Geothermal Well Cost Update 2013

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Abstract

Geothermal well construction costs are critical to geothermal development. Before 2004 well costs were relatively stable. From 2004 to 2012 well construction costs changed significantly in response to changing economic conditions. For the last year well construction costs have been almost stable; however, current well costs are more than twice well construction costs in 2004, whereas the consumer price index has risen about 20%. Thus, well construction costs have increased much more than inflation and there is a need to update information on well cost drivers. Before 2004 well construction costs were below levels required to sustain a healthy well construction industry. When well costs rose 250% in 2006, some thought that well construction costs had risen much too high and would drop back to 2004 levels corrected for inflation. However, recent trends in well construction costs indicate this unlikely. Because the well construction industry is continually in flux, no attempt has been made to forecast future well construction costs, rather information is provided on changes in the well construction industry to aid in understanding how and why well costs are changing.

Introduction

In the last ten years there have been changes in the well construction industry that affect well costs. 2004 was the end of the last period during which well construction costs were relatively stable. Before 2004, rig day rates were depressed relative to the cost required to maintain a healthy drilling industry and thus increases in well construction costs were expected. By chance, 2004 was the cost basis year for several significant evaluations of the geothermal energy. In recent years the price of oil and of well construction materials has changed rapidly and thus the need for updates of well construction costs.

Past geothermal well construction cost analyses (Mansure et al. 2005, Mansure et al. 2006, and Mansure and Blankenship 2008) have been performed to support a number of Department of Energy (DOE) Geothermal Technologies Program (GTP) activities, including the GTP Multi-Year Research, Development and Demonstration Plan (DOE 2009), *The Future of Geothermal Energy* (MIT 2006), and Geothermal Electric Technologies Evaluation Model (GETEM) (Entingh 2006). Mansure and Blankenship (2008) discussed how well construction costs can be updated using Bureau of Labor Statics (BLS) data. Mines (2008) has incorporated that approach into GETEM.

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Impact of inflation, rig availability, and other economic drivers on well construction costs

To compare the cost of wells drilled at different times, one must account for changing prices of goods and services. Past work (Mansure et al. 2006) determined the most appropriate Producer Price Index (PPI) currently available from the BLS. PPI updates are available on a monthly basis, important in a time of rapid cost changes. Recent rig day rate, steel, cement, rental items, expendable items, services, and labor price increases and decreases have significantly affected well construction costs as reflected in "well construction" PPI in Figure 1. The BLS refers to their PPI as an index of drilling costs, but the index is actually for all of well construction costs including drilling contractor costs as well as casing, cementing, etc. For reference the Consumer Price Index (CPI) and chained Gross Domestic Product (GDP) are also shown on Figure 1. During periods where the PPI for well construction is relatively stable (1985 to 2000), predictions of future well construction costs, including the impacts of DOE GTP goals, are more robust and justifiable than during disruptive periods. A disruptive rise in well construction prices occurred during 2005 followed by a chaotic period during which well construction prices appeared trying to stabilize. Before well construction prices could stabilize, the 2008 world economic slump began and well construction prices fell – another disruptive event. In the last three years well construction costs have risen back to the peak values of before the 2008 economic crash.

For a while after 2005, the temptation was to assume that the sharp rise in well construction costs was a bubble and that well construction costs would return to prior values corrected for inflation. That is, it was natural to hope that a balance between oil supply and demand would bring back stable well construction economic conditions like those between 1985 and 2000. But rather than returning to prior well construction costs, changing global oil & gas economics has resulted in well constructions costs significantly above those of 2004 corrected for inflation. To get insight into disruptive events in the drilling industry, one can look at oil prices (price data from the Federal Reserve Bank and the Energy Information Agency – EIA) and rig counts (rig count data from Baker Hughes) as shown in Figure 2. Natural gas prices and rig count show a similar relationship in response to recent economic conditions (Figure 3).

What will well construction costs be in the future? The apparent stable PPI for well construction between 1985 and 2000 was not sustainable; costs had to go up. The rise and fall in oil prices in the 1970's and early 1980's left the US land drilling industry with an excess of drilling rigs. Throughout the 1990's, except in niche operations, e.g. coal bed methane drilling, rig rates were as much as $2k/day below the rate of return required to borrow money from the bank, purchase a new rig, and pay back the bank (Pierce, 2008). It took about twenty years after the 1980 disruptive event for US land drilling contractors to get back to real profitability.. In 2005, the demand for drilling rigs exceeded the supply and thus new rigs, including fit-to-purpose rigs, began to be built in significant numbers. This increase in the demand for drilling rigs and need to charge economically sustainable rig day rates resulted in a significant increase in well construction costs. The construction of new drilling rigs and the replacement of old rigs has continued, even in the wake of the 2008 economic crash. Thus, the rebound in well construction costs after 2010, most likely, indicates well construction costs are in the process of stabilizing at a new economically sustainable rate.

Rig count dropped over 50% after October 2008 (Figure 2), rebounded to close to that just before the 2008 economic crash, but again appears to be dropping. Land rig utilization is down slightly but still about 75%,[2] the minimum considered necessary for a healthy drilling industry according to The Land Rig Newsletter (Dec. 2009). As a result, rig day rates are falling slightly (Figure 4). What has kept the rig utilization rate from dropping even lower as the rig count decrease is that rigs are being decommissioned. Drilling contractor costs including labor and materials continue to rise and thus applies upward pressure that keeps rig day rates from falling too much in spite of declining rig count.

Rig rates are just one part of well construction costs. Besides the drilling rig, other major costs of well construction include steel, cement, rental items (mostly items made of steel), expendable items (e.g. drilling mud), services, and labor. Figure 5 shows BLS PPI for steel, cement, and oilfield labor compared to the CPI and chained GDP. It is reasonable to assume steel, cement, rental items, expendable items, and services on average increase in proportion to or at a rate above the CPI. Before 2001 labor appears to increase more rapidly than the CPI. This may be due to replacement of less skilled labor with fewer more skilled labors. After 2001 labor costs have probably responded to supply and demand imbalances as rig count has changed.

When the demand for casing (the same point can be made for other well construction components) exceeds the supply, the price will be in excess of that expected based on the underlying commodity, steel pipe, from which casing is made. Figure 6 compares the CPI and BLS PPI for steel pipe and tube to an index for Oil Country Tubular Goods (OCTG) based on data from Pipe Logix's databases. From 1985 through 2007 the price index for OCTG tracked the price of steel pipe and tube as indexed by the BLS indicating that the price of casing was governed by the overall balance between supply and demand for steel goods. In 2008 before the economic crash, the price of OCTG's rose disproportionately as a result of a shortage of casing. After the economic crisis of 2008 the price of casing returned to be more in balance with the overall price of steel goods. Currently OCTG costs are low relative to the cost of the underlying commodity index for steel pipe as a result of a supply glut and excess manufacturing capacity according to numerous American Metals Market (AMM) articles.

After rig day rates, steel, and labor another significant cost driver is cement. The BLS provides an index for Portland cement (Figure 5); however, the volume of cement needed for well construction (typically class G cement) is insignificant compared to other construction. As a result, there is often a significant premium that must be paid for well construction cement and its price, much like OCTG, can be disproportionally more than commodity cement (BLS index). A source for historical class G cement costs has not been found. The issue of scarcity and price of class G cement has been significant enough that the well construction industry has sought alternative cements (Hibbeler, et al. 2000).

Closing remarks

Changes in the oil & gas well construction industry that may intimately impact geothermal well construction include fit to purpose rigs and as a result significant improvements in efficiency. According to The Land Rig News Letter, March 2013, at the beginning of 2011 the average rig drilled 9 wells a year, where as currently, the average is 13 wells a year. Similar improvements

[2] Land rig data from The Land Rig newsletter databases.

can be observed by looking at the average time to drill a well or the total footage drilled per rig per year. In part these are due to newly designed drilling rigs with top drives, hydraulic catwalks, iron roughnecks, walking capabilities, etc. According to the Land Rig Newsletter fourth quarter 2012 Day Rate Report competition in the drilling industry has forced drilling contractors to introduce such new technologies without increasing day rates and will probably keep rig rates from increasing significantly until the next spike in natural gas prices which may be years away.

The importance of accurate, documented analyses of well construction costs to the DOE Geothermal Program has been demonstrated by various reports including *The Future of Geothermal Energy* (MIT, 2006). The last published analysis of geothermal well construction costs predates the large increase of well construction costs in 2004. Thus, a systematic update to geothermal construction costs would be especially valuable.

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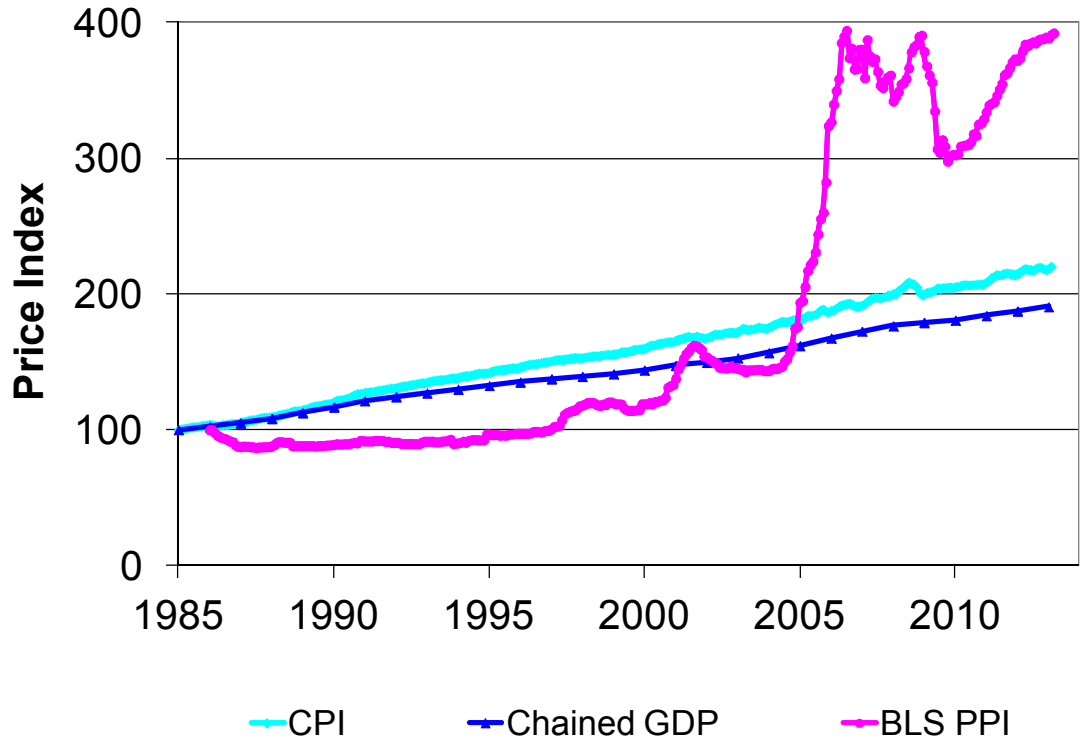

Figure 1: Comparison of BLS drilling PPI, CPI, and chained GDP Price Indices vs. time.

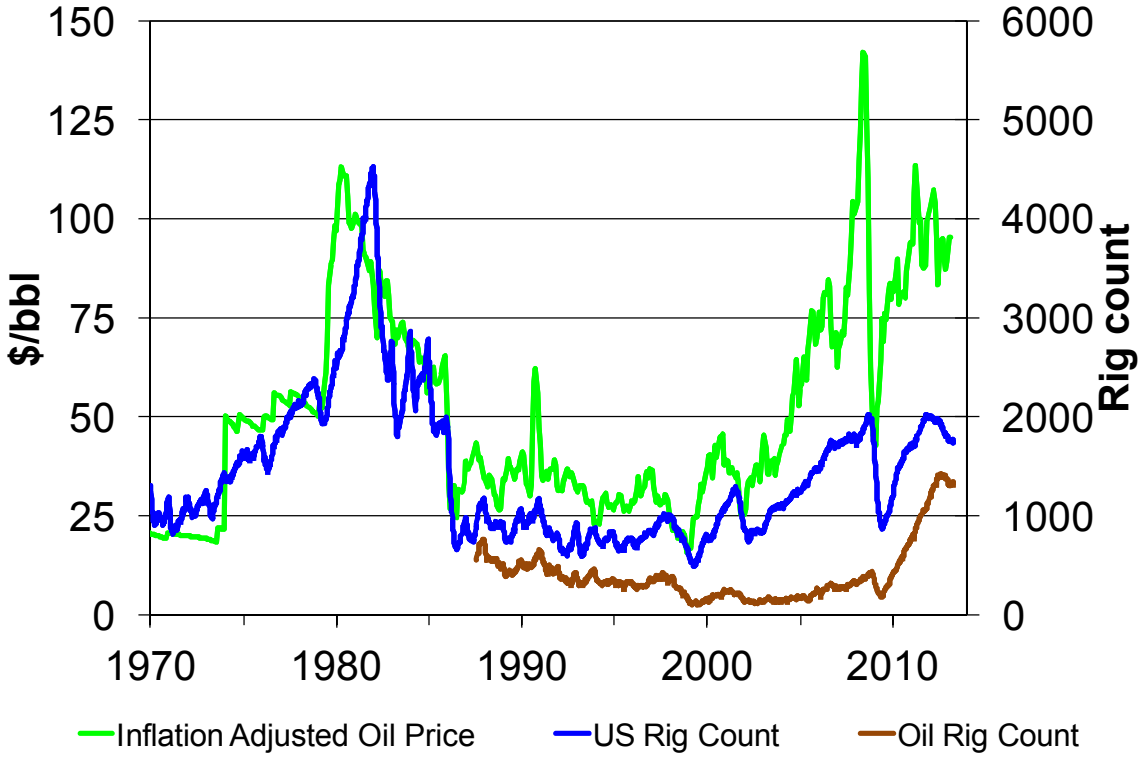

Figure 2: Comparison of oil price and rig count vs. time.

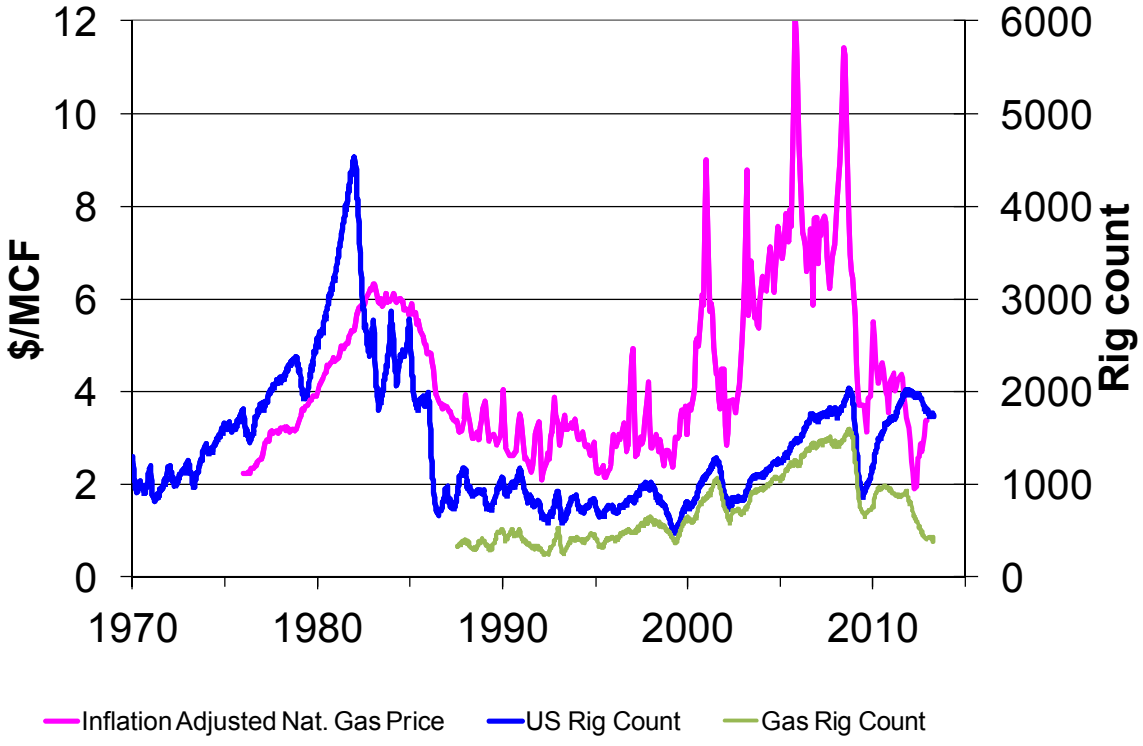

Figure 3: Comparison of natural gas price and rig count vs. time.

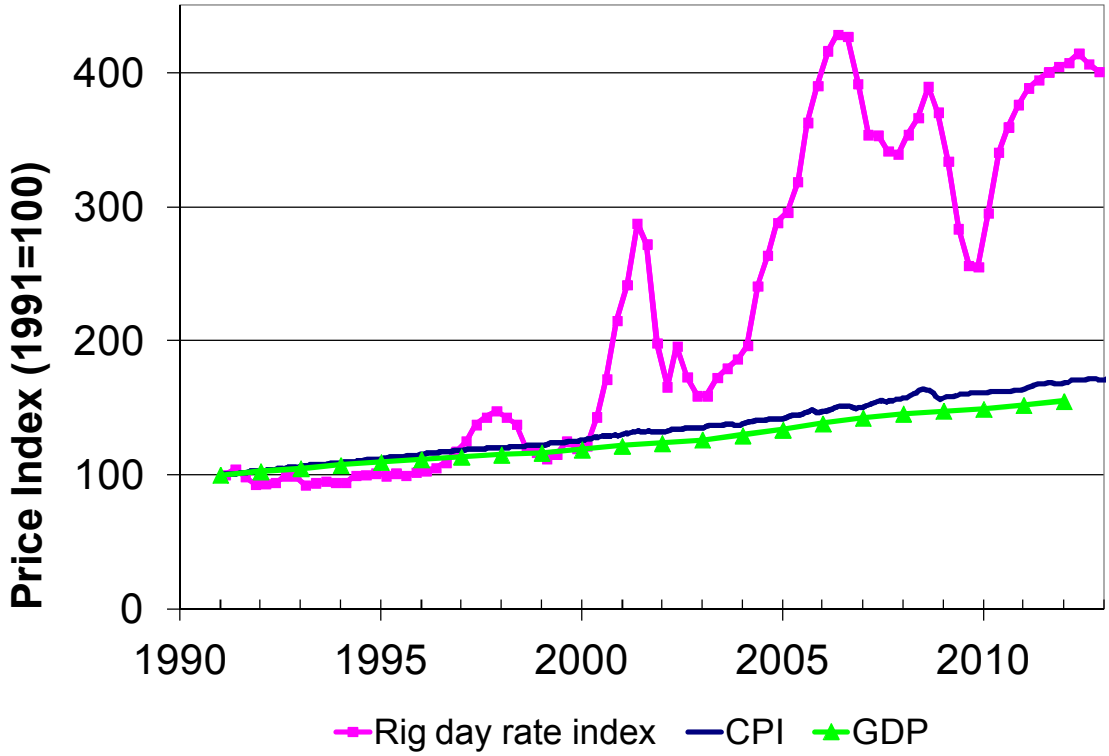

Figure 4: Index of recent rig day rate vs. GDP and CPI.
(Note: rig day rate data runs as much as 3 months in arrears.)

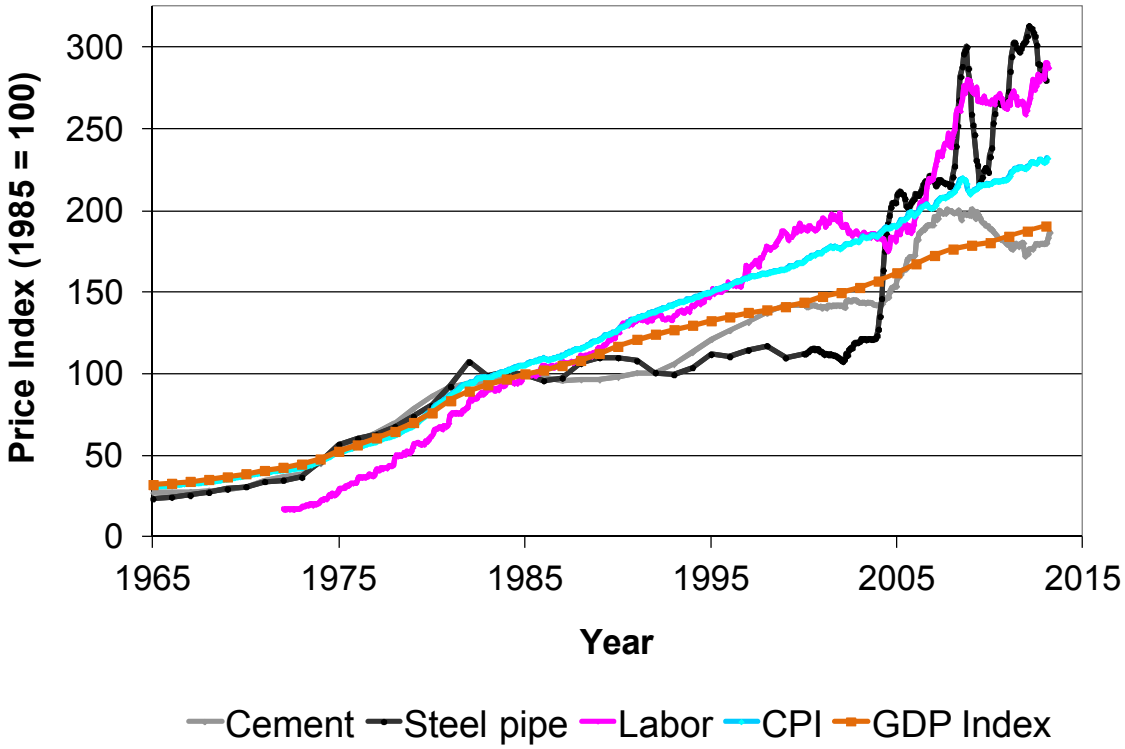

Figure 5: Comparison of cement, steel, and labor PPIs to CPI and GDP chained vs. time.

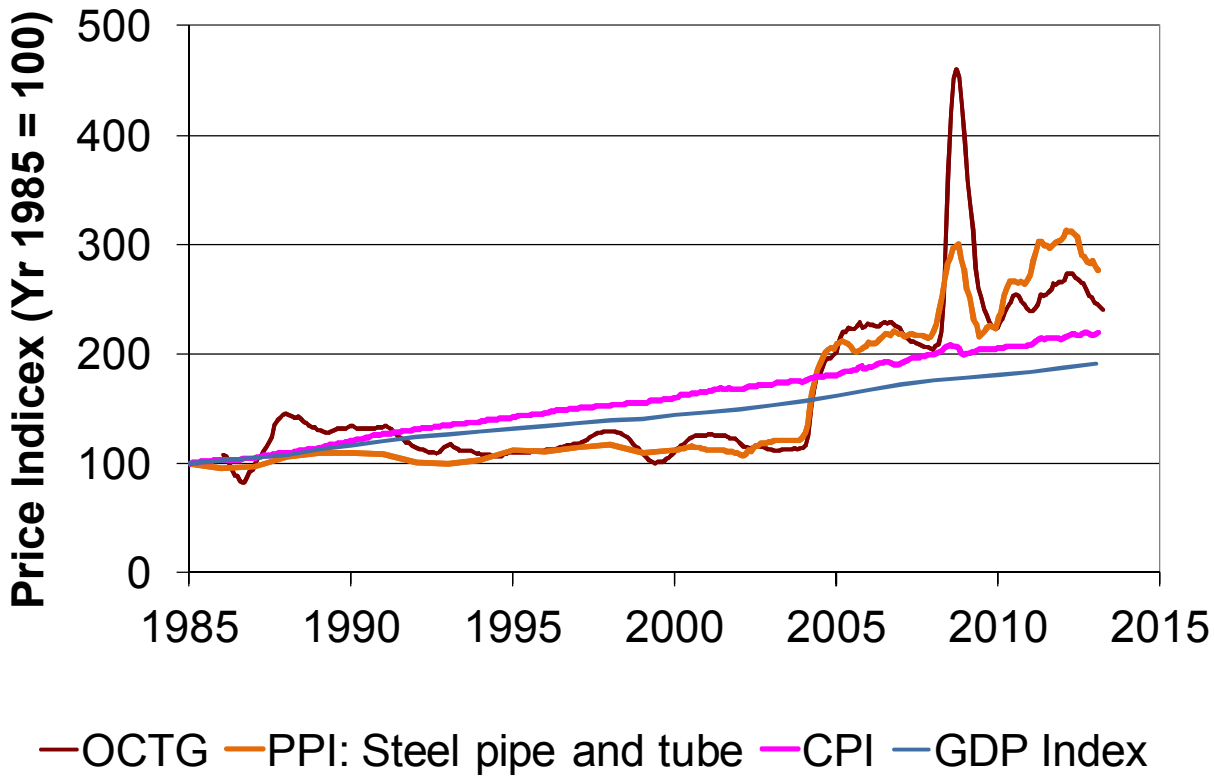

Figure 6: Comparison of Oil Country Tubular Goods (OCTG) price index to CPI and BLS price index for casing and steel pipe and tube.