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TRADE OPENNESS AND CO_2 EMISSIONS NEXUS IN OMAN

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Abstract. Trade Openness (TO) has a strong role in the development of an economy but its impact on the overall environmental profile of a country is debatable. This analysis is focused to test how trade openness affects CO_2 emissions in Oman. Unit root tests are conducted and ARDL model is employed using data from 1972-2014. The results of the study suggested that both Gross Domestic Product (GDP) per capita and trade openness seem to have the positive impact on CO_2 emissions. It means that a higher GDP per capita and trade openness destructs the environment in the country. The results leave space for Oman's government to consider the environment while devising its trade policies.

Keywords: trade openness; CO_2 emissions; per capita GDP

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JEL Classifications: F14, Q53, F43

1. Introduction

Trade openness is one of the most influential determinants of economic growth of a country, and due to its widespread effects, countries tend to focus on improving it to achieve better financial results. With a large number of countries being a part of the World Trade Organization (WTO), a dominant sentiment across the global economy is to focus on more relaxed and even free trade policies. The purpose of these free trade policies is to reduce dependence on the local economy and attain benefits from strengthening trade relationships with other countries. Nevertheless, while delivering many benefits to the host and home countries, trade openness also seems to have some adverse impacts as well that cannot be ignored.

With strong trade-ties, countries rely on each other in many domains and their focus is on achieving an optimal production and trade position that gives maximum results. Eventually, trade openness does bring in higher

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economic and production activity in the country, which is inevitable. Researchers argue that higher economic and trade business in a country means more usage of natural resources, that eventually puts adverse impact on the environment. Another discussion that enters the equation is how countries start emitting more CO_2 when their trade activity increases, but with time, they tend to tackle that challenge as their economic condition gets better (Mahmood et al. 2019).

According to Mahmood and Alkhateeb (2017), trade and environment are firmly connected, and in their study, they also proved that the environmental Kuznets curve (EKC) does prevail in Saudi Arabia while developed an idea of how to trade activities might affect the environment negatively. Chen et al. (2019) mentioned in their analysis that trade openness and export activity tends to produce higher emissions. Their study was conducted on China since the country is responsible for 28% of global emissions. Using a multiregional input-output model, the study used 2007 data, and the findings suggested that trade and outsourcing result in a partial increase in CO_2 emissions. Hence, structural reforms are required in this sector to ensure that higher economic and trade activities do not leave the environment ignored while devising policies.

Although the idea of the environment getting affected by trade is a debatable issue in the field of literature, many studies strongly argue about the existence of a profound relationship between both variables. Trade can lead to CO_2 emissions because to indulge in trade; countries produce more products, which require a higher exploitation rate of natural resources. It can be in the form of natural gas, coal and many more resources while the production process emits greenhouse gases in the environment that is destructive for the overall ecological profile of the country (Kim et al. 2019). Mahmood et al. (2018) talked about financial development and foreign investment affected environment in East Asia and argued that trade openness could lead to higher emissions in the host country and on top of that, there is also a spillover effect of these trade activities on the neighboring countries. Hence, trade openness does not only influence the countries involving in trade but can be destructive for the environment of the surrounding states as well. On the other hand, Shahbaz et al. (2013) argued that financial market carries encouraging environmental effects in Malaysia by reducing emissions.

For many countries, it is an on-going trade-off, and they have to make a rational and strategic decision as to what matters to them the most. If economic growth and open trade has more importance for a country and can help it meet its long-term economic needs, the idea of reducing emissions might go into the background with a possibility of neglect and vice versa. In those instances, countries can focus on the demand levels of both segments and see which one has a higher demand and need in the economy. No matter what they end up deciding, one section has to be given a priority over the other, and both goals of open trade and lower emissions cannot be met at the same time.

It is mentioned by Ren et al. (2020), production and consumption in a specific capacity do seem to have a strong influence on emissions and how taxes are being implemented in that domain. In some countries, e.g. Chile manufactures of products leading to emissions are taxed more than the customers while in Sweden, customers have to suffer that penalty. Either way, the purpose of these taxes is to tackle the higher emissions in the products sector, and the net outcome might be the same. For countries trying to avail open trade opportunities while keeping the emissions lower at the same time, there is a need to consider implementing emissions taxes that can help reduce the effects of a sudden emission shock that these trade activities can give to the economy. Nevertheless, it all depends on how much the government of a country wants to tackle that issue and which of the two segments make it to the top of their priority list. In some instances when a country is promoting open trade, they also want to encourage their local manufacturers and customers in the domain since they would be responsible for giving a boost to those trade activities and if anyone of the two is discouraged, the trade net might fall apart eventually.

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The idea of trade liberalization has been a focus of attention for many years now and considering the fierce economic competition across the world; countries are focusing on optimizing their position in the global market. In a pursuit to achieve that, trade openness plays a vital role since it allows them to look out for each other and live on each other's expenses. The concept of comparative and absolute advantage also comes into play in this regard when countries consider if it is cheaper for them to produce something in their homeland or get it traded with another country. While trade liberalization can play a strong role in achieving a competitive stance in the global market, greenhouse gas emissions can go ignored. Talking about WTO countries specifically, emissions are not just specific to their production structures but can be imported from other countries as well through consumption of goods under trade treaties (Levitt et al. 2019). Considering the influential role of trade openness in higher emissions, not enough literature is available on the Middle Eastern region, specifically Oman. Being a major oil-producing country, Oman has a strong position in the global market, and it is crucial to understand how its economy is getting affected by trade openness. Through the past decade, the country's energy sector has gone through some significant structural reforms, and there is a scope to understand how the trade policies of the country need to be reconsidered that take the environment into consideration (Albadi 2017). Regardless of it eventually being a trade-off, there must be some actions that the government of Oman can consider to bridge the gap between the trade and the environmental sector so both can operate side by side.

2. Literature review

The literature available on trade openness and CO_2 emissions in Oman is minimal, and that is the gap this current study is focused on filling. Nevertheless, many other studies do analyze this relationship and suggest many results. Mahmood et al. (2019) mentioned in their analysis that there is a profound association between trade openness and CO_2 emissions. Their study was limited to Tunisia and using a structured model; they suggested that higher emissions are determined by many factors and trade openness is one of them. Financial development is also expected to lead to higher pollution rates. The data used for the study of Tunisia was from 1971-2014, and the analysis suggested a mixed model of integration with both short and long-term relationships between the variables. For the country, a turning point for the GDP was 292.335 billion constant US dollar. It indicates that when the country of Tunisia reaches this level of GDP, the effects of trade openness on environmental degradation and CO_2 emissions start to reverse (Mahmood et al. 2018). Trade openness leads to higher energy consumption, which eventually affects the environment in a negative way (Alkhateeb and Mahmood 2019). In their study on the East Asian region, Mahmood et al. (2019) used 1991-2014 data for six East Asian countries and suggested the relationship and spatial effect of foreign direct investment and trade openness on CO_2 emissions. In the findings, the factors seemed to have a spatial and spillover effects on the neighboring countries which indicates how destructive trade openness and FDI can be for the environment and how it affects the entire region and not just the host country. With local foreign direct investment inflows affecting the neighboring countries and their environmental profiles, it raises the need for better environmental policies for the industrial and manufacturing sector and how the investment is being intensified in these countries.

In their analysis of the GCC region, Bekhet et al. (2017) mentioned that financial development of a country and the environment has a strong relationship. Considering Saudi Arabia, Oman, Qatar and Bahrain, the study concluded that economic growth could lead to a higher rate of CO_2 emissions, which eventually destructs the environment. This interrelationship of variables is backed by a causal association between financial development, production activities, GDP growth and higher energy consumption. For a longer-term, the association between energy consumption and CO_2 emissions is unidirectional, and an increasing trend of energy consumption turns out to be harmful to the environment. Many other studies, including Kim et al. (2019), Mahmood et al. (2018), Huang et al. (2008), Akbostanci et al. (2009) support these results.

Kim et al. (2019) agreed to the fact that the relationship between trade and environmental degradation is a controversial issue and there is a massive space for improvement in the way research is conducted on this topic.

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Using panel data in a North-North, Nort-South, South-South and South-South context, they controlled for endogeneity and explored how trade leads to an increase in CO_2 emissions in the North while this effect was even more significant in Southern context. The existence of environmental Kuznets curve was tested, and they mentioned that in the developed countries, the degrading impact of trade on the environment is not as destructive as it is in the developing countries which increases the need for the developing countries to be more careful while it comes to adopting trade liberty. Akbostanci et al. (2009) conducted an analysis on Turkey to analyze how income and the environment are related there and the extent to which EKC exists there. The study was unique since it analyzed the effects on a panel and time series basis as well to explore the impact of the independent variables from 1968-2003. In both models, the impact of the economic activities and higher income was seen to be harmful on the environment, and the authors suggested that strong policy implications are required to drive the economies in a sustainable way without having to ruin the environment.

The global trade network has a substantial role in the environmental conditions across the world, and many studies provide that argument. In their analysis, Aller et al. (2015) argued that trade networks have become very important for countries, and it is up to them to decide how they want it to affect their environmental qualities. For developed countries, there is a direct impact of trade networks on the quality of the environment and this effect is indirect for developing nations. Nevertheless, the relationship between environment and trade networks of countries cannot be ignored. The trade networks are seen to affect the environment negatively, but in the developing countries, the effect is not as destructive. There is a need to expand this study and analyze why the developing countries are not affected as much as the developed ones. In a broader perspective, trade networks and policies can be used as a medium for countries to re-evaluate their environmental policies and trade agreements signed with other nations can play a strong role in keeping the environment into perspective (MacDermott and Bang 2018).

Looking at CO_2 emissions from a general perspective, there are many determinants of these emissions mentioned in the literature. The idea of CO_2 emissions is not as simple and is developed through a complex network of perspectives. It is mentioned by Jiang et al. (2019) that there are many driving factors for carbon emissions and trade is one of them. In that context, developing countries can play a role in reducing carbon emissions by getting involved in more sustainable trade relations with other nations. The results of the study align with what was mentioned by Aller et al. (2015) that in developing countries, the role of trade is constructive for the environment. According to Alam and Murad (2020), economic growth, trade openess and technological progress with the environmental sector and this association is even strong in the renewable energy segment of the country. There is a dire need for organization to generate opporunities of cooperation between the economic and environmental sector. Especially in the deveoping countries, this issue has more significance because these nations are supposed to focus on economic growth and a sustainable environment at the same time, which is harder to achieve in their capacity. The technological growth that takes place as a result of trade openness and economic growth, countries can use that in the renewable sector to invest activities that make the industry more advanced and environmentally friendly. In that way, the renewable industry can be given the support it requires to grow in the developing world. If that sustainability is maintained for a longer-term, developing countries can make economic progress by leaps and bounds and a bi-directional association can be established between both segments that can ensure long-term growth.

In France, trade openness and CO_2 emissions seem to have a positive relationship through 1960-2010. It was argued by Mutascu (2018) that through the selected period, there is an existence of a two-way relationship between the two and while trade openness might lead to emissions, higher emissions are also supposed to lead to higher trade openness in a country. For gas emissions, trade openness does not lead to a higher frequency compared to other emissions. From a broader perspective, the existence of a business cycle between trade openness and emissions is suggested in the study, which is a unique concept to consider. For countries focusing on lower emissions and an optimal productivity level in the country, environmental policies also focus on trade

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openness and friction since they seem to put an impact on emission leakages and environmental policies as well (Holladay et al. 2018).

For companies being involved in international trade, it is crucial to ensure that the export and import that they are conducting is on the cleaner side of the manufacturing domain. That is something that can help companies, and eventually, countries promote international trade while still keeping the environment into focus. It is so because no matter how much economic growth has been sustained through trade and related activities, the destructive effects of the emissions through them also have a value associated to them which might even be higher than the value of the open trade. It eventually means that the net impact of free trade in many countries might be zero or even harmful if a holistic view is not taken into consideration (Forslid et al. 2018).

Trade, income inequality, emissions and economic developed are strongly connected, and as a country become financially more stable, and income rises with less income inequality, emissions can tend to decline. Through a panel data study, Hubler (2017) narrated that income inequality and emissions have a negative relationship, and higher income inequality can also lead to higher emissions that degrade the environment. Trade openness and carbon emissions have a strong relationship, and there is a turning point in a trade that countries need to keep into account to explore where does it start to affect the environment negatively. Using data from 105 countries from various income groups including low, middle and high, Shahbaz et al. (2017) argued that there is a role of trade openness in impeding the environmental quality in a broader scale regardless of the income scale a country falls within.

3. Methodology

Following the theoretical model of trade openness affecting the environment, the following model is hypothesized:

$$LCO_t = \alpha_0 + \alpha_1 LGDPC_t + \alpha_2 LTO_t + \varepsilon_t \quad (1)$$

All the variables in equation 1 are taken with their natural log (L). LCO_t is showing per capita CO_2 emissions, $LGDPC_t$ is per capita GDP, and LTO_t is percentage of trade to GDP. Data is used from 1972-2014 for Oman and more recent is not used due to reporting limitations. Data used in the analysis is sourced from World Development Indicators. It is expected that trade openness has a destructive impact on the CO_2 emissions, which means that higher trade openness would increase CO_2 emissions and affect the environment in a negative way. GPD per capita is also expected to have a positive impact on CO_2 emissions, which is essentially because higher GDP means higher production activities led by natural resource exploitation and higher emissions. Augmented Dickey and Fuller (ADF) test of Dickey and Fuller (1979) is conducted to check the stationarity as follows:

$$\Delta y_t = \beta_0 + \beta_1 y_{t-1} + \sum_{i=0}^{n} \beta_{2i} \Delta y_{t-i} + \psi_t \quad (2)$$

Where, the unit root will be tested on a null hypothesis of $\beta_1 = 0$ and its rejection will ensure stationarity of y_t. After testing it, we will proceed for ARDL model of Pesaran et al. (2001) to do impact analyses in the following way:

$$\Delta LCO_t = \phi_0 + \phi_1 LCO_{t-1} + \phi_2 LGDPC_{t-1} + \phi_3 LTO_{t-1} + \sum_{j=0}^{m} \varphi_{1j} \Delta LCO_{t-j} + \sum_{j=0}^{m} \varphi_{2j} \Delta LGDPC_{t-j} + \sum_{j=0}^{m} \varphi_{3j} \Delta LTO_{t-i} + \xi_t \quad (3)$$

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Where, cointegration may be claimed if H_0: $\phi_1 = \phi_2 = \phi_3 = 0$ is rejected and then we may discuss the long and short effects from equation 3.

4. Data Analyses

ADF test is shown in table 1 shows, and it is seen that all variables are non-stationary at the level. After differencing, variables become stationary, so the level of integration is one, and we proceed for cointegration analysis.

Table 1. Unit Root Test

	Intercept	Intercept and Trend
LCO_t	-1.9648	-2.8167
$LGDPC_t$	-1.6247	-1.2766
LTO_t	-1.2882	-1.0677
ΔLCO_t	-4.6613***	-4.6682***
$\Delta LGDPC_t$	-5.5878***	-6.1984***
ΔLTO_t	-5.9167***	-6.4454***

Note: *** shows stationary at 1% level of significance
Souce: Authors calculation

Before moving to the cointegration, figure 1 reflects the co-movement of the hypothesized variables. Figure 1 corroborates the positive relationship among CO_2 emissions per capita, Trade openness and GDP per capita as variables have the co-movements in the same direction in most of sample years (Raw data is provided in Appendix).

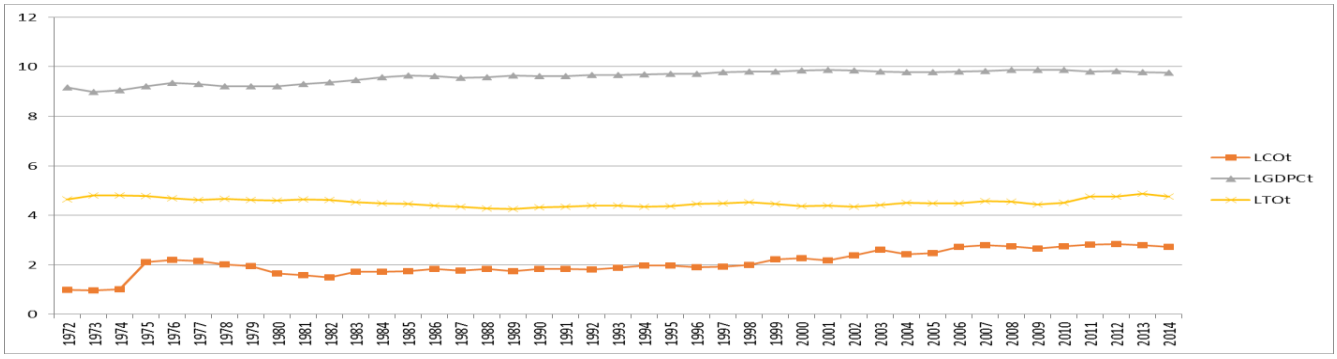

Figure 1. Trends of LCO_t, $LGDPC_t$ and LTO_t
Souce: World Bank (2019)

After the graphical analysis, table 2 shows the ARDL results with selected lag length (1,0,0). Diagnostic tests of heteroscedasticity, serial correlation and functional form show lower F-values along with reasonably high p-values and suggest that our estimated model is out of such econometric problems. The estimated F-value from the bound test is 3.6939, and it is larger than the critical value at 10% significance level. Therefore, it suggests that a long run relationship/cointegration exists in our estimated model.

Table 2. Nonlinear ARDL Estimates

Variable	Parameters	S.E.	t-Statistic	P-value
Long Run Results				

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$LGDPC_t$	1.8031	0.3440	5.2407	0.0000
LTO_t	1.7038	0.5383	3.1652	0.0030
Intercept	-22.8525	4.9082	-4.6559	0.0000
Short Run Results				
$\Delta LGDPC_t$	0.6544	0.2145	3.0498	0.0042
ΔTO_t	0.6184	0.2371	2.6077	0.0130
ECT_{t-1}	-0.3629	0.0968	-3.7481	0.0006
Diagnostics				
Bound Test	Estimated F-value = 3.6939 Critical F-values At 5% 3.0836-3.8155 At 10% 2.6175-3.2969			
Heteroscedasticity	F-value = 0.0141		p-value = 0.9056	
Serial Correlation	F-value = 1.0287		p-value = 0.5979	
Functional Form	F-value = 0.0174		p-value = 0.8957	

Souce: Authors calculation

In the long-term results, there is a positive impact of GDP per capita on CO_2 emissions per capita. For CO2 emissions, income elasticity is found 1.8031, which greater than one. When GDP per capita increased by 1%, it has an accelerating effect of 1.8031 percent on CO_2 emissions. This result contradicts the insignificant effect found by Bekhat et al. (2017) for Oman. We conclude that increasing economic growth of Oman has negative environmental consequences by emitting the CO_2 emissions in the atmosphere. Further, there is a positive and significant effect of trade openness on CO_2 emissions. It means that increasing TO is responsible for environmental degradation and decreasing TO is helping in the protecting environment from CO_2 emissions. Further, estimated elasticity is found greater than one, and it suggests that one percent increase in TO is leading to increasing 1.7038 percent of CO_2 emissions. The effect of TO shows that increasing trade in Oman is responsible for higher CO_2 emissions in the atmosphere. Hence, both economic growth and TO lead to higher CO_2 emissions in the long-run, even CO_2 emissions are increasing at more than proportionate.

In the short-run results, coefficient of ECT_{t-1} suggests a short-run relationship in the estimated model with 0.3629 percent speed of convergence towards long run equilibrium. GDP per capita has again a positive effect on per capita CO_2 emissions in the short run though GDP per capita is positively contributing the CO_2 emissions with elasticity less than one. It indicates that even in the short-run, GDP per capita has a strong influence on the overall environment and its role in the development of the environmental profile of a country cannot be ignored. TO also has a positive and inelastic effect on the CO_2 emissions per capita in the short run. Though, the elasticity parameters suggest that CO_2 emissions are increasing less than proportionate but still both GDP per capita and TO lead to CO_2 emissions even in the short run. It puts light on the fact that even though the impact of both GDP per capita and trade openness is less than proportionate but it does not mean that the environment is not getting negatively affected and the impact is avoidable. In the longer-term, this effect will eventually hit the economy of Oman, and the results might even start to pile up against the financial and strategic strength of the country. Considering the global attention to the environment and reducing the carbon footprint, it is high time for this significant oil-exporting country to consider healthier and more sustainable options. More strategies can be developed to become environmentally more aware while being actively involved in open trade at the same time.

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Conclusions

In the development of any country, TO plays a crucial part, but its environmental effect may not be ignored if the income of a country has been reached at a high point like the case of Oman. So, this present research investigates the impact of GDP per capita and TO on the CO_2 emissions per capita using ARDL methodology on a maximum available sample period of 1972-2014. Empirical findings suggest that GDP per capita and TO have a positive effect on per capita CO_2 emissions in the long run with an elasticity more significant than one. Therefore, increasing trade openness can have adverse environmental pressure due to higher CO_2 emissions and increasing economic growth has also negative environmental consequences. As a country becomes more advanced and its income increases, there is more focus on trade openness since the country is willing to achieve an optimal level of production and consumption as well. However, in that scenario, the destructive effects of this growth and especially trade openness cannot be ignored, and it should be kept into account that all the trade benefits come at a monetary and social price. With more trade growth, the negative impact on the CO2 emissions and the overall environment are more rigorous, which make the activities surrounding trade openness questionable.

Further, elasticities of both effects are found greater than one. Therefore, the increasing GDP per capita and TO have more than proportionate impact on CO_2 emissions. The same positive results of GDP per capita and TO are observed with elasticity lesser than one in the short run. Therefore, we suggest the government of Oman to draw the qualitative checks on the trade activities to support a clean environment in the country. At first glance, the monetary and diplomatic benefits that trade openness brings together are inevitable, but in a larger picture, its other social impacts of a qualitative must be taken into consideration as well since in the long-run, that is the most sustainable approach to development and prosperity. Many studies mentioned in the analysis suggest a more holistic view of the economy if a nation wants to achieve the goal of open trade and a sustainable environment at the same time. In a longer perspective, this idea puts together a better picture of the economy without exploiting one sector more than the other. In some studies, the existence of a spatial effect is also corroborated which indicates that higher income and trade openness is not only destructive for the environment of the host nation; it has destructive consequences for the neighboring countries as well which means that countries must try to be more inclusive when it comes to environmental policy formation since all nations share the same environment and air. Although the benefits of trade openness cannot be denied in an economic context of a country, the policies designed to improve it must be more inclusive of the entire economy, and all positive and negative externalities must be taken into consideration so that the net effect is positive.

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Apendix: Raw Data

Years	**LCO_t**	**$LGDPC_t$**	**LTO_t**
1972	0.990364	9.163808	4.635942
1973	0.962169	8.971383	4.812367
1974	1.020425	9.037821	4.79973
1975	2.107479	9.209899	4.772724
1976	2.194922	9.346526	4.684908
1977	2.163383	9.303662	4.628347
1978	2.021343	9.211311	4.673268
1979	1.956288	9.198114	4.622773
1980	1.65598	9.201031	4.608311
1981	1.595348	9.302668	4.632551
1982	1.491892	9.356752	4.622005
1983	1.710872	9.45734	4.518726
1984	1.728494	9.561739	4.475742
1985	1.754473	9.646849	4.46603
1986	1.844585	9.625637	4.384187
1987	1.765209	9.553726	4.356003
1988	1.84192	9.576326	4.267736
1989	1.754603	9.650602	4.248495
1990	1.837868	9.609328	4.315208
1991	1.827075	9.624245	4.354229
1992	1.806726	9.658851	4.385332
1993	1.870998	9.673708	4.395755
1994	1.963512	9.675565	4.353997
1995	1.975693	9.698659	4.376907
1996	1.909998	9.714079	4.449407
1997	1.92909	9.766821	4.484447
1998	1.995237	9.791968	4.518459
1999	2.217385	9.789369	4.457255
2000	2.267394	9.836193	4.376934
2001	2.179283	9.868297	4.394906
2002	2.389834	9.840164	4.344045
2003	2.608563	9.791512	4.413452

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2004	2.437781	9.779713	4.502555
2005	2.476849	9.777467	4.492447
2006	2.729972	9.801635	4.47548
2007	2.797892	9.814783	4.569259
2008	2.739463	9.858082	4.560811
2009	2.65728	9.873473	4.445965
2010	2.746664	9.866875	4.497795
2011	2.814802	9.793334	4.753111
2012	2.837631	9.814679	4.761056
2013	2.805624	9.788655	4.863315
2014	2.737167	9.750747	4.748536

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