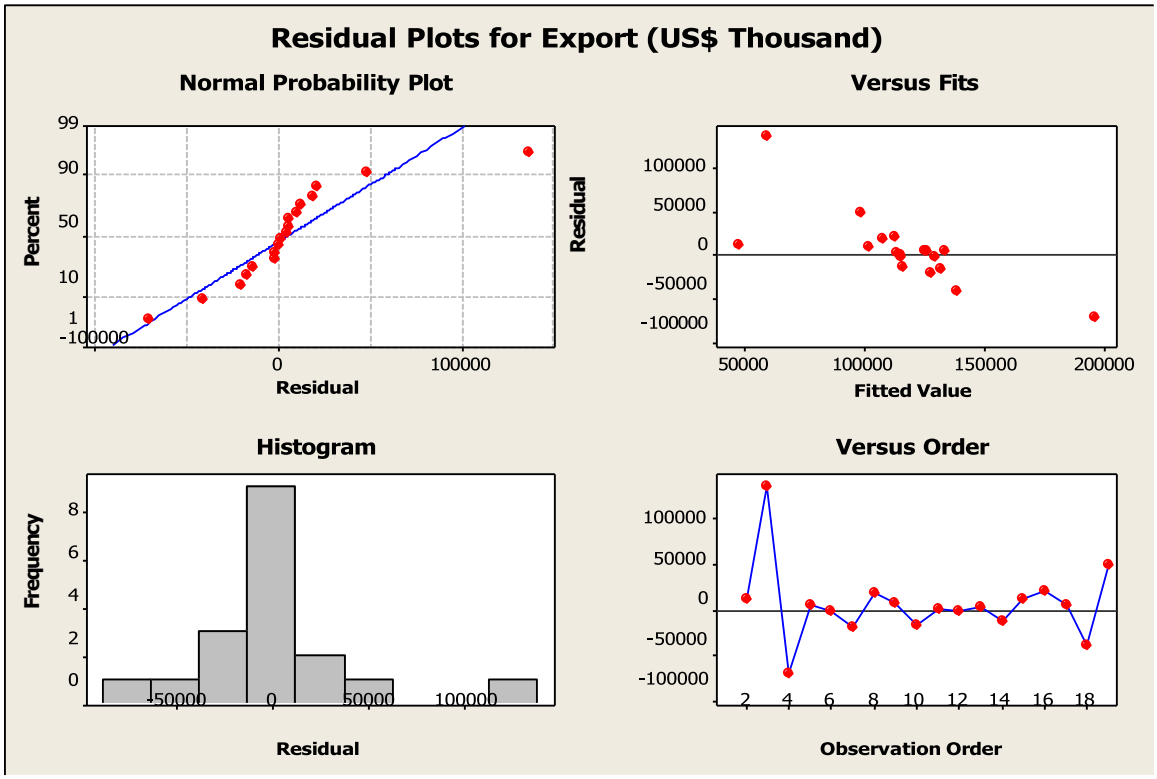


Figure 6 Residuals plots of exports of Srilanka

Time	Export (US$ Thousand)	MA	Predict	Error
2003	170122	170122	*	*
2004	191840	191840	170122	21719
2005	265537	265537	191840	73697
2006	271529	271529	265537	5991
2007	352886	352886	271529	81357
2008	317737	317737	352886	-35148
2009	285314	285314	317737	-32423
2010	395163	395163	285314	109849
2011	480274	480274	395163	85111
2012	230964	230964	480274	-249311
2013	204637	204637	230964	-26327
2014	237642	237642	204637	33005
2015	152495	152495	237642	-85148
2016	172308	172308	152495	19814
2017	257968	257968	172308	85660
2018	216152	216152	257968	-41816
2019	207278	207278	216152	-8874
2020	190842	190842	207278	-16436

2021	216738	216738	190842	25897

Table 7: Moving Average values of textile exports to Turkey from 2003 to 2021

Period	Forecast	Lower	Upper
2022	190842	33608.5	348075
2023	190842	33608.5	348075
2024	190842	33608.5	348075
2025	190842	33608.5	348075
2026	190842	33608.5	348075

Table 8 Forecast of textile exports to Turkey from 2022 to 2026

Turkey's textile exports from 2003 to 2021 exhibited significant volatility, rang from 170 million to 170 million to 480 million annually. The moving average model shows major forecasting errors, particularly during market shocks - underestimating growth in the years like 2011 (480 million) while over estimating periods of crisis like 2012 (52480 million) while over estimating crisis periods like 2012 (52191 million standard, fail to capture Turkey's characteristic recovery patterns and show unrealistically wide confidence ranges (34M−34M−348M). This simplistic approach cannot account for Turkey's economic cycles, currency fluctuations, or trade policy changes, suggesting the need for more sophisticated forecasting methods incorporating macroeconomic indicators and market trends for reliable export planning. The data clearly indicates that advanced analytical models would better support strategic decision-making in this dynamic market.

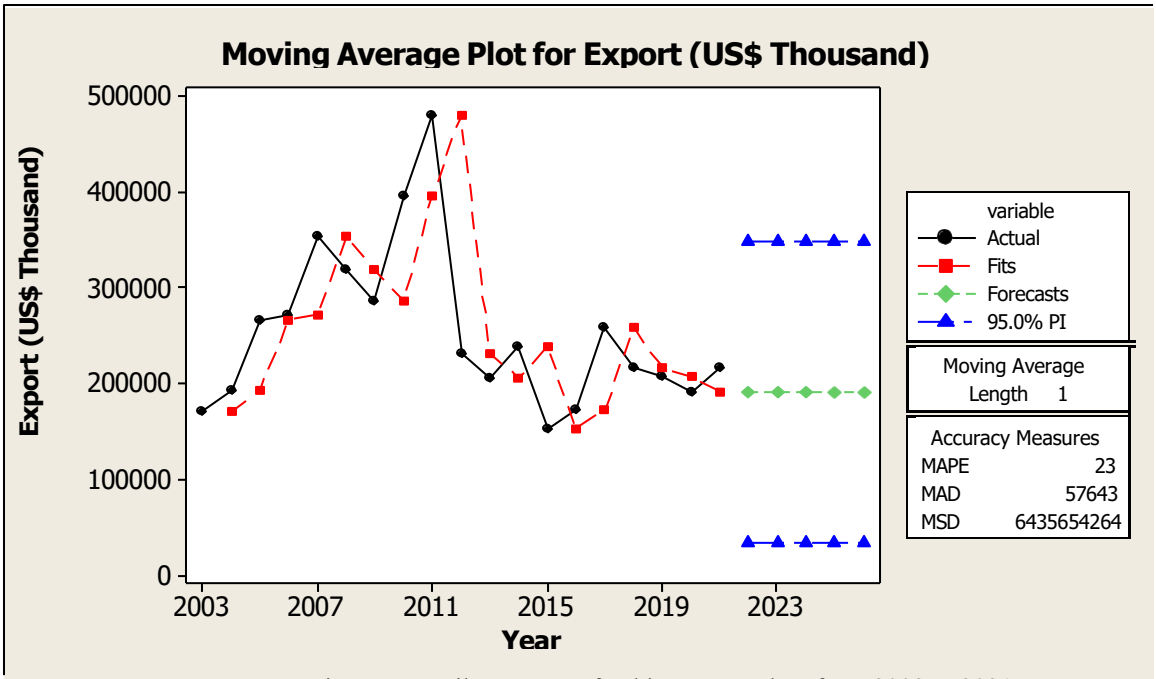


Figure 7 Textile Exports of Pakistan to Turkey from 2003 to 2021

Graph expressed that textile exports to Turkey are rapidly increase in 2012 then dramatically decrease in 2013. Between 2014 to 2020 there are some ups and downs in textile exports to Turkey.

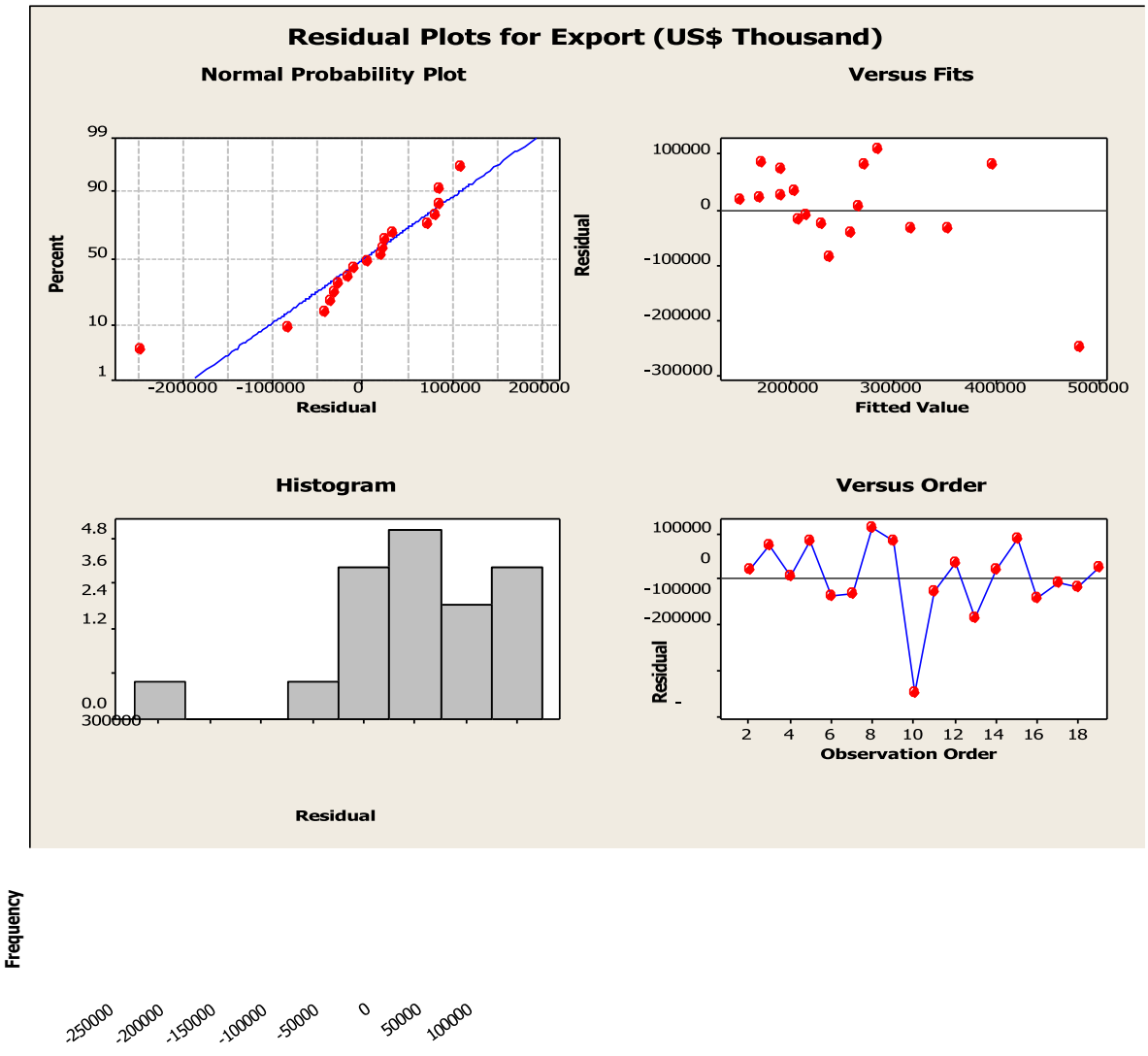


Figure 8 Residuals plots of exports of Turkey

Time	Export (US$ Thousand)	MA	Predict	Error
2003	174513	174513	*	*
2004	209623	209623	174513	35110
2005	277381	277381	209623	67758
2006	364255	364255	277381	86874
2007	384592	384592	364255	20337
2008	393866	393866	384592	9274
2009	718248	718248	393866	324382
2010	934647	934647	718248	216399
2011	1175776	1175776	934647	241129
2012	1878920	1878920	1175776	703144
2013	1986242	1986242	1878920	107323
2014	67751	67751	1986242	-1918492
2015	1326369	1326369	67751	1258618
2016	1037043	1037043	1326369	-289326
2017	960063	960063	1037043	-76980
2018	951667	951667	960063	-8396
2019	892896	892896	951667	-58771
2020	726846	726846	892896	-166050
2021	901625	901625	726846	174779

Table 9: Moving Average values of textile exports to China from 2003 to 2021

Period	Forecast	Lower	Upper
2022	726846	-418425	1872117
2023	726846	-418425	1872117
2024	726846	-418425	1872117
2025	726846	-418425	1872117
2026	726846	-418425	1872117

Table 10 Forecast of textile exports to China from 2022 to 2026

China's textile exports from 2003 to 2021 show extreme volatility, ranging from 67.8 million to 67.8 million to 1.98 billion annually. The moving average model reveals critical forecast weaknesses, particularly in 2014 when it overestimated exports by 1.92 billion and in 2012 when it underestimated by 1.92 billion and in 2012 when it underestimated by 703 million. The 2022-2026 projections, anchored to 2020's 727 million value, produce unrealistic negative lower bounds and excessively wide confidence intervals (−727million value, produce unrealistic negative lower bounds and excessively wide confidence intervals (−418M to $1.87B). This simplistic approach fails to capture China's dramatic market shifts, including the 2014 downturn and subsequent recoveries, highlighting the need for advanced forecasting methods that account for trade policies, economic cycles, and global demand patterns to provide meaningful export guidance. It demands more sophisticated analytical techniques for reliable trade planning.

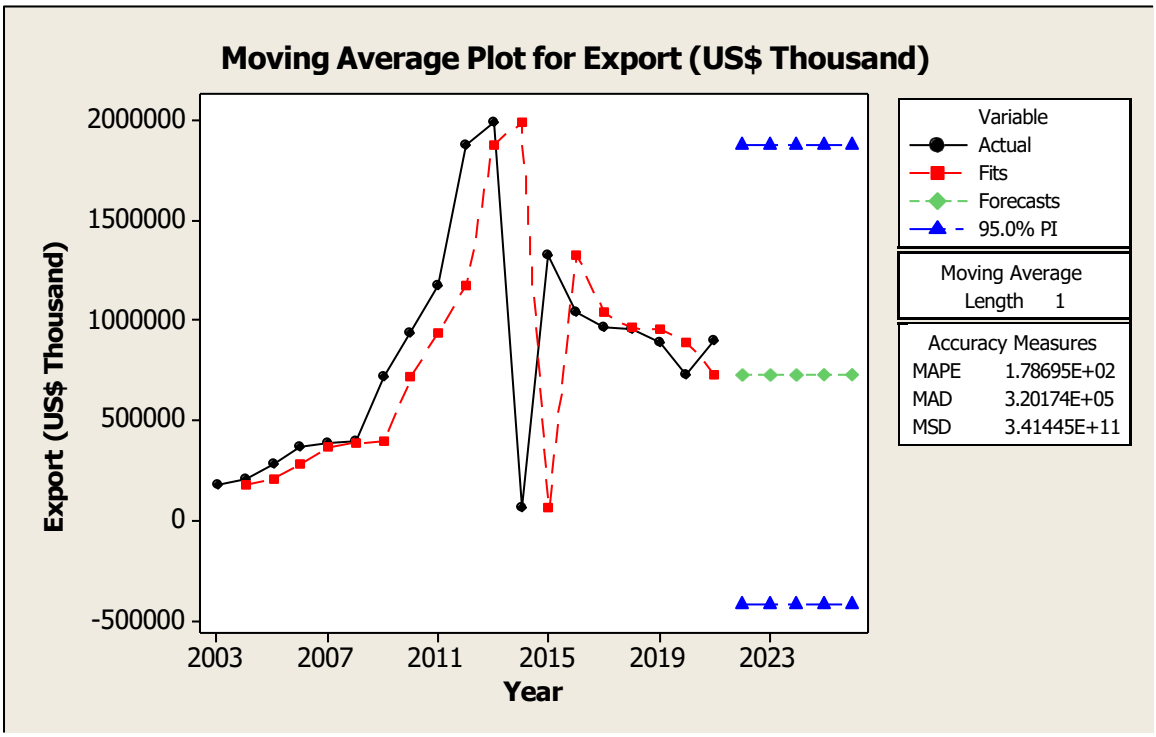


Figure 9 Textile exports of Pakistan to China from 2003 to 2021

Graph indicates that textile exports to China are rapidly increase in 2012 then dramatically decrease in 2014. Between 2016 to 2020 there are some ups and downs in textile exports to China.

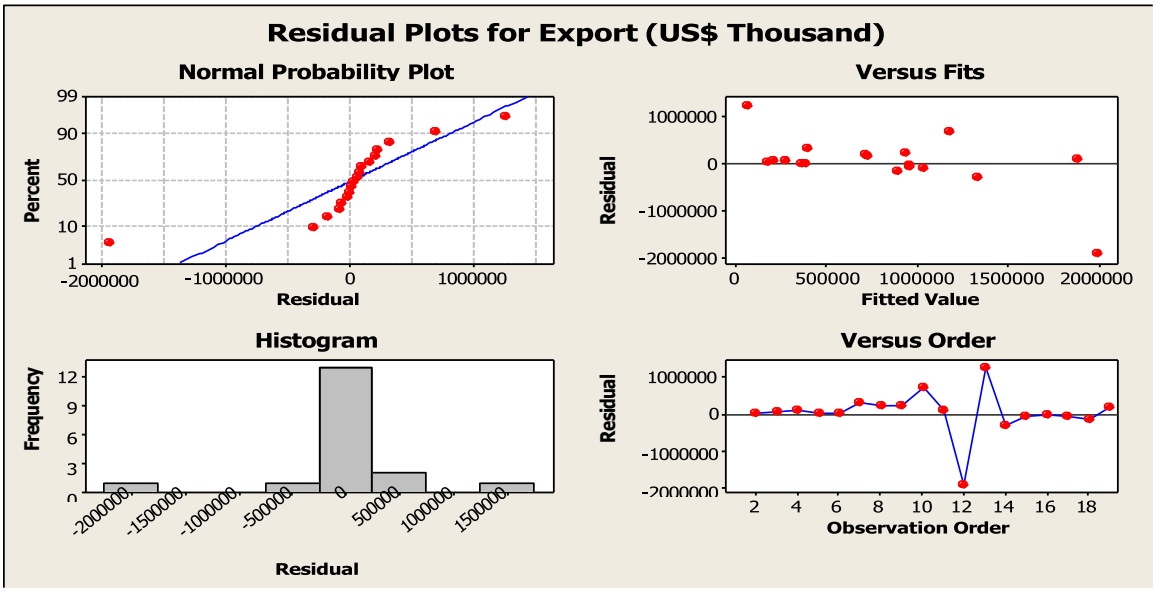


Figure 10 Residuals plots of exports of China

Time	Export (US$ Thousand)	MA	Predict	Error
2003	11219	11219	*	*
2004	12705	12705	11219	1486.9
2005	47497	47497	12705	34791.3
2006	69157	69157	47497	21659.8
2007	70231	70231	69157	1074.2
2008	65611	65611	70231	-4619.8
2009	53974	53974	65611	-11637.3
2010	57512	57512	53974	3538.4
2011	46625	46625	57512	-10886.8
2012	103658	103658	46625	57033.2
2013	66814	66814	103658	-36844.1
2014	77705	77705	66814	10890.2
2015	61107	61107	77705	-16597.4
2016	39711	39711	61107	-21396.3
2017	22083	22083	39711	-17627.8
2018	26944	26944	22083	4860.6
2019	11485	11485	26944	-15459.0
2020	25	25	11485	-11459.9
2021	0	0	25	-24.8

Table 11: Moving Average values of textile exports to India from 2003 to 2021

Period	Forecast	Lower	Upper
2022	24.8	-41648.7	41698.3
2023	24.8	-41648.7	41698.3
2024	24.8	-41648.7	41698.3
2025	24.8	-41648.7	41698.3
2026	24.8	-41648.7	41698.3

Table 12 Forecast of textile exports to India from 2022 to 2026

India's textile exports fluctuated wildly from 0 to 0 to 103.7 million (2003-2021). The flawed moving average model produces absurd 2022-2026 forecasts of 24,800 with impossible ranges (−24,800 with impossible ranges (−41.6M to $41.7M), failing completely to predict 2021's export collapse. This demonstrates the model's total inadequacy for India's volatile market, demanding alternative analytical approaches.

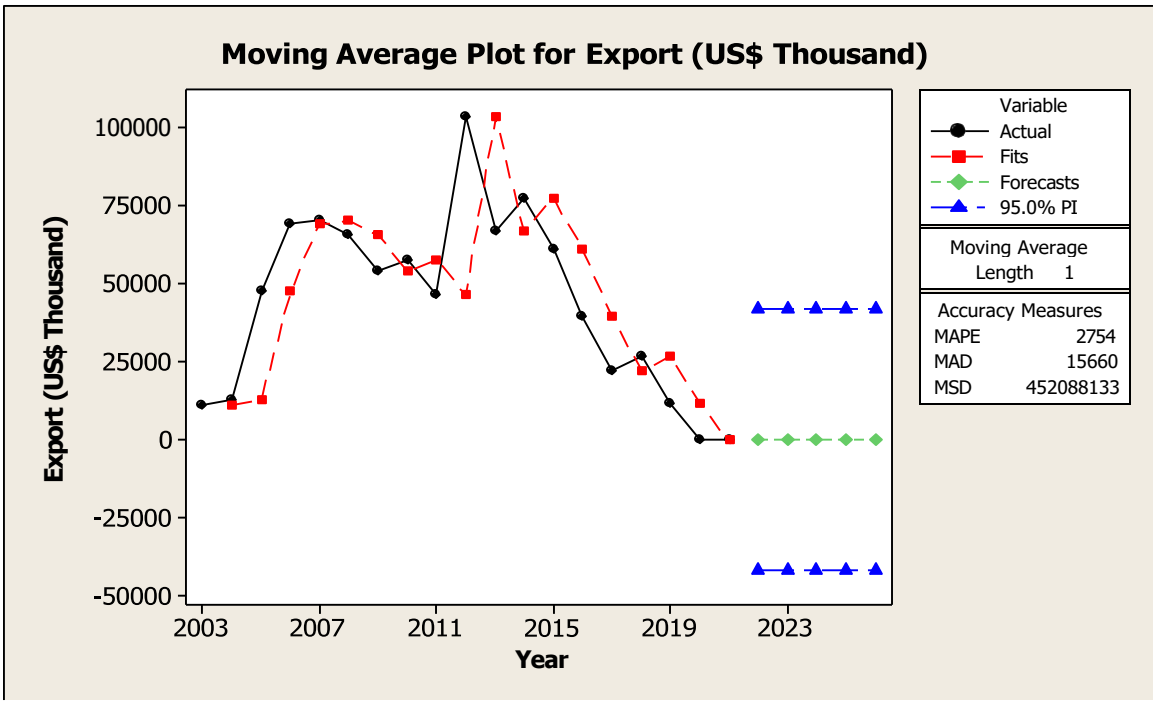


Figure 11 Textile exports of Pakistan to India from 2003 to 2021

Graph shows that textile exports to India are rapidly increase in 2012 then swiftly fall from 2013 to 2020 in textile exports to India.

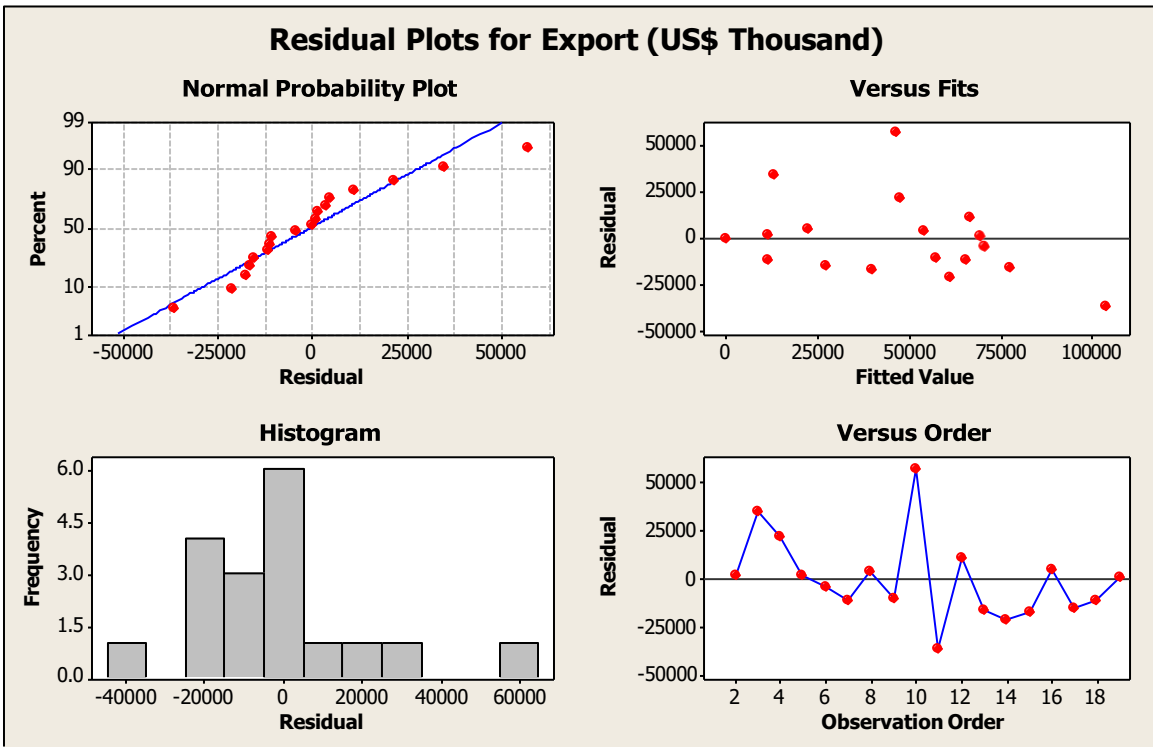


Figure 12 Residuals plots of exports of India

Time	Export (US$ Thousand)	MA	Predict	Error
2003	91317	91317	*	*
2004	95096	95096	91317	3779
2005	94725	94725	95096	-371
2006	25307	25307	94725	-69418
2007	92078	92078	25307	66771
2008	94290	94290	92078	2212
2009	74645	74645	94290	-19645
2010	97429	97429	74645	22784
2011	115022	115022	97429	17593
2012	117250	117250	115022	2228
2013	200012	200012	117250	82762
2014	96496	96496	200012	-103515
2015	99623	99623	96496	3126
2016	109049	109049	99623	9427
2017	106747	106747	109049	-2302
2018	119094	119094	106747	12346
2019	132422	132422	119094	13329
2020	148793	148793	132422	16371
2021	188724	188724	148793	39930

Table 13: Moving Average values of textile exports to Australia from 2003 to 2021

Period	Forecast	Lower	Upper
2022	148793	68276.4	229310
2023	148793	68276.4	229310
2024	148793	68276.4	229310
2025	148793	68276.4	229310
2026	148793	68276.4	229310

Table 14 Forecast of textile exports to Australia from 2022 to 2026

Australia's textile exports grew steadily from 91.3 million (2003) to 91.3 million (2003) to 188.7 million (2021), despite a temporary 2006 decline. The moving average forecast of 148.8 million for 2022−2026 with awide 148.8 million for 2022−2026 with a wide 80.5 million margin of error fails to reflect the consistent growth trend, particularly after 2016. While more stable than other markets, Australia's export patterns would benefit from more sophisticated forecasting techniques to account for its upward trajectory and improve prediction accuracy

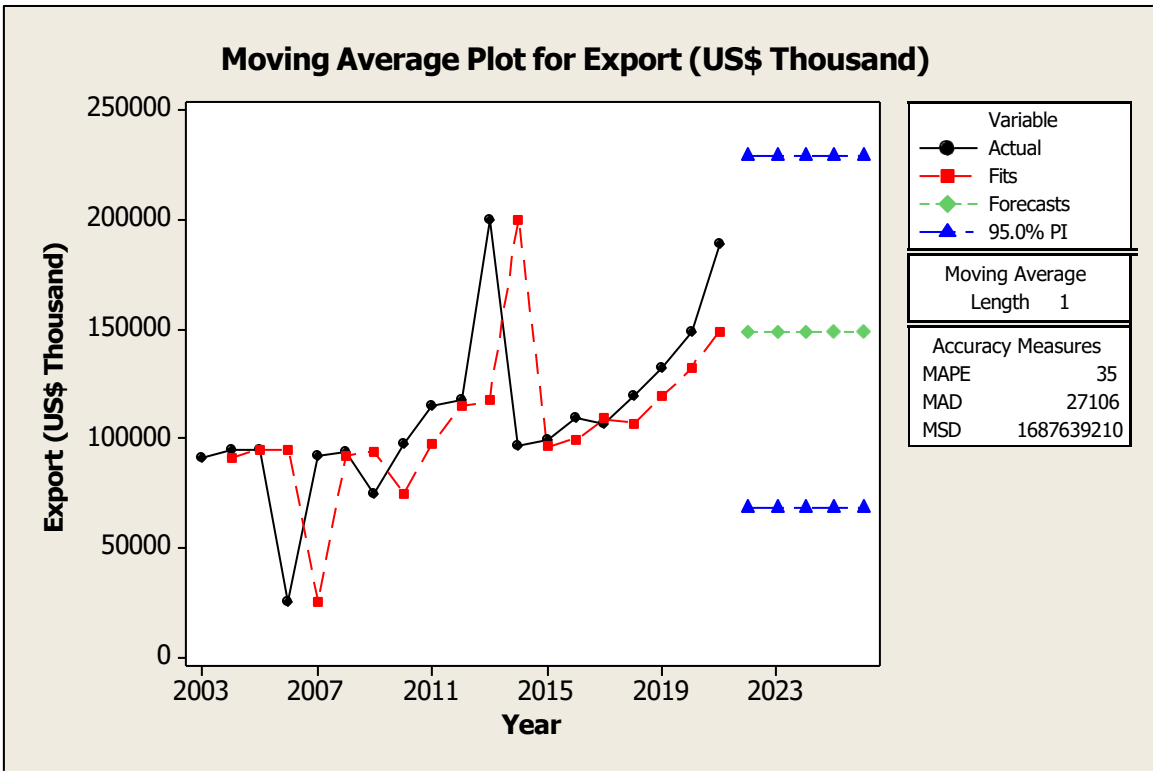
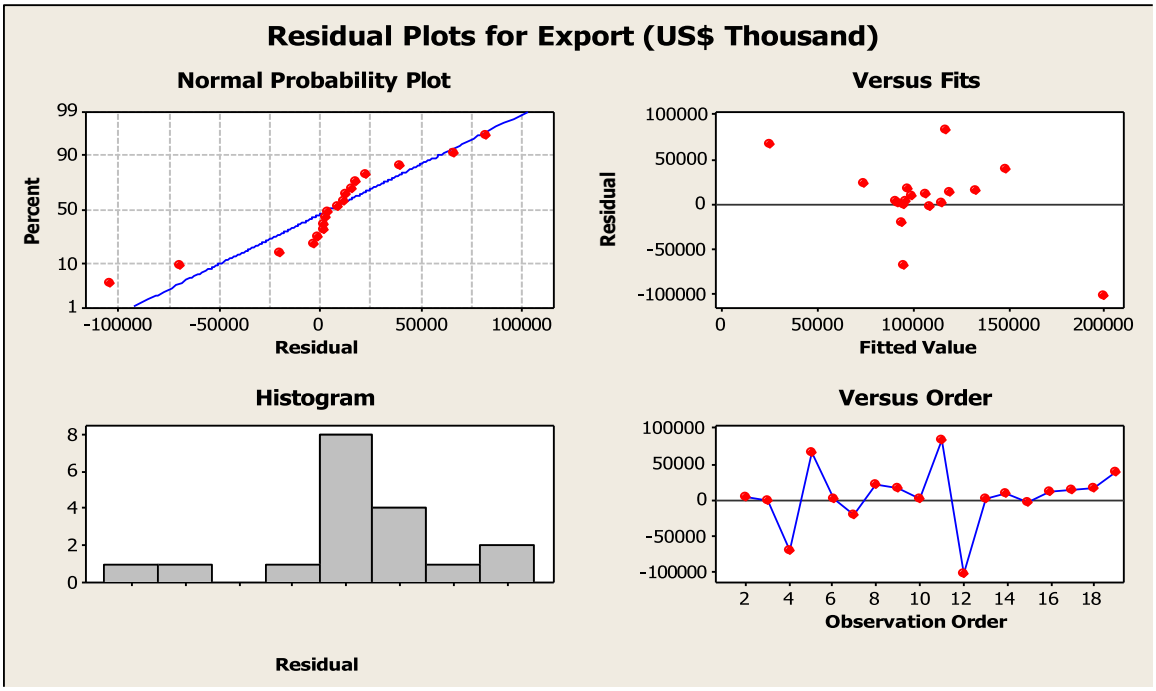


Figure 13 Textile Exports of Pakistan to Australia from 2003 to 2021

Graph expressed that significant rise in textile exports to Australia in 2014- 2021



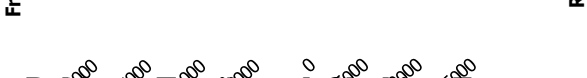


Figure 14 Residuals plots of exports of Australia

Time	Export (US$ Thousand)	MA	Predict	Error
2003	432244	432244	*	*
2004	425360	425360	432244	-6884
2005	500719	500719	425360	75359
2006	494353	494353	500719	-6366
2007	517459	517459	494353	23106
2008	69670	69670	517459	-447790
2009	484231	484231	69670	414562
2010	698952	698952	484231	214721
2011	973770	973770	698952	274818
2012	658269	658269	973770	-315501
2013	694878	694878	658269	36609
2014	796627	796627	694878	101749
2015	805493	805493	796627	8866
2016	864402	864402	805493	58909
2017	970975	970975	864402	106573
2018	975769	975769	970975	4794
2019	1008649	1008649	975769	32880
2020	1048457	1048457	1008649	39807
2021	1196963	1196963	1048457	148506

Table 15: Moving Average values of textile exports to Germany from 2003 to 2021

Period	Forecast	Lower	Upper
2022	1048457	675665	1421248
2023	1048457	675665	1421248
2024	1048457	675665	1421248
2025	1048457	675665	1421248
2026	1048457	675665	1421248

Table 16 Forecast of textile exports to Germany from 2022 to 2026

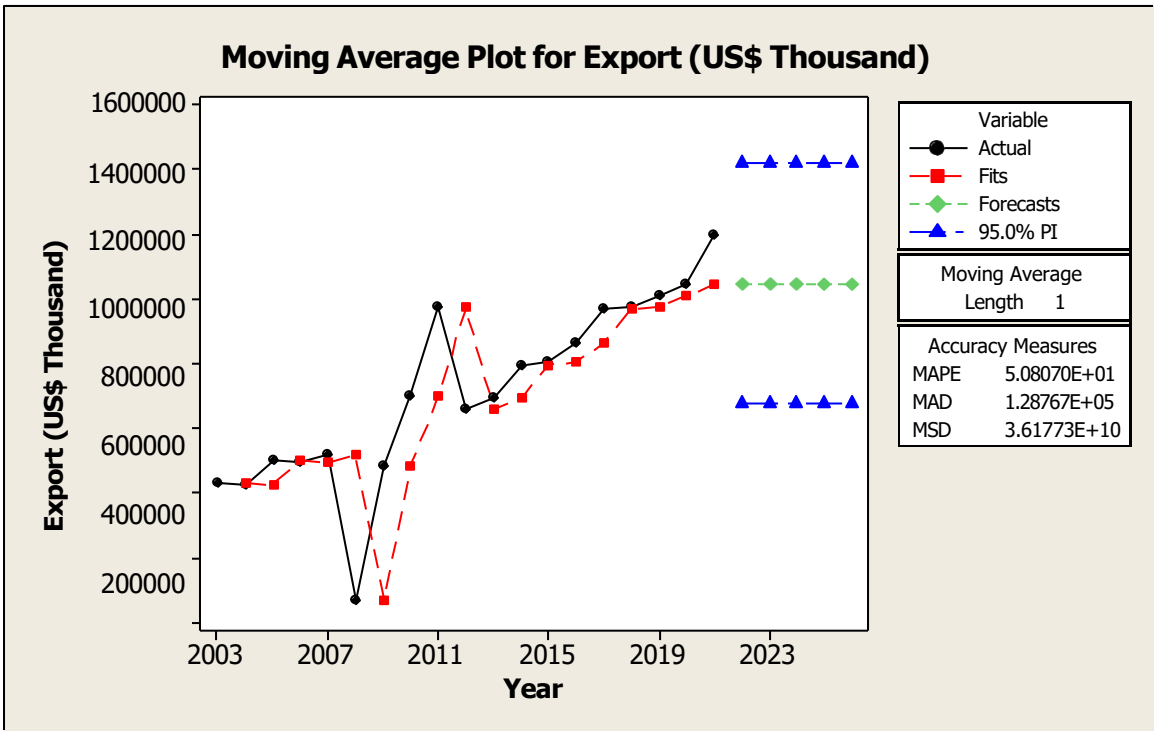


Figure 15 Textile exports of Pakistan to Germany from 2003 to 2021

This graph shows that textile exports rapidly decrease in 2008 then swiftly increased in 2011. There is fluctuation between 2012 to 2020 in textile exports to Germany.

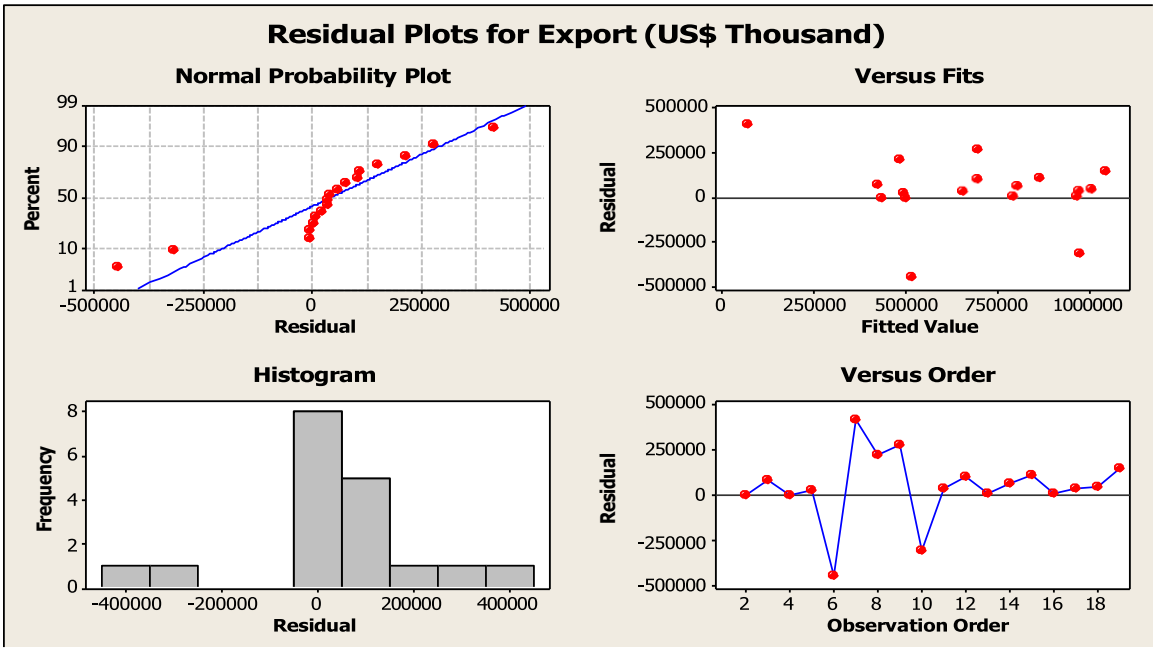


Figure 16 Residuals plots of exports of Germany

Time	Export (US$ Thousand)	MA	Predict	Error
2003	6681.9	6681.9	*	*
2004	5612.2	5612.2	6681.9	-1069.71
2005	5153.9	5153.9	5612.2	-458.32
2006	6586.6	6586.6	5153.9	1432.76
2007	6801.5	6801.5	6586.6	214.88
2008	8593.6	8593.6	6801.5	1792.07
2009	6601.3	6601.3	8593.6	-1992.28
2010	6074.2	6074.2	6601.3	-527.14
2011	8186.3	8186.3	6074.2	2112.13
2012	8535.4	8535.4	8186.3	349.11
2013	9884.4	9884.4	8535.4	1348.94
2014	10175.3	10175.3	9884.4	290.90
2015	9845.8	9845.8	10175.3	-329.45
2016	9322.6	9322.6	9845.8	-523.15
2017	11867.9	11867.9	9322.6	2545.20
2018	13095.4	13095.4	11867.9	1227.57
2019	14212.4	14212.4	13095.4	1116.98
2020	14672.0	14672.0	14212.4	459.55
2021	15223.7	15223.7	14672.0	551.78

Table 17 Moving Average values of textile exports to Qatar from 2003 to 2021

Period	Forecast	Lower	Upper
2022	14672.0	12248.1	17095.8
2023	14672.0	12248.1	17095.8
2024	14672.0	12248.1	17095.8
2025	14672.0	12248.1	17095.8
2026	14672.0	12248.1	17095.8

Table 18 Forecast of textile exports to Qatar from 2022 to 2026

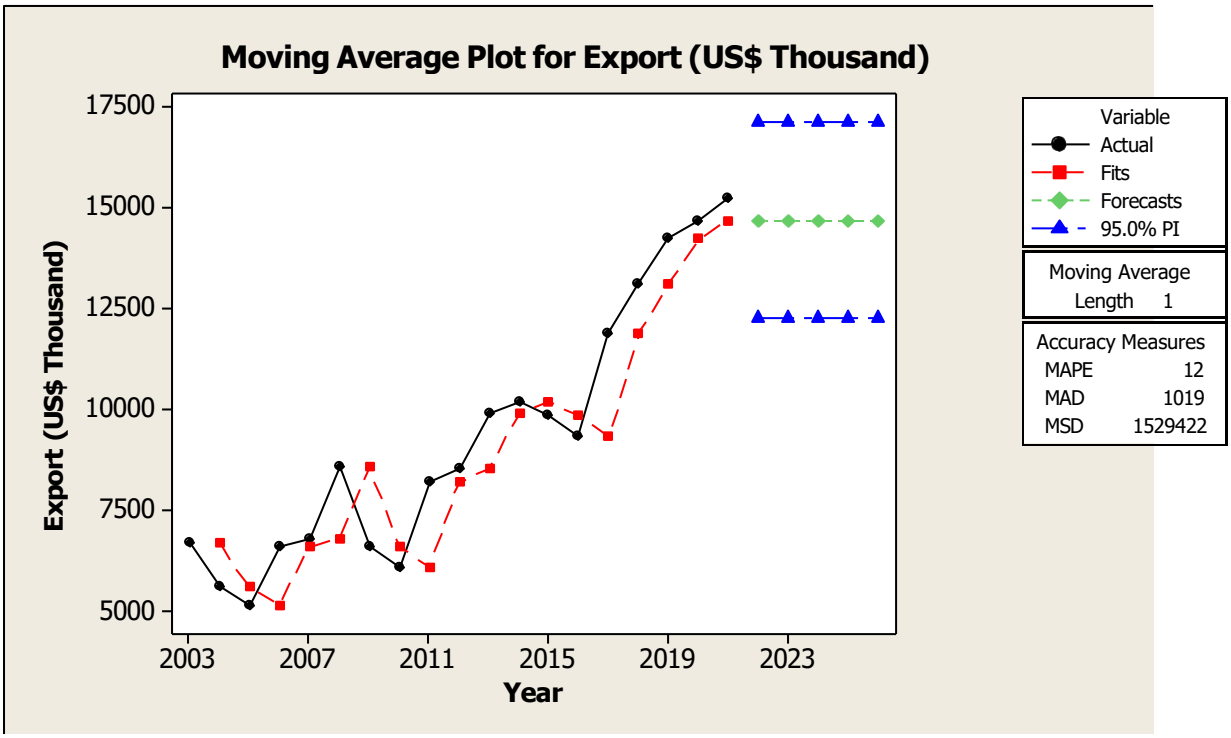


Figure 17 Textile exports of Pakistan to Qatar from 2003 to 2021

Graph indicates that textile exports to Qatar are fluctuated from 2003 to 2016 and then steadily increase in 2017 to 2020 in textile exports to Qatar.

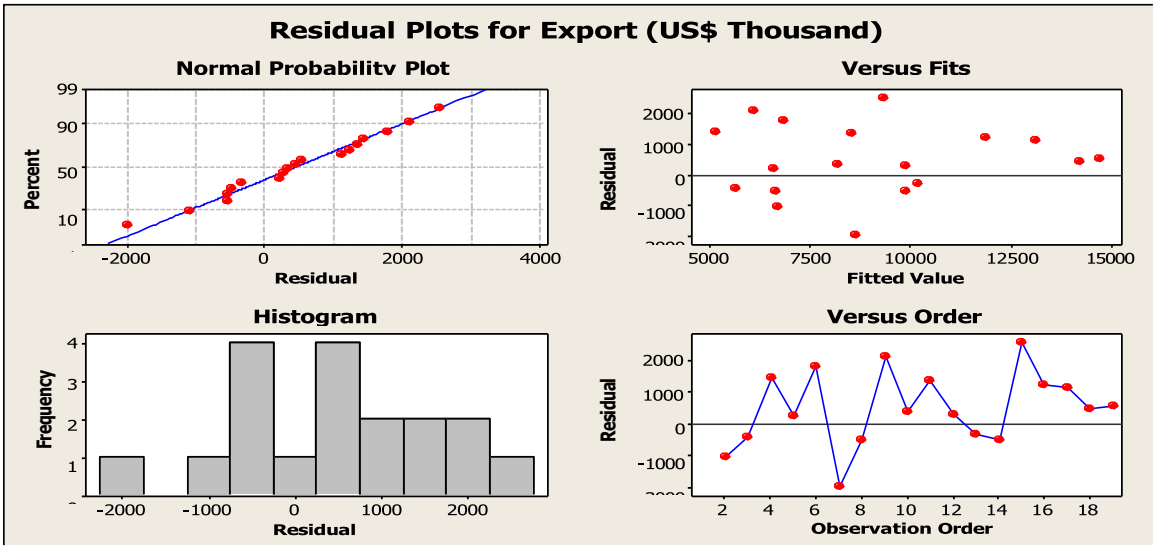


Figure 18 Residuals plots of exports of Qatar

Analyzing Pakistan Textile and Clothing Export trade dynamics- A comprehensive Study from 2003 to 2021 Using Statistical Model

Germany's textile exports to Germany show volatile growth from 432 million (2003) to 432 million (2003) to 1.2 billion (2021), with particularly sharp fluctuations during the 2008 financial crisis. The moving average forecast of 1.05 billion for 2022−2026 fails to account for the se historical volatility patterns. Meanwhile, Qatar′s textile exports demonstrate steadier growth from 1.05 billion for 2022−2026 fails to account for the se historical volatility patterns. Meanwhile, Qatar′s textile exports demonstrate steadier growth from 6.7 million to $ 15.2 million over the same period, though its forecast similarly lacks sophistication. Both cases highlight how simple moving average models often prove inadequate for textile export predictions, whether in highly volatile or relatively stable markets, suggesting the need for more advanced analytical approaches that can better capture each market's unique characteristics and trends.

4. Conclusion

Tragically, Pakistan's textile and apparel industry is rigorously entangled in diverse encounters. Over the past years, the exports of Pakistan have remained much lower as compared to the those of other developing countries. The drawbacks of Pakistan trading policy during the last few decades were evident when one compares the country exports to those of other countries. Even though Pakistan is producing adequate foreign exchange, if the textile industry is straining, there would be a big deal of fear at that point. Pakistan foreign commerce has also not been diversified. The goal may be to initiate long-term trends rather than short-term policy modifications. In order to support economic permanency, political stability may be necessary for long-term policy consistency.

Human resources growth is essential for any technological shift in order to manage that technology. That takes much more time and even while the required textile training facilities are available (such as the institutes at the textile city Faisalabad), they have given in to bureaucratic paralysis. Pakistan must manage the transition to ever-higher additional value if it hopes to retain its foreign exchange earnings.

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