The survival of US shale

Despite the fall in global commodity prices, the US keeps producing. This is due to the 'portfolio effect' and better technology, show Philippe A. Charlez of Total and Pierre Delfiner of PetroDecisions

WHILE US production of hydrocarbons was in steady decline from the early '70s and imports rose accordingly, over the last eight years the US has seen its import dependence fall by half (from 70% to 35%) and it has become nearly self-sufficient in gas (less than 5% import dependency). At the end of 2014, the US was the world's biggest liquids (oil+LPG) and dry gas producer with respectively 11.6mn b/d and 70.7bn ft³/day[1]. The production ramp-up is impressive: from nearly zero in 2006, shale oil accounted for 52% of the total US liquids output (6mn b/d) and shale gas for 48% (41.3bn ft³/d) of the total gas output as of end-2014[2]. Such a fast ramp-up is without precedent.

A large part of the production comes from six "champions": Barnett (Texas), Marcellus (Pensylvania/Ohio) and Haynesville (Texas/Louisiana) for gas; and Bakken (North Dakota), Eagle Ford (South Texas) and Permian (East Texas/New Mexico) for oil.

At the end of 2011 this unexpected and new supply of gas led to a collapse of US prices. In April 2012 the front-month Henry Hub price dropped below $2/mn Btu. At this level, gas production is unprofitable. Consequently, the drilling activity quickly shifted to shale oil. As a result, by the middle of 2014 three-quarters of the US rigs were working in oil fields. However, in October 2014, the same thing happened with oil. Following Opec's decision not to reduce its quota below 30mn b/d, oil prices dropped from $110/b in July 2014 to less than $60/b at the end of 2014.

As breakeven oil prices were between $60 and $70, drilling activity immediately collapsed. In April 2015 only 900 rigs were still operating (compared with 1,850 in October 2014)[3]. It is estimated that in 2015, the investments in shale development will be reduced by 40%[4]. The key question is to estimate what impact this sudden large decrease in drilling and fracturing activities will have on short and medium term US shale production. Will production increase, stabilize or decline; and over which period of time? Is shale production resilient (or not) to price collapses? And if so, why?[5]

[1] Energy Information Administration

[2] ITG

[3] Baker Hughes

[4] Rystad

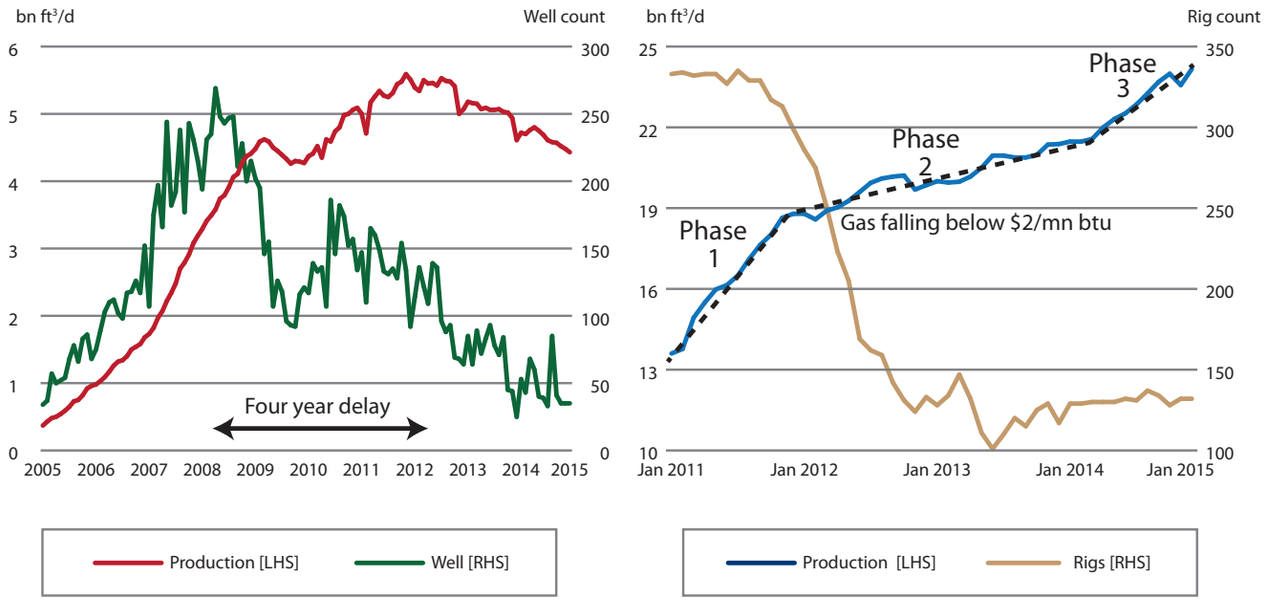
[5] P. Charlez & P. Baylocq (2015) The shale gas and oil revolution. Sustainability or speculative bubble? *Petrostrategies* Vol 28 January 2015

Resilience of the US shale gas production history

The production history of the three major US gas plays (Barnett/Haynesville/Marcellus) provides an answer to these questions. The left hand graph of Figure 1 shows the production history and the associated number of wells brought onstream each month in the Barnett play since the beginning of 2005. After the initial period of intense drilling which peaks at nearly 300 wells/month at the beginning of 2008, drilling activity dramatically fell, following first the subprime crisis in 2008 and then the gas price collapse in 2011. A comparison of the two curves highlights a four-year delay between well and production peaks. After 2012, in spite of the severe cut in drilling activity the production decline is gentle.

The right hand side of Figure 1 shows global daily production (left axis) and associated rig count of the three major US gas plays (Barnett+Haynesville+Marcellus) (right axis) since beginning 2011. There are three distinct periods. Year 2011 sees very strong drilling activity (nearly 350 operating rigs), with a significant growth

Figure 1: Left: Production and associated well count for the Barnett
Right: Production and associated rig count for Barnett+Haynesville+Marcellus



Source: ITG

in output and a large number of wells put on stream. Following the collapse of gas prices at the end of 2011 the number of operating rigs falls quickly below 150. However, production continues to grow steadily. At the start of 2014, despite a low number of operating rigs (about 130), production picks up again with a steep gradient.

The resilience of unconventional production: what are the levers?

To better understand the strong resilience of unconventional production despite the fall in drilling activities a specific model has been developed[6]. It calculates the required drilling and fracturing activity (in rig months/year bearing in mind that many rigs are operating simultaneously) to reach a production plateau and maintain it for as long as possible.

When drilling and fracturing activities stop, the model leaves production to decline over the remaining license period. Maintaining the plateau requires a "critical drilling activity" that supplies just enough new wells to balance exactly the production drop of existing wells. If drilling activity exceeds the critical level, production will continue to rise. If it falls below, production will decline.

In Figure 2, a 3,000 km^2 dry gas core area has been developed with 3,000 wells over a 30-year period. The aim is to reach quickly a production plateau of 1bn ft^3/day (about 1/5 of the Barnett play), maintain it for as long as possible, then leave production to decline. All the wells are assumed to produce according to the same decline curve (using a Barnett analog with 70% decline over the first three years, with an estimated ultimate recovery (EUR) of 3.36bn ft^3). As shown in Figure 2 the ramp-up phase requires a peak of 222 rig-months of drilling activities annually (red dotted line). However, to maintain the plateau during the next 15 years, the critical drilling activity quickly drops below 100 rig-months/year to reach a final asymptotic value of 50 rig-months/year.

When activity stops, production slowly declines, losing only 46% over 12 years. Compared with the 70% drop over the first three years for a single well, this highlights how misleading well-by-well analysis is. When a large number of wells comes on stream at varying maturities the past portfolio plays the role of a "shock absorber" that helps limit the global decline without having to drill and fracture at a sustained rate. Despite the apparently hefty reduction in drilling after 2011, US gas production has kept going up. Given the number of wells drilled in the past, current drilling activity, even if apparently low, is in fact still above the critical level. The portfolio effect is the first lever.

The second lever relies on the huge improvements in completion technology over the last five years[7]. This includes the length of the lateral, the number and size of the fracturing stages, use of slick or Xlink fluid, optimizing proppant concentration and ramp up. For instance, in the Haynesville (Louisiana/Texas), such improvements have doubled the EUR/well[8]. In Figure 2 for the first 1,000 wells an EUR of 3.36bn ft^3 is considered.

After 1,000 wells the completion strategy is improved. The next 1,000 wells produce 4.25bn ft^3, and the last 1,000 wells produce 5.04bn ft^3. For the same total number of wells (3,000), the production plateau (green curve) is extended by 10 years and pushed to 2031. Better completion technology also significantly boosts the declining activity (dotted green line) which is reduced from 50 rig months/year to 25 rig-months/year with just... three rigs.

So after the well portfolio, better completion technology is the next explanation for resilience, judging from the history of US shale gas production over the last two years.

The production of an unconventional play appears very resilient to the decrease of drilling. A large portfolio of wells behaves differently from individual wells. If the production ramp-up requires intense drilling activity with an important initial rig count, once a sufficient portfolio of wells has been drilled, it acts as a shock absorber limiting the global decline even with reduced drilling and fracturing activities. Maintaining output a plateau requires a critical level of activity which tends to an asymptote. If drilling activity is above the critical curve the production will continue to increase. The second lever of resilience relies on better completion technology which has improved dramatically over the past years and increased the reserves/well.

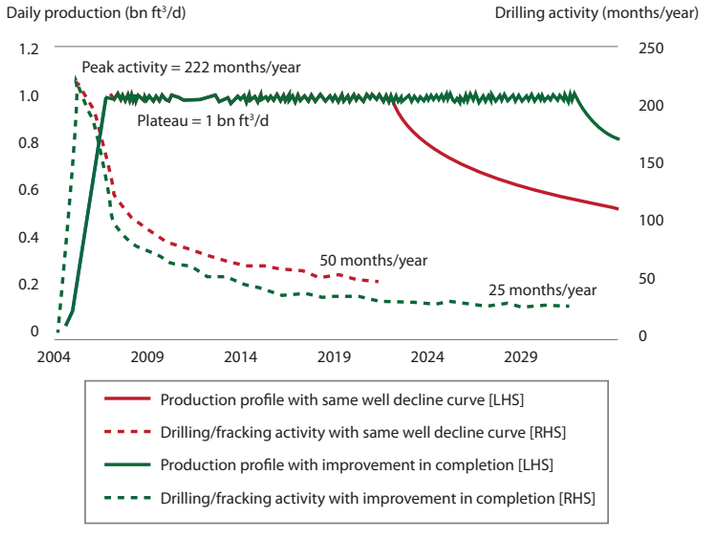
These two levers explain why the strong investment slowdown in gas development observed in 2012 and the reduction in oil development over the last six months were not accompanied by a collapse of the production. The current drilling activity is still clearly above the critical level. After a slowing down of the growth in 2015, a plateau and then a slow decline could start during the second half of 2016. ●

[6]Ph. Charlez & P. Delfiner (2015) A Model for Evaluating the Commerciality of an Unconventional Factory Development Outside North America. Submitted to the SPE Journal of Economics and Management

[7]M.P. Mills (2015) SHALE 2.0 Technology and the coming big data revolution in America Shale Oil fields CEPE Report

[8]Wood Mackenzie (January 2015): New Haynesville gas wells - an alternative to tight oil

Figure 2: Simulated production plateau



Source: Total