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## James Hamilton on Sanctions, Energy Prices and the Global Economy

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### Webinar Transcript

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Markus Brunnermeier: Welcome back everybody for another webinar organized by Princeton for everyone worldwide, we're very happy to have Jim Hamilton with us. Hi Jim. Jim is an expert, not only on time series econometrics, but also on oil and the oil markets and energy markets more generally, and we will talk today about sanctions, energy prices and the global economy. In the light of the invasion of Russia into Ukraine, we tried to learn what are the implications of the sanctions and other measures on the energy markets across the world. Now let me start with a few opening remarks, the invasion into Ukraine was essentially a watershed moment for our global order. We had a pre mutual order before the moment which was characterized by mutual interdependencies so this way both parties or many countries were dependent on each other and essentially we were hoping that insured peace, because it makes wars very expensive, so we were actually together in the same boat, we created a boat to be in the same boat. Such that you know wars become very expensive. You have seen this in trade connection, the global value chain just in time, so we are all very dependent on each other. The idea was that trade would also bring different countries and different people from different countries together and exchange ideas and in this way, we would all convert to an open society and all of this lowered inflation, because we brought a lot of extra labor force in the global economy. In terms of finance, international finance, we also had a lot of cross border investments, open capital accounts, emerging economies, held a lot of dollar reserves and that lowered the real interest rate for the US in particular and the advanced economies. Now it seems like now we're moving away from this global philosophy into a different philosophy which relies much more on resilience, autarky, self-reliance, so breaking these links and making us less mutually interdependent. And this might lead to more than slowbalization, so globalization will not only slow down, but might also go back, so it's a big question whether it will happen. It also leads very clearly to rearmament, so many countries now invest much of the budget for rearmament, so the peace dividend is over. And of course we are already in the green transition which requires a lot of investment, so we have a lot of investments going on. That will increase the real interest rate or the  $r^*$ . And also might have implications for extra demand on inflation as well, so we go away from this low inflation pressure to a much more high inflation pressure environment. But today we will talk much more about the oil markets, but it's this change in a global order that is actually in the background, which drives things. So there are four questions, essentially, the first question is should we impose oil or gas sanctions or not, and how costly are they? Or we might ask a different question, say it's more moral questions, not an economic question. We

have to do it anyway because, in order to defend freedom. The question is, how can we do it in a way which is most cost effective or minimizing the costs. And the question is, will there be sanctions? The third question, will the sanctions be effective in the long run, or might be even counterproductive if they hurt us more than the counterparty. And how long can we sustain that will the mood, which is currently very much in favor of sanctions wanted bites and hurts us, will the mood status way, or will it swing in the other direction, and what helps us to stick to them, the sanctions, and what will weaken us, and these are the questions we would like to address today. So how quickly can we become independent of natural gas and oil and that depends very much on the elasticity of substitutions. So if you have a view of the production chain, and the supply chain, like an o-ring a theory that you know each production chain does some certain input, which is very critical and you take this critical input out, and the whole supply chain is disrupted, like everything is Leontieffs or the elasticity of substitution is essentially zero then actually it will be very, very costly.

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If you have a theory that the elasticity of substitution is actually pretty high, but then it will be less costly, because we can substitute into them as like areas and there's, of course a tradeoff between the short run elasticity is much lower compared to the long run that's the famous Le Chatelier's Principle, Samuelson talked already in his textbooks. There's some recent work by Rudiger Bachmann, Ben Moll, and others, looking at the technological substitution effects. And, of course, the big difference between macro and micro, the finer you go and how it aggregates is a very complicated issue so just to highlight: you have a Company A using gas and they should scale back and the Company B using some renewable energy is should scale up and if you can substitute this fairly easily. And then you'd have a high elasticity of substitution if it's difficult and it's a very low elasticity of substitution and just to enrich the whole way of thinking with financial frictions, it might be company A, because it has to scale back and makes losses, it goes bankrupt it causes financial crisis and company B actually has to scale up, but B can't really scale up because it has to raise some funds from because of financial frictions it's very difficult to raise funds, so the substitution might be actually also not only hindered by technological aspects, but also by financial frictions. And the other aspect I would like to highlight is that these effects might be highly nonlinear so we know that financial frictions themselves have very highly nonlinear, so estimates for small changes might be very, very different from large changes. And the other thing is on top of it that the nonlinearities kick in big time in terms of financial crisis and going on, so that's essentially something we have to figure out in order to quantify how dramatic these effects will be on the Western economies. So, another issue, one of these is elasticity of substitution, which is an important question, then, the question is, how should we implement these sanctions? And there's an interesting proposal by Ricardo Hausmann who essentially proposed that we should— instead of imposing sanctions, we should actually impose a sanction in the form of a tax. The argument is that if you impose sanctions in the form of a tax, we get some tax revenue and with this tax revenue, you can do something, and it seems more credible and also can be more long lasting so that's more convincing that it will stay in the long run. And because the question is, then, who bears costs of these oil taxes or gas taxes so and that depends, is it either the demander, the West, or the supplier, Russia. And that depends very much on the demand elasticities and supply elasticities and the argument he put forward is that demand is very elastic. and supply is very inelastic so if rational operating costs about \$2.7 per barrel, and the total variable costs \$5.67 per barrel, he would argue that you know the supply is very inelastic and that's essentially why the cost would mostly approval rational self imposed attacks, it will really be at the expense of Russia, but other than at the expense of the demand on the West. The only loophole essentially is that essentially that you know it might be that China will be the big beneficiary, in a sense that Russia would then sell the oil to China and China can of course buy it at a bargain price and that people post

essentially attacks have about \$90 a barrel and that's one way to go around that. In a sense, an embargo is the same as a tax, if you said just the tax at infinity and I don't know what the optimal tax rate is, but of course it depends on the elasticity of supply and demand, supply and demand elasticities.

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That's for oil and then we have to think about gas, gas is very different, oil is a more global market, gas is more of a regional market, you cannot just reallocate so easily compared to oil and so we will go into these issues as well. Now another issue is, of course, how should we then in countries and domestically what policies should you design domestically to soften the shock from these high energy prices and you see many countries will just put the cap on some energies prices or some subsidies and the question is, how should you subsidize so you could subsidize the consumption of energy directly. But it's essentially a subsidy to Russia. It's exactly the opposite of imposing a tax, it's a subsidy and then, depending on the supply and demand, elasticity, it actually goes mostly to large extent to Russia, so the more clever ways essentially let the prices go up, but then give lump sum, people some compensation, so they can overcome that. So it should not be tied to the current consumption, but perhaps tied to past consumption and past consumption is fixed so you cannot adjust that as a number, so the subsidy you get is not dependent on the current consumption. This way you drive the incentive to cut back on current consumption and at the same time you compensate people for the loss of welfare. And you can also target less well off people, so this way you also get more compensation on this side. Finally, I would like to say, what are the implications for oil and gas. We have many webinars where we focused a lot on inflation for the last more than a year already now, when the oil and gas prices and energy plasma generally goes through the roof, and what will be the case for inflation anchors, inflation expectations. So we know already before the invasion, it was already inflated. The inflation numbers for the U.S. were 7.9% annualized; for Europe it was above 5%. And so there are high inflation numbers already and we also know that oil and gas are very salient products which impact the inflation expectations of households and the question is now we have this huge additional increase coming up because of oil and energy prices would this actually break the inflation anchor of 2%, that's one reaction. Another reaction which goes exactly the opposite, you could argue that actually it now provides the central bank an excuse to explain why inflation is so high, inflation is still anchored in the long-run. We have this inflation because of oil prices, and because of the war. And that's signaling jamming stories or you still stick with your inflation framework. It's still okay, I mean it didn't work so well but it's still okay, but it's just muddled up and jammed, the signaling is jammed because of these high oil prices, which was not part of the framework. So there are a lot of interesting questions, starting from how to design the sanctions, how to make sure the social hardship is avoided and how to design the internal policies, and the whole global market. And then also implications, even for monetary policy and how to think about to preserve the inflation expectations anchor. Let me stop with the poll question, as usual, the polls, Jim put forward and let me just say the three questions, the first question is will the Russian oil exports in June, be lower roughly the same or higher than they are today and essentially 66% said they will be lower, about 25% said same, and higher was 9%, so some people think it will be even higher. And will Germany experience recession this year, and the answer is about 55%, so the majority think Germany will experience a recession this year, 45% think they will not. And finally should Europe really stop all the imports of oil and natural gas from Russia and 62% said yes and 38% said no, so the majority, clear majority, said yes, at this stage, and then we have to see how things play out. So, with these opening remarks, I would like to give the floor to Jim, he will go much more in depth, and he has the expertise to tell us, and how it links back and what we can learn from the 1970s, our experiences there, so Jim we're looking forward to your presentation and thanks again for doing this and for preparing the special talk for us.

13:11

James Hamilton: Thank you Markus and everyone for joining us. Everyone sees my screen. Yeah so as Markus was saying, trade between countries can benefit everybody. Some people say, well, we have to in the West stop buying oil and gas from Russia to hurt Russia, takeaway Putin's ability to finance this war. At the same time that Putin is threatening well, I'm going to stop selling oil and gas to Europe to punish them. And both sides are right, it would be incredibly costly to Russia if they couldn't sell the oil and gas, and it would be a big cost to the rest of the world if we're not able to buy Russia's energy exports. I'm going to talk entirely today about the second issue, the economic costs to the rest of the world of trying to make do with less oil and gas from Russia. I want to make clear from the beginning, that my focus and talk about economic costs is not meant to deny in any way that the much bigger issue is the human costs. As we speak, the tragic events, frightening events in Ukraine, I think, on a human level outweigh everything I'm talking about and my personal view is in agreement with the majority of the poll takers there that we should do everything we can to try to take away the ability of Putin to finance this bloodshed, but I think we should do so with open eyes about what the consequences for us will be, and that's what I want to talk about today. Now the first point to acknowledge is that oil prices increased very dramatically before the invasion, before any talk of sanctions, and whether we have sanctions or not that's a fact of the world now. I want to briefly comment on what caused that and essentially it's the same explanation as why we saw increases in a number of other prices, namely demand for oil in this case recovered more quickly from the Covid lockdowns than did the ability to produce oil, and let me just give you some data to illustrate this. I should perhaps apologize in advance that a lot of the numbers I'll be using are from the United States and the reason is that I'm a little more familiar with the U.S. Data. I know a little better what those numbers mean but I'll be trying to make broader points in the process, but at least as far as the U.S. goes, we have counts for example of the number of cars out on the highways, that data is available monthly, and what it shows is that driving in the U.S. is back now higher than it was before Covid, that's very seasonal. If we are indeed back to where we had been, you would expect a big surge in driving this spring and summer. A second measure we have for the U.S. we have a monthly estimate of the total amount of gasoline being consumed in the U.S., that's again very seasonal. That's again more or less back where it had been so demand is up but production is not. This is a measure, one of the measures of crude oil production that I'll be using, which is the production of crude oil and and these condensate from the field this top panel is is worldwide production each month of crude oil, this is in units of thousands of barrels per day. And the blue line on this graph marks the level in January 2020, and you can see that we're far from recovery. The production levels that we'd had before Covid, the shortfall is something like over a little over 3 million barrels a day. And I can talk more about the various factors contributing to that, but actually the biggest single factor, it could be said to be U.S. production. U.S. production in the bottom panel there/ U.S. production accounted for maybe a sixth of that world total, the less than the top.

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But accounts for about a third of the shortfall, a million barrels a day below where we had been, and the explanation for why the U.S. production hasn't recovered is fairly straightforward. There was a – OK, I see a questionnaire but it's quite complicated, I will try to monitor– there was a big drop in the price of oil in 2014, the U.S. production is the marginal world production at this point, high cost, can produce volume if the rewards are there, is a big – we're looking here at a graph of the number of rigs, drilling rigs at work on U.S. fields at each point in time. There's a big drop off when the price went down, went back up when the price went up and then with the Covid recession we had a tremendous drop in oil prices. Actually measured praise actually became negative there in April of 2020, that's another interesting story, but maybe save that for another

day but that led to a real shakeout. You had maybe 100 of the smaller U.S. oil producers that went bankrupt. Those that are still in it are very much looking for a positive cash flow model and what that means is that drilling rigs are gradually increasing, few more every week, that's been going on, that's going to continue to go on. I expect that eventually to bring production back up. Certainly at current prices there's incentive for more but it takes some time to do that, takes some time to get those operations physically going, you can tear it down a lot quicker than you can build them up, and that's the basic story in oil, as it is in many other sectors. Logistical problems in getting production backup at the same time, the demand, at least by some measures, is back where it had been.

Markus Brunnermeier: Can I just interject one question which came from the audience but William? He wanted to know whether you would when the U.S. is auctioning off the drilling rights, you could make it dependent on the current circumstances, do you think the U.S. should modify its auction or how much it auctions off the drilling rights depending what circumstances are going on.

James Hamilton: This is a politically volatile issue in the U.S., and certainly the Republicans are wanting to say well it's all the policies that Biden imposed. I think, by far the biggest part of this story would have been the same regardless, it was a market response to the market incentives and it's a function of the physical problems really of getting the rigs back in place. Now, having said that, I do think there is some contribution, for example, I think it would be a little different situation today, if the keystone pipeline were operating because one of the obstacles facing, for example, the producers in North Dakota which is where some of the bankruptcies came is it that they're not getting the same price for the crude oil they sell, as somebody in Oklahoma and that's that's a function of the difficulty in transporting the oil. So there's actually a big price differential there, if there were a cheap and easy way to do that transportation, it would reduce that differential and you'd see more production from there. So I think there is a marginal contribution, but it's not the biggest part of the story, in my opinion. So let's see, I got a little head of myself, anyway so that's the situation with the U.S. Now, in terms of Russia, they produce 10 million barrels a day of that crude oil in the graph of just looking at about 13% of the world total and an even bigger percent of the world total of natural gas. Now there's a big difference and Markus alluded to this in the nature of the oil markets and the gas market. Oil is readily transported and essentially sells on a world market. Now there are qualifications to that, a given refinery has particular kinds of crude it can process, and there's some logistical constraints and moving the crude to different locations, but to a first approximation, it's a world market for oil and when there's a disruption in the supply anywhere in the world, it's going to affect the price that everybody everywhere in the world, pays for the product.

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James Hamilton: If, for example, there's a decrease in U.S. purchases of oil from Russia, but offsetting increase in the purchases from China it's a negligible effect on the world market overall, I'm going to be taking the perspective that we want to look at the total production and potentially up to a 13% production in oil. Let me just comment here on the issue that Markus raised about Hausmann suggestion of a tax and as Markus said, who pays the tax the buyer or the seller depends on the elasticity, but I emphasized this role of world market here for those discussions, and I think as suitable analogy is different states in the U.S. have different taxes on gasoline. And what you're talking about there in terms of the elasticity of supply is that it is relatively easy for me as a supplier to sell my gasoline in Florida or sell it in Alabama. And that state-specific supply function is quite elastic and the result is that when Florida imposes a higher tax on gasoline, as they do, that pretty much translates one for one into a higher price that

consumers in Florida pay for gasoline. And so, if you're saying, well, the U.S. would have a tax and Europe would have a tax, but China and India don't, I think it would be the U.S. primarily that pays that tax. Now, natural gas is a very different market and is much more localized. There is technology for transporting natural gas, liquefy and put it in tankers, we have that and will be ramping up that process certainly but it's currently nowhere near on the volume to arbitrage price differentials around the world and increasing the volume substantially raises a lot of logistical questions so it really is to a fair degree, Europe and Russia as far as natural gas goes, whereas it's the world and Russia, in my view, as far as oil is concerned. Now, how would we value, say, economically what we're sacrificing if we were to give up say 13% of our consumption of petroleum worldwide. Let's just take the U.S. as an example where, again I know the numbers. The dollar value of refined petroleum products consumed in the U.S. amounts to about 4% of U.S. GDP. And so you can do a quick calculation of what the dollar cost of what we're giving up if we had to make do with 13% less oil and that's 13% less refined products obviously well you calculate 13% of 4%, which is about a half percent of GDP. That's the current dollar value of what we would be giving up with our share if we tried to do entirely without oil from Russia. Now to put that in perspective, in an average U.S. recession, if you look at the decline in real GDP relative to trend, from peak to trough, you're talking about a number like 5% of GDP. So yeah this oil is valuable, but it's about 1/10 of what we're used to sacrificing in a typical recession, so you might look at this calculation and say well okay what's the big deal let's do that. Now it's not just a reporter's kind of calculation I just described, you can justify that calculation with economic theory which I presume you're all familiar with. Let me just remind you how it works. If we think of output  $y$  is coming from a production function depending on inputs of capital  $K$ , Labor  $N$ , and energy. In competitive markets, the marginal product of energy, the derivative of  $F$ , with respect to  $e$ , would equal the relative price of energy, price of energy divided by the price of output. And if we take both sides of that equation, multiply by the quantity of energy used, divide by the quantity of output produced, we have on the left side the elasticity of output, with respect to energy. The answer to his question was, we have to make do with such percent less energy, what happens output? And on the right hand side, we have the expenditure share, the dollar value of that energy in total output, but so that would be one way you could give a quick justification for that calculation, I did a moment ago.

27:41

James Hamilton: Moreover, people have correctly commented that expenditure share has been declining over time for the U.S. and throughout the world. Here's another measure. It's not quite the same thing I was just talking about but it's easier to get this data, this is measuring in terms of consumption, it's again for the U.S. The dollar value of expenditures that consumers pay on energy, goods and services— so this does not include, for example, the Jet fuel used by airlines does not include the diesel used for trucks and transportation, and it's as a percent of consumption spending, not GDP, but it's roughly the same kind of ballpark number, and we have it every month, you can look at it, it's declining over time. So by this simple calculation, whatever ought to be less now than it used to be. However, one thing people sometimes don't mention is that that's not a monotonic decline. And you'll see, for example, that there was some significant increase in the expenditure share of energy in the 1970s and in the bottom graph here, I have the real price of oil increased substantially in response to the Arab oil embargo of '73-'74, we will be talking about a little more in a moment, and in response to the Iranian revolution in 1978, and because the demand for oil is quite price any elastic in the short run, if this month you buy the same number of gallons of gasoline you did last month, and the price of gasoline goes up, doubles, you're going to spend twice as much of your budget on gasoline as before. So that expenditure share actually changes quite a bit and kind of raised the question okay, well do I use expenditure share before the price went up or after the price went up and just to take this argument to an extreme, this formula I was using a moment ago, says well if we

gave up all the oil, it would only cost us 4% of GDP: well that's right as far as the math goes, but we all understand that can't be the right answer. The reason it's not the right answer is because the cost of that first barrel may be very small, but as he tried to give up more and more it becomes much bigger. Now, a recent paper by Baqaee and Farhi developed calculations that get around this issue, taking into account okay. The shares change as you change conditions and a new paper by Barchmann and Baqaee and a bunch of other distinguished people basically use that approach to try to put numbers on it for the case of Germany and they conclude that a cutoff of energy imports from Russia would reduce German GDP by somewhere between half a percent and 3% where the range comes from exactly how substitutable you think it's going to be, how easy it's going to be to make the substitution, or an effect how large that expenditure share would be with market market prices. So of course 3% is much more significant, but it's still less than we're talking about in a typical recession so inclusion, you might try, it's okay, it could be a significant cost, but it's very doable.

Markus Brunnermeier: This does not include all the amplification effects which come on top of it, this is purely the production functional aspects.

James Hamilton: Yeah that's exactly the point I'm going to make. Just a moment. Thank you, thanks for setting it up. There's another way you could answer this question to try to answer it, which is to ask if there is a historical precedent, has something like this happened before? And the answer is yes, it has happened tonight, this has happened a number of times, and let me walk you through some of those examples.

31:57

James Hamilton: The first comes in 1973-1974. When the Arab members of OPEC announced an embargo on the United States and other countries, so they won't sell oil to the US. Now, as I said, it's a world market for oil. What really matters is the total decrease in production from those countries and the black line on this graph summarizes that. It summarizes the change in crude oil production from the countries that were participating in this embargo as a percent of total world production before the embargo and you'll see that this amounted to a reduction in the world supply of a bit over 7%. Now, in this episode and others there may be some possibilities to increase, make up some of that production elsewhere. In this particular episode, there was a pretty modest increase in production from Iran and some other sources, the overall drop in real production was a little less than 7% and it was a relatively short lived episode. So that's one example, we could look at historically. Another example came a few years later, in 1978 the Iranian revolution knocked out all the...

Markus Brunnermeier: Can I just ask a quick question: on the X axis is months or quarters.

James Hamilton: Months, yes I'm sorry. I'm sorry I should have said that yes, this is a number of months. From September of 1973, so we're talking about less than a year when most of the world's production is almost back to where it had been. Thank you, thank you for having me clarify that. And, we got a second example, a few years later, when the Iranian revolution knocked out about 7% of world production again, in this case, there was more significant increase from other places, maybe about a 4% drop in the world total, as another instance, historically, we can look at and there's several others. A few years after that Iran and Iraq went to war; Iraq a major producer that knocked out a 6% of production for a while and then, when Iraq invaded Kuwait in 1990. Iraq and Kuwait between the were quite significant producers again fairly significant increases from elsewhere, so we have sort of for examples in history of on the order of a 5% drop in oil production globally. And so to put that in perspective, if half of

Russian oil production were to cease, it would be an event comparable to any of these four examples in terms of the world market. If all of Russia oil production were to stop, and along with it significant amounts of the natural gas. We are talking about an energy shortfall that's far larger in history than I'm familiar with in terms of these episodes, so they were all associated with dramatic increases in the price of oil. And in fact following each of these four episodes the U.S. went into an economic recession and to a fair degree, these were global recessions as well. Now, if that quick back of the envelope calculation I made a moment ago is correct, you'd have to say, well, the recession couldn't have been caused by making use of less oil, it must have been something else. And, in particular the way we usually think about recessions separate from those production functions I was talking a moment ago is underutilized resources, in fact, the defining feature of a recession is that the unemployment rate spikes up. You have large number of people who say they're trying to find work and can't, we see a big drop in utilization of capital, so during a recession we're certainly changing N, labor and we're certainly changing utilization of K, along with the change in energy, and that's why it's the recession we're not just losing the value the energy.

36:21

Now, is there a reason to think that these oil shocks could have been contributing factors in the rise of unemployment. Well, I think there is. For example, one dramatic feature of those downturns in the U.S. was a big drop in automobile production. And so, for example, here I'm asking the What if question, what if everything in GDP stayed the same, but for production of autos, and we're talking about a half percent hit to real GDP, something on that order in each of these episodes, in other words the auto production is the same order magnitude or more, as the direct production function calculation, and if you thought that energy price changes were a factor in auto sales, then you would say well Okay, maybe there's potential for much, much more of an effect of these episodes, then you might have thought from the first simple calculations, we were doing. Now it's true that auto sales are always cyclical. Maybe it is going to happen anyway, a couple of facts relevant for that. The decline in auto sales coincides with gasoline price increases. For example, in a couple of these episodes, '73 gas prices were actually going up quite a bit before the OPEC embargo and you saw auto sales falling before that, before the recession. Same thing happened in '78 with the Iranian revolution. Furthermore, at the same time you're seeing the sales of the less fuel efficient vehicles go down, we see sales of more fuel efficient vehicles go up. It's a change in the composition of demand and so, in terms of the details, I think you make a very good case for at least some of what was happening to the auto industry should be attributed to what was happening in in our markets, and that's one avenue, by which these effects could be somewhat larger. Now how about spending, overall. Well we did...

Markus Brunnermeier: Can I ask a few questions: is there any way to disentangle the different channels, you have so there's one channel which is like in the last 2007-2008 crisis which was financing of autos became so much more difficult. And that's why the automobile or durable consumption went down a lot, and there are the various channels essentially or there is the switch— would you expect if I take, for example, some electric cars. The impact would not be there at all? Or would still be an impact there because the equilibrium effects would still hit the industry as well.

James Hamilton: Yeah so that's a great question. Here's a graph I had available in case people want more discussion. This is a graph of those two series I was talking about. Sales in the U.S., of cars manufactured in the United States, which tend to be less fuel efficient. And cars manufactured abroad that we're importing, the U.S. is in blue, the imports or in red. And you



see, for example in 1974 this feature I was talking about. Car sales, the large car sales, are falling when the gas prices go up. We don't see the same thing with the Iranian revolution, we don't see it in the imports. Now, in terms of 2007-2008 and this is a point I made elsewhere. There was a big spike in oil and gas prices from late 2007 to the middle of 2008 and you see there is a big decline again in the sales of U.S. manufactured cars, at the same time that imports are going up, and so that's one bit of evidence that to me suggests that the oil itself is certainly playing a role.

40:40

Now once we get into the bankruptcy of Lehman Brothers, there are other factors that play and I'm not saying oil was the only thing, but I think it made a material contribution. I've actually caught this particular graph from that episode because I think you can measure a separate contribution there. Now, I was going to go on to a broader point about spending overall, and I think we tend to think too much in terms of representative consumers and there's actually substantial differences across consumers. For example, there're large numbers of Americans who never buy any gasoline. And there's large numbers of others who are spending 10% of their budget every month on gasoline. The median is a number like 4%. And we know a lot of these households are paycheck to paycheck, they're spending, whatever they have this month. And you go to the same gas you went to last month, you fill up the tank just like you did last month, you're finding 4%, 10% less money to spend on other things that's a shock to spending and it also upsets Americans and everybody else and there's certainly a correlation in the data between what's happening to the price of oil, that's in the top panel here and what's going on with consumer sentiment. That's in the bottom when oil prices go up, and this graph doesn't go back '73-'74 but, for example, with the Iranian revolution when oil prices are going up, consumer sentiment is tanking and consumer sentiment in the U.S. has fallen pretty substantially with these recent increases in the price of oil. Now consumer sentiment: optimism overall is one of the canonical shocks in a Keynesian way of thinking about things, if you're persuaded that some of overall pessimism was coming, induced in part by these developments, then again you're talking about substantial multiplier effects. So my view is that the production function calculation is underestimating. What happens is underestimated because of basic macro effects, now the traditional interpretation of that has to do with nominal rigidities. People say well it's because prices don't respond quickly enough that these changes in overall demand translate into lower real economic activity. If that's the case, then, in principle, you ought to be able to use expansionary monetary fiscal policy to offset and that's in fact the view that the Bachmann paper I mentioned is taking. My view is that there's another factor, it's not just nominal rigidities. Their technological problems and reallocating resources and, for example in '73-'74 we saw this, you can't move those workers instantly from producing large cars to producing small cars. Instead, what happens is that the large car producers become unemployed and to the extent as part of what's going on the potential for monetary and fiscal stimulus is limited. Now, I also want to comment briefly on the effects on inflation. So okay there's something that is going to increase the relative price of energy, that doesn't necessarily mean overall inflation, it would be possible for other prices to decline and the overall price level remains constant. However, a lot of prices are relatively inflexible downwards. It's hard to see declines in some prices and to the extent that's the case, increasing the relative price of gasoline translates into an increase in the overall price level. And you can summarize that mechanical idea, you can ask well what mechanically would be the consequences if oil prices were to go up, but other prices were to stay constant. And the algebra that is very similar to the back of the envelope things I was doing having to do with expenditure shares. So, for example, crude oil represents about half the retail after tax cost of the refined product, if those costs are fixed when the price of oil goes up 10%, the price of the refined product goes up 5%, so we take that 4% share, multiply by half to get a quick and dirty answer to the question suppose crude oil prices go up by X percent, and no

other price changes, we multiply the crude oil price change by 0.2, and that's the rough answer to that question.

45:47

I might mention here taxes are much higher in Europe, for example. That difference between the retail price and the original cost is much larger and so you'd use a smaller multiplier here for those. I mentioned Jerome Powell, who recently gave a statement that he had a rule of thumb about inflation that was very similar to what I just described, you said when the price goes up \$10 a barrel, it is going to add about .2 percentage point to headline inflation, \$10 a barrel about 10% so there's number ways you can come up with this with a simple calculation, I have and I'm not sure how we hated it, but let's look at the consequences of that simple rule of thumb. So here's a graph: the black line is the year over year percent change in the CPI for the U.S., and the blue line is literally .02 times the year over year percent change in the dollar price of crude oil. We ask this question: suppose it had only been crude oil prices changing and nothing else, but when inflation, and you can see that those two events we talked about in the 70s, the OPEC oil embargo, the Iranian revolution were significant, it would have been about two percentage points in the U.S. inflation rate and what's happened over the last year in the U.S. would be about two percentage points of the inflation and the black is the total inflation, as they say. Now, this blue is a step up step down function: when oil prices go up okay that's causing inflation, when oil prices don't go up, you get zero from this calculation, the actual inflation is not a step up step down. It seems to be a ratcheting up process and that's, of course, related to a number of other factors such as how is this affecting expectations of inflation and how is the Federal Reserve responding. And a lot of people have argued well the way the Fed responded to the situation caused inflation that was in part, caused by what's happening energy markets to become entrenched. And here are a couple of measures that people sometimes point to as far as that is concerned. The top graph here is the real interest rate, it's just the difference between the nominal interest rate and the inflation rate over the previous year over year inflation rate measured by the CPI. And that's, for example, a summary of whether we're following the Taylor principle, the Taylor principle says when inflation goes up 1%, you want to raise the nominal interest rate by more than one percentage point, so the real interest rate as measured here should go up. And what in fact happened was in the 1970s, that number went very negative, and this is often pointed to as one of the features of monetary policy that ratified those oil price increases and meant high overall inflation. Mechanically the oil price increases were a big part of the inflation, the monetary response affected that. Now, if you look at that Taylor principle, right now, as you think you will know, you get a very negative real rate and we would be— possible to be in a similar situation right now. Here's another variable people used to talk about a lot, not so much recently, the growth of M2. Ultimately, whatever the Fed is doing it summarized by a path for the money supply and there were surges in that, surges in money growth in response to those two oil episodes talked about which maybe were another factor in the surging inflation and we've come to downplay M2 in recent years, but this graph you have to pay attention to, I think that there has been a tremendous growth in the money supply in the most recent episodes so we're certainly.

Markus Brunnermeier: Can I ask you some questions, two type of questions: the first one is, if you look at other countries like, for example, in the 1970's Germany's Bundesbank was following a different policy and hence have you ever eaten the real interest rate for Germany at that time?

50:15

James Hamilton: I don't know that number, but again, this blue line here was global, you're going to have inflation in Germany, everywhere in the world from this simple idea if you have a downward price elsewhere and that's unavoidable, no one can do anything about that.

Markus Brunnermeier: No, I understand that. It didn't go up to the same numbers as it went in the U.S.

James Hamilton: No, I haven't. I haven't looked at their calculation to the Taylor rule for Germany. I don't know that.

Markus Brunnermeier: The other thing is just as a judgment, the fact that we have the experience of the 1970s, do you think it will help us to overcome the current crisis and hence, we will not repeat similar policy mistakes. What's your judgment?

James Hamilton: You know another aspect of this policy mistake was the Fed in the 1970s were saying well we're way below potential here and that goes back to this issue, I was talking about, to an extent is this something real going on, that you can't do too much about. You know there's work, for example on this, that the real time estimates were suggesting maybe they're not overdoing it, I think we're seeing some replay that as well. Now I think will catch on sooner this go around but I think there's certainly a potential for the inflation to translate into broader inflation so the big theme of both these examples I talked about is the oil itself is making a contribution to output, making a contribution to inflation, you can measure that, and big enough change okay it'll show up in whatever data you look at, but it's really these other potential mechanisms, Keynesian or other type of rigidities as far as output goes. What's happening with expectations and monetary policy in terms of inflation that can magnify those developments and make the effects bigger than you might have thought from the simple kind of calculations we were doing. Now I have some other slides here, but I did want to leave time for questions. I don't know Markus, do you want me to?

Markus Brunnermeier: We can go on and just another question, you made a very good case that the oil market is a global market and gas market is less of a global market, the fact that the U.S. is now in on energy export that does it change drastically compared to the '70s and what implications should this have to monitor policy or, more generally, for any policy measures.

James Hamilton: Yeah so actually this graph is a little bit relevant for that as well, but so one of the things you might have asked about that the story, I was telling in terms of spending patterns, is it say well okay, consumers are spending less on other goods but they're spending more and gasoline, if it's domestically produced, why are the recipients of those funds out offsetting it. And an answer from a case in point view as well as the oil producers have a much smaller marginal propensity to consume than the guys, who have the big energy expenses, but I can also this is allocated issue that you don't, you can't move those auto workers who are unemployed to the Texas oil fields. Now the point I was going to make is a different estimate of impulse response functions estimated for the response of real output in the top row and inflation in the bottom row for several different countries, China and India the first two, Brazil the third. You see similar kinds of effects in a lot of countries. What I wanted to just mention in connection with Markus point is Brazil, the third, because Brazil is a net exporter and you might have thought well okay aren't they going to see a boost in GDP and they do initially when oil prices go up but actually there's a bigger subsequent decline, I think that's because Brazil is actually a diversified economy, not just an oil producer and they're suffering from the same decline and global demand for produce goods that everybody else's so, so I think the issue of import or export or

is not the core issue, I think one of the ways that it does matter is, as I was saying, the U.S. has become essentially the marginal world producer today and so that's where the added production insofar as it can offset some of what we lose from Russia that as far as oil is concerned, is going to come from and natural gas, to the extent that we're talking about liquefied natural gas and exporting. We do have the potential now, we can ramp that up for a limited contribution to Europe to do it on the scale it's going to be necessary, though it's going to take some time.

55:11

James Hamilton: Possible implications for world food prices, Markus asked me to mention, one of the things we saw response earlier is well okay if get a crude oil is so expensive let's make the the fuel for our cars from corn, ethanol, and there's a study you may have seen a Roberts and Schenkler that said that by using corn to make our fuel instead of feeding people, that increased the cost of meeting your minimum daily calorie requirement if you're one of the people in the world trying to get enough food to eat for today so there are effects here so let me, let me stop there.

Markus Brunnermeier: So let me... perhaps we can raise a lot of questions in the chat box, I would like to address some of them. One thing you touched upon already, I think it's very interesting to see that even if you're an energy exporter all exporters like Brazil. You benefit temporarily, but then it goes back, but how would you see the whole emerging economies, more generally, particularly looking at India, and all this and how will this potentially bring the whole global economy down if especially a lot of emerging economies face much higher energy prices and large fraction of the poor population depend on it, do you have any sense, how this might amplify the current challenges we face anyway?

James Hamilton: So China and India are both big oil importers and so it's a— in terms of trade effect, on top of everything else, that the nation as a whole is poor and you don't see the same magnitude of response, I think I think a big component of the effect, as in the case of Brazil is the collateral damage, the collateral effects of the decrease in production elsewhere, now we really don't have observations on China from the 1970's that I think are at all relevant. China did fair a bit better in the price run up of 2007-2008. I think they might be more immune relative to other countries from these kinds of events and frankly, as I mentioned that the U.S./Europe with less oil I'm thinking is quite possible, China will buy more. India recently made a purchase of oil from Russia, they got a substantial discount on it, because of problems Russia's having selling their oil elsewhere and that's terms of trade that's a benefit to India.

58:05

Markus Brunnermeier: So you would say we could stabilize the emerging economies by imposing hard sanctions on Russia in a sense.

James Hamilton: They would benefit to some degree, except, as I said, insofar as the U.S. market and European market goes down that's going to affect everybody in the world.

Markus Brunnermeier: So another question which came is by Eric Johnson, he would like to know that we all face supply chain problems anyway, so how will we think this is cumulating to the existing problems on top of it.

James Hamilton: Let me come in on that. So the auto industry is a good example where we've seen the chip shortage, shortage of the computer chips made to make cars, and this has really held production of autos back and, by the way, that's another example of this theme I've been

emphasizing that if you thought it was just the dollar value of the chips, what's the big deal, but try to build a modern car without one you can't, and so this is a plot here of the ratio of inventories on dealer lots of cars to the sales. A big drop in inventory sales ratio, a lot of those sales were coming out of inventory. And so I would have expected some restocking of those inventories attributed to some extra growth this year, I think, with what's happening with gasoline prices, it won't be as large, but this is one reason that I think we're not going to have quite the same replay with the auto industry, this time around exactly as the question was posed.

Markus Brunnermeier: I see, so Viral Acharya would like to go a little bit more in the financial arena so he argues that you know a lot of U.S. banks are exposed to oil and gas industry quite heavily and there might be some fallout from the financial fallouts and that might need some amplification effects this way. Can you comment on that? Do you have any ideas, to what extent the oil industry might suffer from that and then it might hit the financial industry, or is it the case that the oil industry is actually benefiting from the high oil prices?

James Hamilton: The oil industry is going to benefit, there's no question about it. The U.S. oil producers are back to making a profit and so that's not an issue, but I think there is a parallel issue that, in addition to the energy sanctions, various financial sanctions imposed on Russia have been, in my opinion, a big deal. When you lock down a lot of the basic transactions that people in Russia use or the ability of Russian exporters or importers to interact with the rest of the world, that's a huge shock, if anything, we've learned from history, when you have financial turmoil, freezing of payments technology, it's a big shock to the economy, Russia is going to default. And it may be a little bit like Lehman Brothers, we didn't really know at the time who's holding the bag, who, who all has an implicit lending stake in this operation and I don't see indications of that so far in terms of credit spreads but it's a potential question. Who all is going to be facing— and you mentioned this also Markus in your introduction— who's going to be facing potential financial problems from this and will those have spillover effects? And again that's something that, as far as emerging economies goes, we see when there are financial problems in the major developed economies, you often have big problems borrowing from the emerging economies, for example when Russian debt defaults that's going to raise new questions on the debt of a number of other countries, so I am concerned about the financial ramifications, but I also emphasized that may be the most effective thing that the West has done in terms of actions.

1:02:27

Markus Brunnermeier: Let me come to perhaps a very controversial point. I could say very cynically, I'm very convinced that we have to go through the green transition as quickly as possible for climate change reasons. And this is actually just speeding up the whole transition phase, so we don't slow it down anymore. And hence it might be very hard for the short term, but in the long term it's beneficial to us so that's one perspective. Or do you see more the other way around that actually be stepping backwards so rather than going very quickly to the Green transition. We open up new oil rigs, in order to overcome that and actually be going backwards and rather than going more green routes? Or do you see different continents going in different directions, Europe moving more to complete the transition and the U.S. might opening up our oil rigs, how do you see this playing out and do you think it's problematic if you go back to temporarily go back, how would you as a global planner design this optimally.

James Hamilton: That's a great point so people are talking about the social cost of carbon sometimes like attacks of 50 cents, \$1 a gallon or something. Well that's what you want if you've

got that times two or three here. And you're exactly right there's going to be a big reduction in use of carbon and an acceleration of the move to alternatives like electric vehicles that's a consequence here. I think there's also a political issue and I would, if you have somebody like Bill Clinton was President, but he was very savvy politically, he would recognize okay, I need to pivot on this. Biden is very vulnerable in the U.S. to the Republican challenge, here you're wanting to buy oil from Russia, you want to buy oil from Iran, you're not letting the domestic producers give us the oil in regardless of the magnitude of of of what their contribution would be, and I think it's relatively modest but it's it's a very powerful political argument. And long run, green objective if you lose that battle, you've lost in the longer run. So what I think Biden should do would be to get in front of this issue and say okay, we are going to do everything we can to frack that gas, and ship it to Europe to help out, we're going to do everything we can to produce oil and in the meantime we're going to do this, and this and this, just as you said, this whole event has to accelerate that long run transition but I don't think you want to do it in a way that costs resources. That's my view.

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Markus Brunnermeier: But just give me an idea. Let's suppose we go for this strategy that for the next two or three years, we have to expand the supply in the U.S. or in different parts of the world, but in the long run, you have to cut back. Can we expand it? Is it worthwhile to pay the fixed costs to expand it for two or three years? Which investor will do this, knowing that you know in two years, they will step back on us and regulate the heck out of us. How can— I don't know what the fixed costs are relative to the variable costs, can you give us an idea? Nobody will expand now, knowing that later, they will be in trouble one they have to write down as stranded assets, these assets.

James Hamilton: Yeah as far as this, the U.S. shale production, that is a short run thing, those fields deplete very quickly, given well in a couple of years you're going to be down to a fraction of what you started with, and so it very much is a short run calculation, and in addition, I'm not sure how long we could keep that up logistically. There are debates about that, but it's a different, very different kind of thing from say deep ocean drilling which you're talking about decades of lead time and and I don't think that's about to pick up for market reasons, though companies say well okay what's going to happen in 10 years so I don't think that long run just the cost issue should really be the deciding factor here in whether we try to provide for example the natural gas production. And I'll remind you that U.S. emissions of carbon have declined substantially as a result of such a natural gas for coal and to lesser extent oil. I think it's a winning political strategy, and I think it's what the social planner would do.

1:07:35

Markus Brunnermeier: And just a final question: the capacity to expand fracking in the United States let's say for— so it's a kind of thing that's actually any way depleting very quickly, each one individually, then it can help us to make this transition easier. But how much capacity does the U.S. or the world have in this fracking technology, is it you can just substitute the 13% we are missing from Russia, and of course we have to hold gas and everything has to be moved to Europe so it's a transportation issue as well, but how much capacity is there.

James Hamilton: Nowhere near, yeah no way you can get 10 billion barrels a day from U.S. fracking. I kind of mentioned the problems we're having just getting back to where we were in the U.S., let alone add 10 million. It's not going to happen.

Markus Brunnermeier: So, how would you speed it up and enlarge it?

James Hamilton: How would I speed up fracking? Well, as I said, the market forces are really the driver here. So it's in the process of happening, even before any of this and I was, I was making just a political point, maybe I shouldn't have gone quite that far, but that it's something I would think politically, everybody would want to jump on. Okay we're all making sacrifices we're doing all we can to try to make up for it, I think that has to be the core message.

Markus Brunnermeier: Okay, so I think, ultimately, hopefully, there are some positive elements to it, but we can see there's a lot of decisions to be made and we're very grateful to Jim Hamilton for illuminating us, what are the issues and, of course, there's very specific energy technology which really should guide us and our policy, and we should not forget all the amplification effects which might hit us. Not only the production technology itself, but all the amplification be it on financial or near other sides, I think, taking into account, but ultimately the sanctions are not, probably turns out to be more and more question rather than an economic question, but we should use our economics to do it smartly and minimize our costs. Thanks again Jim and hope to see you soon in the real world, and thanks for doing it, thank you.