3 A preliminary analysis of the long-term trends of real commodity prices

Significant drop in commodity prices

Commodity prices have recently experienced a significant fall. Following the surge recorded from the outset of the past decade, overall, commodity prices in real terms$^3$ began to retrace their upward trend from 2011. To appreciate the scale of these falls we have grouped commodities into three broad categories: energy, metals and agricultural (see figures 3.1 and 3.2). Thus the biggest corrections since then have taken place among metal commodities, these being 29% on average, followed by agricultural, with 20%, then energy with 9%, the latter being affected by the markedly different performance of the oil price.

Figure 3.1
Non-Renewable commodities prices: energy and metal*$^*$

Figure 3.2
Renewable commodities prices: agriculture*$^*$

* In real terms at 1982 prices
Source: Banco Mundial y Haver

Should the heavy commodity price falls continue, this will have a major impact on the growth of export-intensive countries. The IMF has given over Chapter 2 of its latest World Economic Outlook$^4$ to trying to show the channels through which a change in commodity prices affects the growth prospects of countries that export them, concluding that the recent dive in commodity prices could make an average negative impact of up to 1 percentage point in the medium term (2015-17).

In this piece, we look at the dynamics of real commodity prices and whether there is any long-term trend in the terms of trade of those economies which are most dependent on commodity production.

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3: Using the US consumer price index (CPI) as a deflator.
Hypothesis with respect to commodity price trends

Long-run commodity price movements represent a subject that has been studied extensively in economic literature. Notable in this sense is the hypothesis set out by ECLAC\(^5\) midway through the past century, which raises the issue of the inequality produced by the steady erosion of the terms of trade of exporters of primary products. The so-called Prebisch-Singer thesis, which focusses on renewable primary commodities, concludes that exporters of primary products are forced to drop their prices in relative terms (i.e. real commodity prices have a secular downward trend) as a result of the low income elasticity of demand exhibited in the case of such products\(^6\).

More recently, the literature has laid less emphasis on equity and focussed on merely determining the long-run trend which commodity prices follow. An example of this is to be found in the work of Robert Pindyck. In a classic paper,\(^7\) he tries to demonstrate that energy prices move around a trend and that such a trend is described by a convex quadratic function. The price of non-renewable resources that are traded in a competitive market, where there is some agreement over the existing level of reserves, would fit this type of trend as, according to the author, it would reflect the marginal cost of production\(^8\).

To verify his hypothesis, Pindyck analyses three commodities: oil, coal and natural gas, for a sample which begins in 1870 in the case of the first two, and in 1919 in the case of natural gas, and which ends in 1996. In the first part of his paper (section 2) he runs a two-step test:

1. Estimating the parameters of the quadratic trend which best fits with the data.
2. Testing the assumption of price reversion to the previously estimated trend.

Since the results are not conclusive (the tests run do not provide enough information to establish the process with the best fit with the evolution of prices), in a second part of the work (section 4) a model is constructed for each product which jointly estimates both the trend and the difference with the observed price. Such estimation incorporates two assumptions in keeping with the hypotheses maintained in the paper:

1. Reversion of the prices to an unobservable long-run (marginal cost) trend
2. Both the level and slope of the trend show stochastic fluctuations over time\(^9\)

According to the author, the results provide an acceptable tool for making long-run forecasts for the oil price, although it is less useful for coal and natural gas price projections.

Is expecting renewable and non-renewable commodities to follow a similar trend the right thing to do?

We aim to replicate the testing carried out by Pindyck for a different sample, 1960-2014, and for a very large number of commodities: 43 products which, besides energy, include metals and agricultural commodities.

One preliminary consideration which should be made, given that we are incorporating renewable commodities in the analysis, is whether the assumptions made in Pindyck’s paper and which are in

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5: Economic Commission for Latin America and the Caribbean, set up in 1947, whose first Executive Secretary was Raul Prebisch.
6: The concept of low income elasticity of demand means that as income rises, the marginal increase in demand for such products rises by a smaller amount.
8: According to research carried out at the beginning of last century by the economist Harold Hotelling, the most profitable way to exploit a non-renewable resource is one where its price is determined by the marginal net revenue from selling it and moves according to the interest rate and the expected stock of reserves.
9: These changes reflect technological innovations in commodity markets
principle appropriate for non-renewable commodities, particularly for energy resources, are also suitable for renewable commodities.

First, the existence of a single price that is representative of the product in a competitive market has to be verified. This is a phenomenon that occurs in the case of the vast majority of renewable commodities (foods and agricultural products), which are highly tradable and devoid of monopolists. One example of a commodity where a single price is not to be found is natural gas, for which there are different geographical markets with different prices, which arises from the virtual non-existence of trading among them on account of a lack of infrastructure (figure 3.3) and the high cost of transport.

It is more relevant to check whether the trend which commodity prices follow is characterised by a convex quadratic function, not just in the case of non-renewable products, but also for renewables. As Pindyck makes clear in his study, as well as in some before it\(^\text{10}\), this trend derives from factors associated with marginal extraction costs and mainly with existing (proven) reserves. On the other hand, in the case of renewable commodities, it seems that the supply of these is replenished every year and that, since they are overwhelmingly perishable products, it is not possible to stockpile them for long periods of time. This means that every year renewable commodity prices will primarily relate to supply factors, which in turn hinge on matters concerning nature (e.g. the weather, crop yield, etc.). But then the long-run trend ought to be more determined by demand and technological factors in the production process. Therefore, we would expect a priori that, given their different nature, non-renewable and renewable products would have separate specifications for their long-run trends — moreover with greater volatility in the case of renewables, given the influence of natural factors such as the weather.

In general, movements in the real prices of different commodities revert to deterministic long-term trends

We carry out the testing suggested by Pindyck and extend the sample to 43 commodities, which include four energy resources, and 10 metal and 29 agricultural commodities. As an information source we have used the World Bank’s commodity price database with annual frequency for 1960-2014.

The nominal prices are expressed in real terms after using the US consumer price index as a deflator. Finally, the log real price for each commodity is taken and the testing performed on this transformation. The use of the price index as a deflator applied to the nominal prices of the commodities is in itself relevant. First because the index has a trend which alters the commodity’s nominal price trend when it is used as a deflator. And second because the relative cheapening or pricing up of the commodities, and therefore the conclusions regarding whether or not being a commodity producer is profitable in the long-run, depends entirely on the benchmark chosen (figure 3.4).

Based on the transformations indicated, for each of the 43 commodities we estimate the quadratic trend parameters that best fit with the observed data. In practice, this means estimating the $b_1$ and $b_2$ coefficients for the equation below via straightforward regression (ordinary least squares), where $T$ and $T^2$ are the linear and quadratic trends respectively.

$$\text{Log real price of the commodity} = a + b_1 \times T + b_2 \times T^2$$

After estimating regressions for the trend of each of the 43 commodity prices, we find the following results:

1. Only 13 commodities reject the hypothesis of a quadratic trend, i.e. the coefficient used with the quadratic trend ($b_2$) is not statistically significant. Of these 13, three are inputs for drinks (e.g. cocoa, coffee, etc.).

2. The other 30 commodities, which fall into the renewable and non-renewable categories in almost equal measure, exhibit significant coefficients, which means that a convex quadratic trend is an acceptable hypothesis for the long-run evolution of their prices.

Having accepted the quadratic trend hypothesis, we go on, as does Pindyck, to test whether prices move around that trend, or, which amounts to the same thing, we test whether prices revert to the estimated trend. To do this, the test which Pindyck proposes in his article is a unit root test on prices after controlling for the quadratic (deterministic) trend estimated beforehand. If the unit root hypothesis is rejected, the test means that we can accept that prices revert to the trend. In this case, the estimated trend becomes even more interesting since we can be sure that, after breaking away from it, prices will revert to it over time, which means that shocks which take place have only a transitory effect.

The unit root tests that were run do not yield very favourable results, since, of the 43 commodities, only in six cases could the unit root hypothesis be rejected. Moreover, we cannot really refer to a pattern, since the six favourable cases are spread across disparate commodities (cereals, textiles, woods, metals, etc.). This finding comes as no surprise to us for two reasons. First, because the literature warns of the low power which unit root tests tend to exhibit, i.e. the difficulty of rejecting the unit root hypothesis even if it is false. Second, because Pindyck runs into the same problems even though he has a significantly longer sample, which would give his tests more power.

An alternative way to test for reversion to the trend, given the lack of conclusiveness of the unit root test, is proposed by Pindyck himself, in the form of a variance ratio test. The thinking behind this test is that if the prices show a unit root, i.e. shocks have a permanent effect on them, the variance for two periods should

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11: World Bank Commodity Price Data (The Pink Sheet). This database includes the prices of 65 commodities for 1960-2014. We have used only 43 commodities, as we reject those that do not have an available price for the entire sample.
grow when they break away, whereas if the prices revert to the trend, the variance for two periods ought not
to grow whatever the interval between them.

Again, the results of the variance ratio test for each of the prices are not conclusive and throw up
conflicting evidence, as for roughly half of the commodities we can reject the hypothesis that variance
grows, whereas this result is unobtainable for the other half.

In summary, after extending the tests proposed by Pindyck to a considerably larger number of commodities,
we can conclude that our findings are not very informative as they yield mixed evidence. This means that
we are not in a position to maintain that commodity prices move around a (quadratic) trend in much
the same way as happens with Pindyck in section 2 of his piece. For this reason, we think that in any
future article it would be a good idea to do as Pindyck has in section 4 and move on to slightly more
sophisticated models which leave aside the assumption of a deterministic trend and accept
stochastic trends.

Analysis of prices by categories does not allow definitive conclusions to be
reached either

One point worth considering is that, contrary to
what our intuition tells us, we have not observed a
different pattern between the results for renewable and non-renewable commodities. In this respect,
both groups of commodities have shown that a convex quadratic function is an acceptable trend for
movements in their prices, although in several cases it is hard (and the likelihood of this is almost the same
for both groups) to find evidence that prices are mean-reverting. We therefore think it wise to run an
additional test to try and address whether there is a different pattern in the trend for renewable and non-
renewable prices. To do this we construct a price index for each of these two commodity categories thus:

1. We arrange the 43 commodities in our database into an initial group of non-renewables comprising the 14
energy and metal resources, and into a second group of renewables consisting of the 29 agricultural
commodities.

2. We obtain the price index for each commodity category via two alternative procedures: i) calculating the
median for the combined series for any one group,
ii) obtaining the first principal component for
these.

Figures 3.5 and 3.6 show that the indices for the prices obtained using the two methods exhibit similar
dynamics for both sets of commodities12.

As we did previously for each individual real commodity price, we estimate the quadratic trend which best fits
the previously constructed series for renewable and non-renewable commodity prices and do this for each of
the methods mentioned (median and principal components). As can be seen again from figures 3.5 and
3.6, the trends for both groups of commodities have a clear convex quadratic shape. Furthermore,
and given that the estimated coefficients of the equation are highly significant, we can accept the
hypothesis that a quadratic trend suitably represents the long-run evolution of prices13. Finally, we
make the point that, as would be expected, there are no major differences in the trends that emerge from the
median and principal component methods, given the similarity of the series.

12: It can also be seen that the movements in the price indices for both commodity categories are similar to those that would come from the World Bank
data if the weights suggested by the multilateral institution are used to construct them.

13: It is however necessary to make the point that it was not possible to reject the hypothesis that prices are not mean-reverting. That said, this test cannot
be taken as conclusive as the statistics in almost all cases approached the rejection area and because of the low power that such tests tend to offer as we
have noted previously.
Based on the evidence presented thus far, we can draw the following conclusions:

1. The evolution of most commodity prices can be fitted to a convex quadratic function, although in many cases we cannot accept reversion to this trend.

2. Perhaps counter-intuitively, there would not appear to be relevant differences between the long-run dynamics of renewable and non-renewable prices\(^4\).

These conclusions are nonetheless only of a preliminary nature, as we think that further tests are called for and, if possible, a longer data sample to work with to achieve greater power in the testing conducted, even though this could mean paring down the number of commodities examined. As well as this, models with stochastic trends, which represent changes in the marginal production costs of commodities, are an interesting avenue to explore.

When observing the evolution of series of renewable and non-renewable commodity prices, it can be seen that movements have been similar for the past two decades, although in the first part of the sample they are clearly different. Such different behaviour is greatly influenced by developments in the oil market, particularly the two oil crises (1973 and 1979). Stripping out the evolution of such a singular commodity from the group of non-renewable commodities, the price movements for both categories become more alike.

This similarity would, however, run counter to the hypothesis that renewable and non-renewable commodity prices should follow different patterns according to their different natures. We think that the key to addressing this question lies in the existence of factors which have cross-cutting effects on all commodities regardless of their characteristics and the market where they are traded, an example of these being the economic cycle itself.

\(^{14}\) As we have seen, this conclusion was arrived at both by running tests for individual commodity prices and grouping them into categories.
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