Energy Policy 37 (2009) 181–189

Contents lists available at ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

When will fossil fuel reserves be diminished?

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ARTICLE INFO

Article history:
Received 8 February 2008
Accepted 14 August 2008
Available online 27 September 2008

Keywords:
Worldwide fossil fuel reserve
Econometrics model
Non-renewable energy depletion time

ABSTRACT

Crude oil, coal and gas are the main resources for world energy supply. The size of fossil fuel reserves and the dilemma that "when non-renewable energy will be diminished" is a fundamental and doubtful question that needs to be answered. This paper presents a new formula for calculating when fossil fuel reserves are likely to be depleted and develops an econometrics model to demonstrate the relationship between fossil fuel reserves and some main variables. The new formula is modified from the Klass model and thus assumes a continuous compound rate and computes fossil fuel reserve depletion times for oil, coal and gas of approximately 35, 107 and 37 years, respectively. This means that coal reserves are available up to 2112, and will be the only fossil fuel remaining after 2042. In the Econometrics model, the main exogenous variables affecting oil, coal and gas reserve trends are their consumption and respective prices between 1980 and 2006. The models for oil and gas reserves unexpectedly show a positive and significant relationship with consumption, while presenting a negative and significant relationship with price. The econometrics model for coal reserves, however, expectedly illustrates a negative and significant relationship with consumption and a positive and significant relationship with price. Consequently, huge reserves of coal and low-level coal prices in comparison to oil and gas make coal one of the main energy substitutions for oil and gas in the future, under the assumption of coal as a clean energy source.

1. Introduction

Fossil fuels play a crucial role in the world energy market. "The world's energy market worth around 1.5 trillion dollars is still dominated by fossil fuels" (Goldemberg, 2006). The World Energy Outlook (WEO) 2007 claims that energy generated from fossil fuels will remain the major source and is still expected to meet about 84% of energy demand in 2030. There is worldwide research into other reliable energy resources to replace fossil fuel, as they diminish; this is mainly being driven due to the uncertainty surrounding the future supply of fossil fuels. It is expected, however, that the global energy market will continue to depend on fossil fuels for at least the next few decades.

"World oil resources are judged to be sufficient to meet the projected growth in demand until 2030, with output becoming more concentrated in Organization of Petroleum Exporting Countries (Chedid et al., 2007) on the assumption that the necessary investment is forthcoming" (IEA, 2007b). According to WEO 2007 oil and gas supplies are estimated to escalate from 36 million barrels per day in 2006 to 46 million barrels per day in 2015, reaching 61 million barrels per day by 2030. In addition, oil and gas reserves are forecast at about 1300 billion barrels and 6100 trillion cubic feet in 2006, respectively (BP, 2007b). The World Energy Council (WEC) in 2007 estimated recoverable coal reserves of around 850 billion tonne in 2006 (WEC, 2007).

Table 1 shows the distribution of remaining reserves of fossil fuels. All figures are presented in giga tonnes of oil equivalent. Firstly, as seen in Table 1, coal constitutes approximately 65% of the fossil fuel reserves in the world, with the remaining 35% being oil and gas. Secondly, while the size and location of reserves of oil and gas are limited in the Middle East, coal remains abundant and broadly distributed around the world. "Economically recoverable reserves of coal are available in more than 70 countries worldwide, and in each major world region" (WEC, 2007). In other words, coal reserves are not limited to mainly one location, such as oil and gas in the Middle East. These two geological reasons support the fact that coal reserves have potential to be the dominant fossil fuel in the future.

Fossil fuel reserve trends tend to mainly depend on two important parameters: consumption and price. The Energy Information Administration (EIA) has projected that energy consumption will increase at an average rate of 1.1% per annum, from 500 quadrillion Btu in 2006 to 701.6 quadrillion Btu in 2030 (EIA, 2007b). Currently, the growth in world energy consumption is approximately 2% per annum (Mason, 2007). "In terms of global consumption, crude oil remains the most important primary fuel

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0301-4215/$ - see front matter
doi:10.1016/j.enpol.2008.08.016

Table 1
Location of the world's main fossil fuel reserves in 2006

Region	Fossil fuel reserve (giga tonnes of oil equivalent)				Fossil fuel reserve (%)			
	Oil	Coal	Gas	Sum	Oil	Coal	Gas	Sum
North America	8	170	7	185	0.86	18.20	0.75	19.81
South America	15	13	6	34	1.61	1.39	0.64	3.64
Europe	2	40	5	47	0.21	4.28	0.54	5.03
Africa	16	34	13	63	1.71	3.64	1.39	6.75
Russia	18	152	52	222	1.93	16.27	5.57	23.77
Middle East	101	0	66	167	10.81	0.00	7.07	17.88
India	1	62	1	64	0.11	6.64	0.11	6.85
China	2	76	2	80	0.21	8.14	0.21	8.57
Australia and East Asia	2	60	10	72	0.21	6.42	1.07	7.71
Total	165	607	162	934	17.67	64.99	17.34	100.00

Source: WCI (2007) and BP (2006).

accounting for 36.4% of the world's primary energy consumption (without biomass)" (BP, 2007a). The International Energy Agency (IEA) claims oil demand as the single largest consumable fossil fuel in the global energy market will fall from 35% to 32% by 2030. Coal is the second largest consumable fossil fuel relative to the three main fossil fuels; in part largely due to consumption over the past couple of years. According to WEO 2007, "coal is seen to have the biggest increase in demand in absolute terms, jumping by 73% between 2005 and 2030" (IEA, 2007b). "Coal accounted for about 28% of global primary energy consumption in 2005; surpassed only by crude oil" (BGR, 2007). Reserves of gas in comparison to oil and coal will moderately increase for the next two decades, from 21% to 22% (IEA, 2007b). Although other energy resources are expanding in the world, the rate of fossil fuel consumption for energy will also continue to increase through to 2030 (Shafiee and Topal, 2008a).

The next important issue after global consumption of fossil fuels is fossil fuel price movement. Proven fossil fuel reserves will fluctuate according to economic conditions, especially fossil fuel prices. In other words, proven reserves will shrink when prices are too low for fossil fuels to be recovered economically and expand when prices deem fossil fuels economically recoverable (IEA, 2007a). In addition, the trend of fossil fuel prices significantly affects fossil fuel consumption. On the other hand, fossil fuel price fluctuations affect other variables such as international inflation, global GDP growth, etc. Consequently, the size of fossil fuel reserves depends on their prices.

The oil price is currently very high at around $140 per barrel in nominal terms. This is much higher than after several other oil price crises, such as the Iran/Iraq war, Gulf war and 9/11(WTRG, 2008). According to OPEC (2007), "OPEC benchmark crude price is assumed to remain in the $50 to $60 per barrel range in nominal terms for much of the projected period and rising further in the longer term with inflation" (OPEC, 2007). Therefore, the oil price at the moment is much higher than the OPEC prediction. Moreover, WEC (2007) forecast "the oil price based on the assumption that the average crude oil price will fall back from recent highs of over $75 per barrel to around $60 (in year 2006 dollars) by 2015 and then recover slowly, reaching $62 (or $108 in nominal terms) by 2030" (IEA, 2007b). Coal prices have had less fluctuation in comparison to oil in the last 50 years. The coal market depicts relatively constant coal prices in historical data.[1]

[1] Coal prices in last couple of decades follow the mean reverting approaches. However, oil and gas prices show some jump diffusion in its historical data. For more information refer to Shafiee and Topal (2008b), A Review of Literature of Price Modelling Working Paper. School of Engineering at CRC Mining, The University of Queensland, Brisbane.

WEC (2007) assumes that this trend will remain flat until the middle of the next decade, then increase very slowly, reaching just over $60 per tonne by 2030 (IEA, 2007b). Gas prices have generally followed the increase in oil prices since 2003, typically with a 1 year lag. Annual Energy Outlook 2007 predicted that the average transmission and distribution margin for delivered gas is projected to change from $2.38 per thousand cubic feet in 2006 to between $2.07 and $2.44 per thousand cubic feet in 2030 (2005 dollars) (EIA, 2007a). As a result, forecasting fossil fuel prices are uncertain and for the future are unpredictable.

2. Review of literature on energy reserves

Views about world fossil fuel reserves differ and nobody can predict exactly when supplies of fossil fuels will be exhausted. According to the Director of Biochemistry at the University of York, one day fossil fuels will run out and the world demand for them will not be met; the only imponderable is, when it will happen. Salameh (2003) claimed that "global oil supplies will only meet demand until global oil production has peaked sometime between 2013 and 2020". Seifritz (2003) has shown through the formalisation of the depletion of fossil fuel rate curves, which can get extremely asymmetrical, doubting that the symmetrical bell curve is the last resort in predicting the end of the fossil fuel era. Edigera and his colleagues showed Turkey as a typical example for emerging energy markets in the developing world. They found that the fossil fuel production peak has already been reached in Turkey and indicated that fossil fuel production for Turkey will diminish in 2038 (Edigera et al., 2006; Edigera and Akar, 2007). Asif and Muneer presented the energy reserves and years to exhaustion of non-renewable energies for some countries in 2007. The predicted years to exhaustion of coal, based on a compound growth rate for India, China, Russia and USA, are about 315, 83, 1034 and 305 years, respectively (Asif and Muneer, 2007). Thielemann et al. (2007), from a geoscientific perspective point to the year 2100 when they believe there will be no bottleneck in coal supplies in the world. Recently, countries such as the USA, India and Ethiopia are attempting to discover coal reserves and to find new clean coal utilization techniques (Khadse et al., 2007; Wolela, 2007). For example, the Department of Energy (DOE) in the USA announced "power plants based on Solid State Energy Conversion Alliance (SECA) fuel cells and coal gasifiers will generate power with overall efficiencies greater than 50 percent, compared to approximately 25 percent for traditional coal-fired power plants, including CO_2 capture processes" (US DOE, 2008). Therefore, coal is one of the main geological reserves and resources for the next century.

The global community is looking for renewable energy instead of non-renewable energy as a solution to replace fossil fuel resources in the future. Goldemberg attempts to find a solution to encompass extending the life of fossil fuel reserves. This research suggested that expanding the share of renewable energy in the global system would be one possibility that promises clean energy (Goldemberg, 2006). Klass (2003) suggested "practical solutions to the problems of disposing of spent nuclear fuels and the development of clean coal applications will enable these energy resources to afford major contributions to global energy". Grubb demonstrated links between climate change objectives and the distribution of fossil fuel resources. This research suggested some policies such as reducing tax incentives for the development of new resources and technologies and strengthen the development of policies and institutions for tackling climate change to restrict consuming fossil fuel (Grubb, 2001). Some other authors believe biomass has been a major source of energy in the world before industrialization when fossil fuels became dominant. Kelly-Yong et al. (2007) claimed "the potential availability of palm oil biomass that can be converted to hydrogen through gasification reaction in supercritical water, as a source of renewable energy". Demirbas claimed that Turkey as one of the major agricultural countries in the world will increase in biomass energy. Thus indicating that non-fossil-fuel energy sources have a high share of energy supply in Turkey and biomass energy can replace fossil fuels. "Biomass represents a secure domestic source of energy that is not subject to the price fluctuations and supply uncertainties of imported petroleum and natural gas" (Demirbas, 2008). Nuclear is another alternative for energy in the future. While there is a fear of the greenhouse gas effect, it may produce a carbon tax similar to coal (Walters et al., 2002). According to Khan et al. (2008) "it would be possible to sustain world power needs till end of 21st century by using coal, uranium or energy mix but eventually new energy sources would be required to volte-face global warming and meet the increased population energy demand". Consequently, biomass, nuclear, solar and hydrogen are destined to become major energy sources for the next century after fossil fuels run out.

While renewable energy sources are increasing, one of the interesting circumstances surrounding fossil fuels is that despite the rise in consumption, the quantities of proven reserves are also rising with time. According to Lior (2008), the ratio of resources to production has remained nearly constant for decades, around 40, 60 and 150 for oil, gas and coal, respectively. Maugeri (2004) claims that new oil discoveries are only replacing one-fourth of what the world consumes every year. Although there is no obvious answer about this amazing ratio, the unknown resource exploration data, price fluctuations and abnormal energy markets are potential reasons. For example, the US Geological Survey released undiscovered volumes of 3.65 billion barrels of oil, 1.85 trillion cubic feet of dissolved natural gas and 148 million barrels of natural gas liquids in five different regions in 2008 (USGS, 2008). On the other hand, consumption and production around the world do not follow the same trend, for instance the US oil consumption has been approximately 22% of world oil consumption over the last 40 years, while the US and world oil do not follow the production logistic growth curve (USGS, 2006; Caithamer, 2008). Consequently, fossil fuel reserves are running out, and the supply of fossil fuels is inelastic.

3. Data resource

To calculate the time when fossil fuels will be depleted requires estimation using a new econometrics model and analysis of the variables. To do this, a data set has been collected from different sources. The main variables in this research are oil, gas and coal reserves and fossil fuel consumption data between 1980 and 2006, extracted from the Annual Energy Review (AER) 2007 and British Petroleum (BP). Moreover, price data for oil,[2] gas and coal have been collected annually between 1980 and 2006, from the International Energy Outlook 2007 and the AER 2007.

Collecting the data for reserves of coal is more difficult than for oil and gas. There are some organizations that estimate fossil fuel reserves periodically and forecast their own inventory. The Bundesanstalt für Geowissenschaften und Rohstoffe (BGR) in Germany, the WEC and recently BP are the most notable. But there is not one coal organization providing technical data and reserves, such as OPEC. Furthermore, some companies have published reports according to national agencies and focused on specific regions as cross-sectional data. As a result, the coal reserve data as time series, such as oil and gas, are less available and reliable.

4. Fossil fuel reserve versus consumption

In this section, the trends of fossil fuel reserves versus consumption are discussed. In Figs. 1–3 the trends of oil, coal and gas consumption with their reserve are illustrated. As can be seen in Figs. 1 and 3 the trend of oil and gas reserves with their consumption increased. This means that reserve and consumption for oil and gas over the last 26 years have an unusual positive correlation. Fig. 2 shows reserve versus consumption of coal. This graph shows a negative correlation between coal reserve and consumption. In spite of the fact that the data for coal were less available and more volatile in comparison to oil and gas, the relation between coal reserve and coal consumption is still negative and significant. According to Shihab-Eldin et al. (2004), the increase in fossil fuel resources is due to the availability of improved data, as well as technological improvements. Consequently, the reserves of oil and gas have not shown any decreasing trend during the last couple of decades and predictions that they were about to run out are not substantiated.

Coal has the largest worldwide reserves and resources, compared with oil and gas. "Coal remains the most important energy, amounting to about 55% of the reserves of all non-renewable fuels" (BGR, 2007). It is clear that coal will supply more energy than oil and gas in the future. On the other hand, world coal resource assessments have been downgraded continuously from 1980 to 2005 by an overall 50%. Thus in practice, resources have never been reclassified into reserves for more than two decades despite the increase in coal prices (Zittel and Schindler, 2007). Even though the coal reserve data are biased and shrank over the last 25 years, coal still has the biggest reserves of all fossil fuels.

The main question concerning fossil fuels is "for how long will global energy supply depend on fossil fuels?" A lot of economists believe implementation of the Kyoto commitments will shrink worldwide fossil fuel consumption. As WEO 2007 mentioned around 84% of energy up to 2030 will come from fossil fuels. For this huge dependence on fossil fuel, Fig. 4 illustrates the trend of fossil fuel consumption worldwide from 1965 to 2030. As can be seen, the three types of fossil fuel will have an increasing trend over the next 22 years. In this figure, world oil consumption is always more than that of coal and gas, and coal consumption is greater than gas. Consequently, the consumption of fossil fuels has

[2] In this paper proved reserve of oil is taken to be those quantities that geological and engineering information indicates with reasonable certainty can be recovered in the future from known reservoirs under existing economic and operating conditions, which includes tar sands and oil shales.

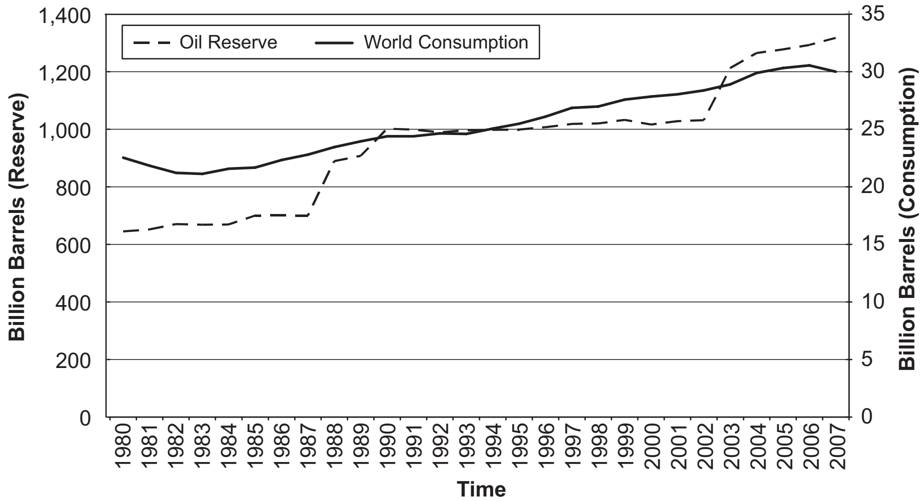

Fig. 1. Trends of world crude oil proven reserves and oil consumption from 1980 to 2007. Data collected from EIA and BP.

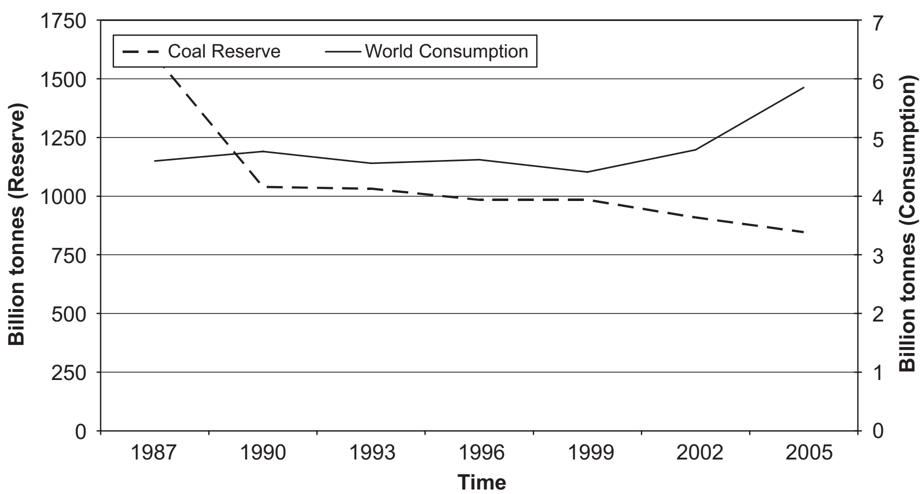

Fig. 2. Trends of world coal proven reserves and coal consumption from 1987 to 2005. Data collected from EIA and BP.

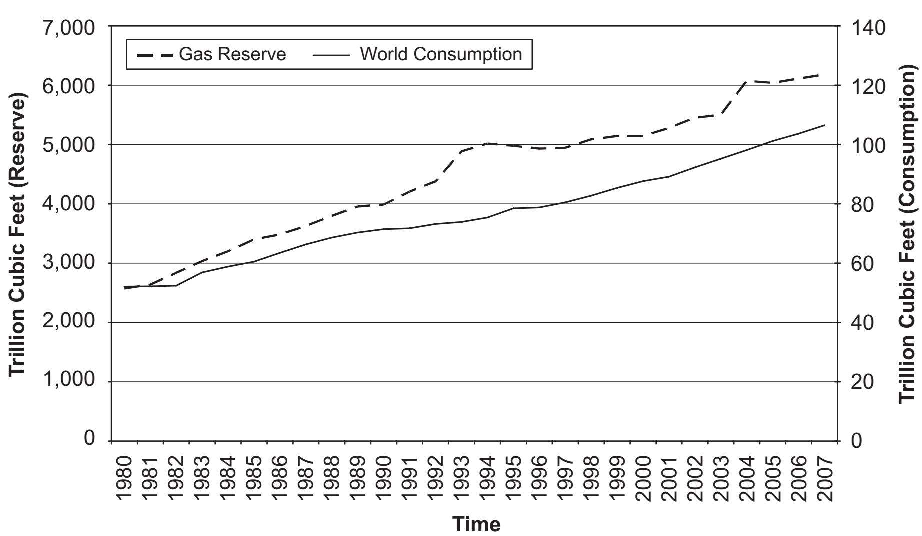

Fig. 3. Trends of world natural gas proven reserves and gas consumption from 1980 to 2007. Data collected from EIA and BP.

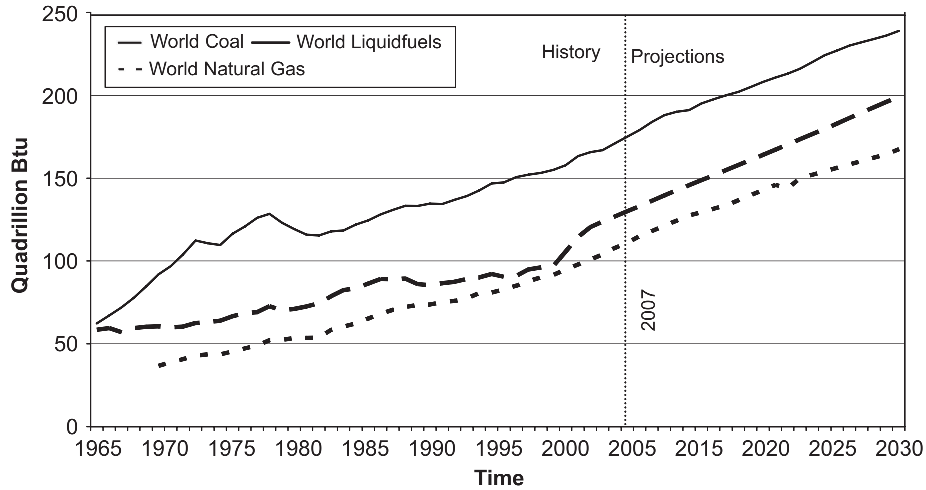

Fig. 4. Consumption of fossil fuel worldwide from 1965 to 2030. Data collected from EIA and BP.

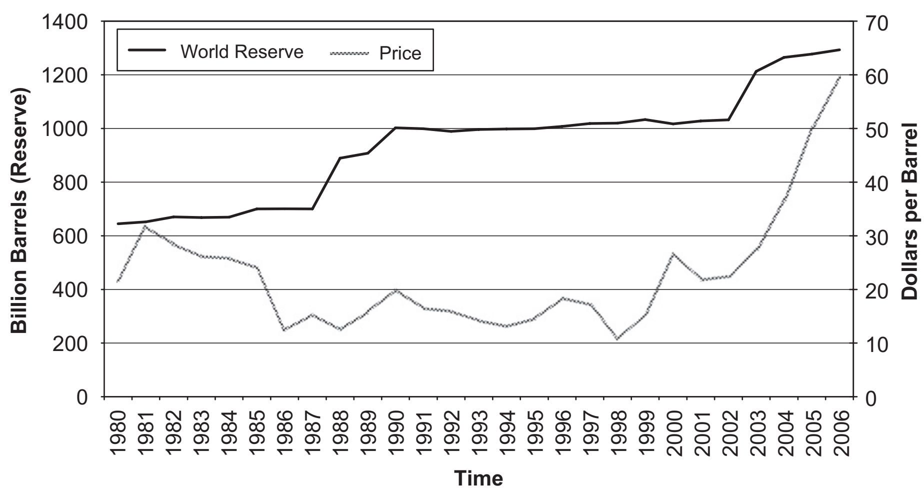

Fig. 5. Trends of world crude oil proven reserves and oil price from 1980 to 2006. Data collected from EIA and BP.

grown over the last 40 years and is expected to follow the same trend in the future (Shafiee and Topal, 2008a).

5. Fossil fuel reserve versus price

Figs. 5–7 depict the trend of fossil fuel prices and reserves for oil, coal and gas. Radetzki (2002) concluded that "the price impact will be insignificant if the climate policy goals are established credibly and in the near future, for that will give rationally behaving fossil fuel producers ample time to adjust production capacity to the changed outlook for future demand". This means if capacity develops in line with demand, prices will remain constant. Therefore, price movements are irrespective of the speed and direction of changing demand.

Figs. 5–7 exemplified fossil fuels versus their prices. In these figures oil and gas prices unexpectedly increase with their reserves over 26 years. The oil price in 2008 reached over $138 per barrel. Canadian tar sands, Venezuelan and Russian heavily oil are some alternatives for increasing oil reserves in future in a high-level oil price environment, but these new reserves are not a good substitute for cheap oil. On the other hand, in Fig. 6 the coal price and reserve are decreasing. This trend for coal is slightly different when compared to oil and gas. While, over the last couple of years the coal price has moderately increased in comparison with the previous coal price trend. "Some argue that these higher coal prices might indicate the threat of a physical scarcity of fossil fuels, similar to the situation with oil and gas" (Thielemann et al., 2007). In other words, huge reserves of coal, and low level of prices in comparison to oil and gas, make coal one of the main energy substitutes for oil and gas.

6. Fossil fuel depletion time

This section calculates fossil fuel depletion time using two methodologies. The first method is a modified Donald Klass' formula in order to compute fossil fuel depletion (Klass, 1998). Klass assumed that the rate of fossil fuel consumption was constant and used a compound rate formula in his model. The formula uses a continuous compound rate formula to derive a new formula. Eq. (1) illustrates total fossil fuels consumption over time. The second model calculates the ratio of world consumption to reserves:

$$TFC = \sum_{i=1}^{n} FC_i = R \tag{1}$$

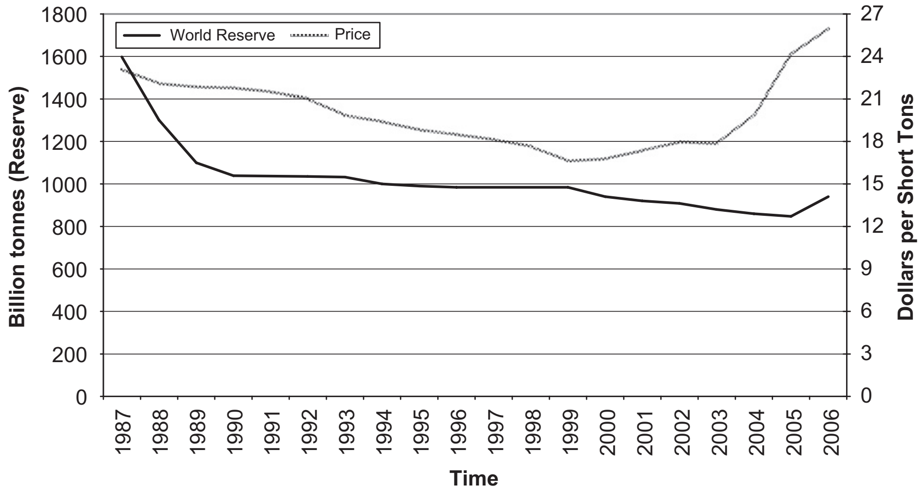

Fig. 6. Trends of world coal proven reserves and coal price from 1987 to 2006. Data collected from EIA and BP.

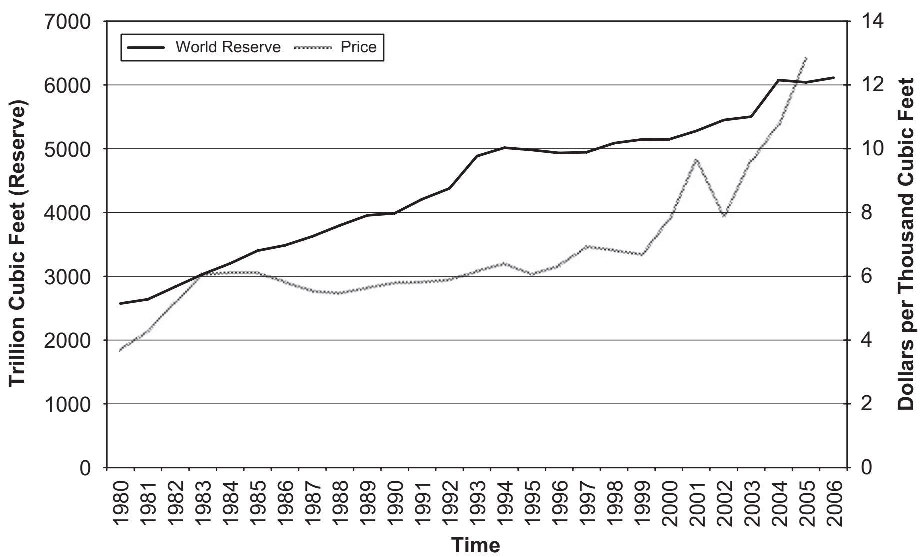

Fig. 7. Trends of world natural gas proven reserves and gas price from 1980 to 2006. Data collected from EIA and BP.

where *TFC* is the total fossil fuel consumption, *FC* the fossil fuel consumption, *n* the year and *R* the reserve.

As can be seen in this equation *TFC* is assumed to be consumed in "*n*" years. *FC* is derived in Eq. (2):

$$FC_n = FC_1\, e^{(n-1)g} \tag{2}$$

where *g* is the annual continued growth rate of fossil fuel consumption.

From Eqs. (1) and (2), we can simply derive Eq. (3) to compute "*n*":

$$n = \frac{Ln[(R/FC_1)(e^g - 1) + 1]}{g} \tag{3}$$

Most researchers estimate reserve depletion time by assuming constant production rates. For example, WEO 2006 estimated a ratio for oil of between 39 and 43 years, 164 year for coal and 64 years for gas (IEA, 2006). Lior (2008) assumed constant fossil fuel production rates and then estimated the ratio of production to reserves to be approximately 40, 60 and 150 for oil, gas and coal, respectively. As can be seen, none of the research modified the rate of production or consumption of fossil fuel to calculate the ratio of consumption to reserves. Consequently, the new model added this assumption and adjusted new formula to calculate fossil fuel reserve depletion time.

Table 2
Fossil fuel reserves depletion times

Model	Ratio of consumption to reserves			Klass model			New model		
	Oil	Coal	Gas	Oil	Coal	Gas	Oil	Coal	Gas
Year	40	200	70	34	106	36	35	107	37

Source: Data collected from EIA and BP, and computed by authors.

Table 2 illustrates the time that fossil fuels will be depleted using the Klass model and new model. As can be seen in this table, the Klass model for oil, coal and gas depletion times is calculated to be about 34, 106 and 36 years, respectively, compared to 35, 107 and 37 in the new model. Ultimately, the reserve of coal using either approach still has a longer availability than oil and gas. This means at this rate coal reserves will be available until at least 2112, and it will be the single fossil fuel in the world after 2042.

The second method tries to calculate the time that fossil fuels will be depleted by computing ratio of consumption to reserves. Thus, the average ratios of world consumption to reserves for oil, coal and gas can be computed from Figs. 1–3. Fig. 8 graphs the trend of ratio of world consumption to reserves for oil, coal and gas from 1980 to 2006. As can be seen in this figure these ratios for oil and gas were constant, around 40 and 60 years, respectively. This means during the last 26 years, the reserves of oil and gas were increasing. However, this ratio for coal decreased from 350 to 150 years, in 20 years. This shows the estimation of coal reserve was not very accurate in the last two decades. One of the reasons for this big difference is some political policy against releasing the real data. In other words, to release the real data of reserves has a direct effect on prices and vice versa. Finally, the average of this ratio for oil, coal and gas calculated approximately constant around 40, 200 and 70, respectively, from 1980 to 2006. This means that if the world continues to consume oil, coal and gas at 2006 rates, their reserves will last a further 40, 200 and 70 years, respectively.

This new model estimated fossil fuel reserve depletion time according to the assumption that the trend of reserve in the world would be constant. For example, if the new reserves are discovered in the world, the depletion time should be calculated again.

7. Econometrics model on fossil fuels reserve

This study endeavours to use econometrics techniques to find out the effect of variables on fossil fuel reserve and is based on the ad hoc liner model:

$$RES_t = \alpha + \beta_1 C_t + \beta_2 P_t + \varepsilon_t \quad (4)$$

where RES_t is the world fossil fuel proven reserves, C_t the world fossil fuel consumption, P_t the world fossil fuel price.

As can be seen, this model focuses on reserves of fossil fuel as the dependent variable and fossil fuels consumption and prices as independent variables. In Table 3, three individual econometrics models for oil, coal and gas have been developed to explain the influence of consumption and prices of fossil fuel, on their

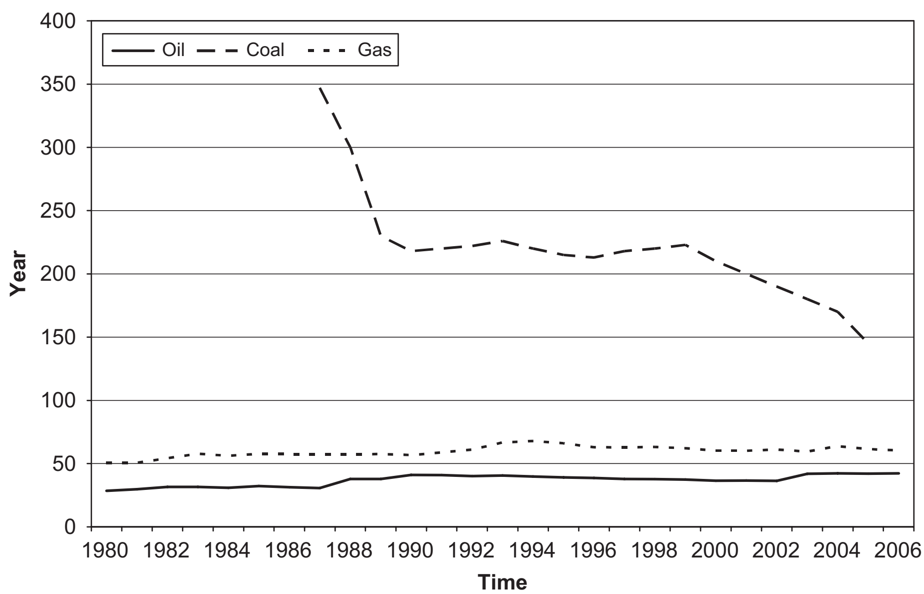

Fig. 8. The ratios of world consumption to reserves for oil, coal and gas from 1980 to 2006.

Table 3
Regression models of oil, coal and gas reserves in the world from 1980 to 2006

Model Endogenous variables	Oil World oil reserves (billion barrels)	Coal World coal reserves (billion tonne)	Gas World gas reserves (trillion cubic feet)
	Result		
Exogenous variables			
Constant variables	−710.46(0.99)[a]	1199.15(0.99)[a]	−975.91(0.99)[a]
World oil consumption (billion barrels)	66.48(0.99)[a]		
World coal consumption (billion tonne)		−402.82(0.99)[a]	
World gas consumption (billion cubic feet)			0.08(0.99)[a]
Oil price (US dollars/barrel)	−1.26(0.60)[a]		
Coal price (US dollars/short tonne)		39.85(0.99)[a]	
Gas price (US dollars/thousand cubic feet)			−73.37(0.95)[a]
Adjusted R-squared	0.92	0.89	0.98
Durbin–Watson	1.74	1.57	1.65
F-statistic	105.94	52.55	355.55
Probability of significance	(0.99)	(0.99)	(0.99)

Source: Data from EIA and BP and modellings computed in Eviews.
[a] Entries in parentheses denote probabilities of significance.

reserves. The models are estimated by autoregressive moving average approaches for fossil fuel reserves from 1980 to 2006.

The first econometrics model estimates the relationship between world oil reserve and consumption and price. This model unexpectedly shows that oil consumption (at the 99% confidence interval) has a positive effect on world oil reserve, and oil price (at the 60% confidence interval) has a negative effect on world oil reserve. The oil model indicates that if oil consumption increases by one million dollar per year, the world reserve of oil will be increased by 66.48 billion barrels as well, ceteris paribus. The second econometric model in Table 3 estimates the world coal reserve. World coal consumption (at the 99% confidence interval) has a negative effect, and coal price (at the 99% confidence interval) has a positive effect on the world coal reserve. This model shows that if coal consumption increases by one billion tonne, the world reserve of coal will decrease by 402.82 billion tonne, ceteris paribus. The last econometric model estimates world gas reserve. This model unpredictably illustrates that gas consumption (at the 99% confidence interval) has a positive effect on world gas reserve, and gas prices (at the 99% confidence interval) has a negative effect on gas reserve. This model indicates that if gas consumption increases by one billion cubic feet in 1 year, the world reserve of gas will be increased by 0.081 trillion cubic feet, ceteris paribus. These results in Table 3 can also be derived by comparing Figs. 1–3 and 5–7. Thus the models for oil and gas are not usually expected for fossil fuel reserves. Additionally, the Goldfeld–Quandt test, the Durbin–Watson test and the *F*-statistic test for all three models prove that the developed model has 99% significance and has no multicollinearity, heteroscedasticity or autocorrelation problems.

8. Conclusion

This paper has shown that the reserves of oil and gas did not decline over the last few decades, and predictions that oil and gas are diminishing were not reliable. Also the prediction about coal reserves over the last two decades was not accurate. The fossil fuel time depletion is calculated to be around 35, 107 and 37 years for oil, coal and gas, respectively, by the proposed method. In contrast, the ratios of world consumption to reserves for oil, coal and gas show if the world continues to consume fossil fuels at 2006 rates, the reserves of oil, coal and gas will last a further 40, 200 and 70 years, respectively. These figures prove that oil will be depleted earlier than the other types of fossil fuel, and coal will remain longer than oil and gas.

Three econometrics models were developed for world reserves of fossil fuel as a function of world consumption and fossil fuel prices. These models have shown that fossil fuel consumption has a surprisingly significant (at the 99% confidence interval) positive effect on oil and gas reserves, and significant negative (at the 99% confidence interval) effect on coal reserves. On the other hand, fossil fuel prices have unexpectedly had a negative effect on world oil and gas reserves, and a positive effect on the coal reserves. The econometrics results for oil and gas reserve models are in the opposite direction to the coal reserve model.

Consequently, the positive correlation of reserve and consumption for oil and gas combined with the negative correlation of reserve and price over the last 25 years shows that prediction of reserves was underestimated for oil and gas. On the other hand, the negative correlation between reserve and consumption and plummeting ratios of world consumption to reserves for coal in the last two decades prove that data for coal reserves were overestimated over the last 20 years. Comparing these two results, plus the fact that coal is the main substitution energy for oil and gas, shows that to release fossil fuel reserve data are instrumental in controlling the energy market. Furthermore, oil and gas organizations such as OPEC try to dominate the fossil fuel market and control the prices. The huge coal reserve and its cheap price are the main factors in improving coal potential as the most available fossil fuel in the future. Clean coal and environmental problems are still barriers for coal expanding as a major fossil fuel. This paper recommends further research into other variables that influence the fluctuation of fossil fuel reserves, especially technological solutions that may facilitate the consumption of coal as a clean energy.

Acknowledgement

The authors are pleased to acknowledge the contribution made by Micah Nehring towards this paper.

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