Exhibit 24

UNITED STATES DISTRICT COURT

SOUTHERN DISTRICT OF NEW YORK

SECURITIES AND EXCHANGE COMMISSION, Plaintiff,	)	
v.	)	Case No. 20-Civ-10832(AT)(SN)
RIPPLE LABS, INC., BRADLEY GARLINGHOUSE, and CHRISTIAN LARSEN, Defendants.	)	

CONFIDENTIAL - SUBJECT TO PROTECTIVE ORDER

VIDEOTAPED DEPOSITION OF

FRANK ALLEN FERRELL, III, Ph.D.

Wednesday, February 23, 2022

Reported by:
BRIDGET LOMBARDOZZI
CSR, RMR, CRR, CLR
Job No. 2202232BLO

UNITED STATES DISTRICT COURT

SOUTHERN DISTRICT OF NEW YORK

SECURITIES AND EXCHANGE COMMISSION, Plaintiff,	)	
v.	)	Case No. 20-Civ-10832(AT)(SN)
RIPPLE LABS, INC., BRADLEY GARLINGHOUSE, and CHRISTIAN LARSEN, Defendants.	)	

Videotaped deposition of FRANK ALLEN FERRELL, III, taken on behalf of Plaintiff, held at the offices of Debevoise & Plimpton, 919 Third Avenue, New York, New York, commencing at 9:27 a.m. and ending at 6:49 p.m., on Wednesday, February 23, 2021, before Bridget Lombardozzi, CCR, RMR, CRR, CLR, and Notary Public of the States of New York and New Jersey, pursuant to notice.

A P P E A R A N C E S (Via Remote where indicated):

For the Plaintiff:

UNITED STATES SECURITIES AND EXCHANGE COMMISSION
NEW YORK REGIONAL OFFICE
BY: MARK SYLVESTER, ESQUIRE
ARTUR MINKIN, ESQUIRE
JON DANIELS, ESQUIRE
200 Vesey Street
Suite 400
New York, New York 10281-1022
Telephone: 212.336.1060
Email: sylvesterm@sec.gov
minkina@sec.gov
jdaniels@sec.gov

A P P E A R A N C E S (Continued):

For Defendant Ripple Labs Inc.:

DEBEVOISE & PLIMPTON LLP
BY: SCOTT CARAVELLO, ESQUIRE (Remote)
919 Third Avenue
New York, New York 10022
Telephone: 212.909.6000
E-Mail: Scaravello@debevoise.com
-and-
KELLOGG, HANSEN, TODD, FIGEL & FREDERICK PLLC
BY: MICHAEL KELLOGG, ESQUIRE
REID FIGEL, ESQUIRE
JUSTIN BERG, ESQUIRE
ELIANA PFEFFER, ESQUIRE (Remote)
COLLIN WHITE, ESQUIRE (Remote)
Sumner Square
1615 M Street, N.W.
Suite 400
Washington, D.C. 20036
Telephone: 202.326.7999
E-mail: Mkellogg@kellogghansen.com
rfigel@kellogghansen.com
jberg@kellogghansen.com
epfeffer@kellogghansen.com
cwhite@kellogghansen.com

A P P E A R A N C E S (Continued):

For Defendant Bradley Garlinghouse:

CLEARY GOTTLIEB STEEN & HAMILTON
BY: NICOLE TATZ, ESQUIRE (Remote)
2112 Pennsylvania Avenue, NW
Washington, D.C. 20037
Telephone: 202.974.1500
E-mail: Ntatz@cgsh.com

For Defendant Christian A. Larsen:

PAUL, WEISS, RIFKIND, WHARTON & GARRISON LLP
By: SARAH PROSTKO, ESQUIRE (Remote)
MICHAEL GERTZMAN, ESQUIRE (Remote)
1285 Avenue of the Americas
New York, New York 10019-6064
Telephone: 212.373.2491
E-mail: sprostko@paulweiss.com
mgertzman@paulweiss.com

ALSO PRESENT:

DEBORAH McCRIMMON, Ripple (Remote)

STELLA UVAYDOVA, SEC (Remote)

THOMAS DEVINE, Videographer
Shereck Video Service

INDEX

EXHIBITS

EXHIBITS

SEC - AF

DEPOSITION SUPPORT INDEX

DIRECTION TO WITNESS NOT TO ANSWER

Page	Line
58	9
60	9

STIPULATIONS

Page	Line
11	15

PORTION MARKED HIGHLY CONFIDENTIAL

Page	Line
- -none- -	

REQUEST FOR DOCUMENTS

Page	Line
- -none- -	

- - -

9:27 a.m.

February 23, 2022

- - -

THE VIDEOGRAPHER: Good morning. We're going on the record at 9:27 a.m. on February 23rd, 2022. This is the videotaped deposition of Allen Ferrell in the matter of Securities and Ex -- Securities and Exchange Commission v. Ripple Labs, Inc., Bradley Garlinghouse and Christian Larsen, Case Number 20-cv-10832 (AT)(SN).

This deposition is being held at the offices of Debevoise & Plimpton, 919 Third Avenue, New York, New York.

My name is Thomas Devine, certified legal video specialist with Gradillas Court Reporters located at 400 N. Brand Boulevard, Suite 950, Glendale, California.

Appearances will be noted on the stenographic record.

Will the court reporter please swear in the witness and we may proceed.

F R A N K A L L E N F E R R E L L, III, Ph.D., having been duly sworn, was examined and testified as follows:

THE REPORTER: Thank you.

You may proceed.

MR. SYLVESTER: Good morning --

MR. KELLOGG: Before we begin, Mark --

MR. SYLVESTER: Sorry.

MR. KELLOGG: -- I'd like to put one thing on the record. Per prior practice, any objection by one defendant is considered an objection by all defendants.

MR. SYLVESTER: Sounds good.

DIRECT-EXAMINATION

BY MR. SYLVESTER:

Q. Good morning, Professor.

A. Good morning.

Q. Could you please state your name for the

record?

A. My full name is Frank Allen Ferrell, III.

Q. I'm Mark Sylvester. I'm an attorney with the SEC. I'm here with my colleagues from the SEC, Artur Minkin and Jon Daniels. A few of my colleagues are joining by Zoom as well.

You've had your deposition taken before, correct?

A. Yes.

Q. Okay. Is there anything that would prevent you from testifying fully and truthfully here today?

A. No.

Q. Were you retained to provide expert services in this case?

A. Yes.

Q. Who retained you?

A. I -- I was -- I worked with Kellogg Huber -- Kellogg and Debevoise. I believe the engagement letter's with them. I did the engagement letter through Compass Lexecon, so I would -- I would have to -- I would refer back to that engagement letter.

Q. Are you also retained by the individual

defendants in this case?

A. Again, I don't remember the engagement letters with the law firms or with the underlying clients. I would have to look at the engagement letter. My understanding is I'm on the engagement letter with Compass Lexecon pursuant to which I performed my work.

Q. Do you know whether Paul Weiss or Cleary are parties to that letter as well?

A. I don't remember.

Q. Okay. Are you familiar with the term "XRP"?

A. Yes.

Q. Are you familiar with the term "digital asset"?

A. Yes.

Q. Are you familiar with the term "investment contract"?

A. Yes.

Q. Does "investment contract" have a generally accepted meaning in the field of economics?

MR. KELLOGG: Objection. Calls for a legal conclusion.

MR. SYLVESTER: Actually,

Counselor, I'm asking him to narrow his answer to the field of economics.

BY MR. SYLVESTER:

Q. So my question is, does "investment contract" have a generally accepted meaning in the field of economics?

A. My understanding of the phrase "investment contract" is it's a legal term.

Q. Okay.

A. It has a legal component to it.

Q. Again, focusing on the field of economics, is there any authoritative economics text that defines investment contract to your knowledge?

A. Same answer as before. That is the invest -- the phrase "investment contract" has a legal component to it. And just to be clear, I'm not providing an opinion on whether anything's an investment contract or not.

Q. Whether or not the term has a legal component to it, are you aware of any authoritative economics text that defines investment contract?

A. None occurs to me sitting here. That is, the phrase "investment contract" -- and,

again, as used in this litigation and the complaint -- has a legal component to it.

Q. Okay. Does it also have an economics component?

A. Well, I don't want -- there is -- obviously "investment contract" is a reference to contracts, but it has a legal component to it and so I'm not opining on whether anything is an investment contract or not.

Q. Okay.

MR. KELLOGG: I'm sorry to interrupt, but the people on Zoom said they can't see the witness.

MR. SYLVESTER: Let's go off the record if this takes more than a second.

MR. KELLOGG: A little more.

THE VIDEOGRAPHER: What should I do? Go off the record?

MR. SYLVESTER: No, if you just need to tilt the camera, that's fine. I just didn't know if it was going to be a longer correction.

MR. KELLOGG: That's good. Thank you.

BY MR. SYLVESTER:

Q. In preparation of your expert opinions in this case, did you review any economics literature that discussed the economic characteristics of an investment contract?

A. No.

Q. Are you aware of any economics literature that sets forth how to assess whether the economic substance of an asset or a transaction constitutes an investment contract?

A. No. That's -- that would constitute in part a legal opinion.

Q. Okay. When you say "that would constitute in part a legal opinion," can you explain what you mean?

A. As I said before, the phrase "investment contract" is obviously a phrase that's used in -- in the case law and in legal texts. And so my understanding of the phrase "investment contract" is that it has a legal -- it's a legal construct or a legal meaning to it. And I'm not opining on that question given it would involve a legal opinion.

Q. Okay. So fair to say that the economics literature doesn't address the question of -- of

how to figure out what the economic substance of an investment contract is?

MR. KELLOGG: Objection.

A. Phrased in that way, I agree with that statement. That is, "investment contract," as I understand that phrase, is a phrase that's used in case law and in legal argumentation. So that would involve a legal opinion and I'm not providing that.

Q. Does the term "commonality" have a generally accepted meaning in the field of economics?

A. I'm sure the phrase "commonality" is used in economics, but I -- I -- I'm not aware of -- offhand, I don't have a citation for the usage of the word "commonality."

Q. When you used the word "commonality" in your expert report, are you referring to an economics term or to one of the elements of the Howey test?

A. You would have to -- you would have to refer me to my expert report to answer that question fully. But if we're talking about commonality as part of providing an opinion on investment contract status, I'm not providing that

opinion.

Q. Let's -- let me hand you what's been marked AF-1. Let me try to hand that to you.

(Whereupon, exhibit is received and marked SEC Ferrell Exhibit AF-1 for identification.)

BY MR. SYLVESTER:

Q. There you go.

A. Thank you.

MR. SYLVESTER: Michael, I'll just ask you to pass these out if that's all right.

MR. KELLOGG: Thank you.

THE WITNESS: Oh, she -- the -- the court reporter wants a copy, too.

THE REPORTER: Thank you.

BY MR. SYLVESTER:

Q. If I could just direct you, Professor, to the -- well, let me start with authentication. Do you recognize AF-1?

A. I do.

Q. Okay. And is this the expert report that you prepared in this case, or one of them?

A. Yes.

Q. Okay. Let me turn you to romanette III of the table of contents of AF-1.

A. Romanette III?

Q. Yes. Near the bottom -- bottom of the page, there's a Section F, "Economic Assertions for Commonality are Fundamentally Flawed."

Do you see that?

A. I don't see where you're looking at. Can you -- what -- can you repeat where you're -- what part you're looking at?

Q. Sure.

Are you on Romanette III?

A. Yes.

Q. Okay. Do you see the bolded "XRP is a Virtual Currency" at the very bottom of the page?

A. Yes, I do.

Q. Immediately above that there's a subsection title, Section F, "Economic Assertions for Commonality are Fundamentally Flawed."

A. Yes.

Q. Okay. So my question is, when you used "commonality" in that title, were you referencing an economic concept or were you referencing an element of the Howey test?

MR. KELLOGG: Objection.

A. I'm referencing my discussion on pages 67, 68, 69 and 70. So that's what I'm referencing there. And just give me one second here.

Yeah. And in that discussion that's being referenced in that bullet or in that table of contents, I, in part, reference back to my analysis in Section II where I get into the economic substance of the -- of the contracts.

So I would just reference the actual content of that discussion on pages 67 through page 70.

Q. What is the definition of commonality as used in the -- as used in Subsection F of your opening report?

MR. KELLOGG: Objection.

A. It's really the discussion I have in that section of the report in terms of what I'm talking about. So, for example, in paragraph 141, I mention there's no pooling of the funds. Paragraph 142, I talk about the contracts. I also talk about my factor model.

So it's really a reference to these economic points that I'm making in that section.

Q. Returning to my question about the economics literature, as used in your Subsection

F, is "commonality" a generally accepted term in economics literature?

MR. KELLOGG: Objection.

A. So what I'm referencing here in the beginning of paragraph 140 is -- and I cite to the complaint -- is the economic theory by the SEC as articulated in the complaint. So the first sentence in this Section F is I am citing to the complaint and then I'm discussing thereafter, as I explained at the end of paragraph 140, the economic analysis.

So, again, Subsection F is the economic theory articulated in the complaint and then the economic analysis that I reference and discuss in paragraphs 141 through paragraph 145.

Q. Okay. I think you've answered, as far as I understand it, how you're using commonality for purposes of AF-1, is that right?

MR. KELLOGG: Objection.

A. I -- I -- I just discuss what I'm actually doing in paragraph F -- I'm sorry, in Section F. So Section F is called "Economic Assertions for Commonality are Fundamentally Flawed." And it is correct that in paragraph 140, I cite to the complaint for the articulation of

the economic theory by the SEC in the complaint. So I am working off of that.

As you see at the end of paragraph 140, I then say "As I explain below, the SEC's claims" -- that is the claims about the economic theory -- "are flawed as a matter of economic substance."

So that -- that's what this section is doing. That's what I'm referring to when I say "Economic Assertions for Commonality are Fundamentally Flawed."

Q. And did you cite any economics literature in your report for the definition of commonality?

MR. KELLOGG: Objection.

A. I -- all the citations I use are in the report. We can talk about the citations. But for purposes of this section, I am focused in the beginning, in paragraph 140, for the economic theory as articulated by the SEC in its complaint.

Q. Sitting here today, can you think of any economics literature that defines the term "commonality"?

MR. KELLOGG: Objection.

A. I don't -- I don't have a view on that. When I'm discussing in this section the economic

assertions for commonality, I'm talking about the economic assertions in the complaint.

Q. Is --

A. I'm sorry. Just to -- just to elaborate one second. I didn't mean to interrupt.

Q. Please.

A. So just to be a little more specific, the first three footnotes in Subsection F that we've been discussing -- Footnotes 243, Footnotes 244, Footnotes -- Footnote 245 -- are all citations to the complaint. Again, apropos of my earlier answer that I'm dealing here with the economic assertions for commonality as articulated in the SEC complaint.

Q. And as used in the SEC complaint, commonality is one of the elements of Howey, right?

MR. KELLOGG: Objection.

A. That calls for a legal conclusion. I -- I have read the complaint and it is certainly the case that the complaint does talk about commonality.

(Whereupon, exhibit is received and marked SEC Ferrell Exhibit AF-2 for identification.)

BY MR. SYLVESTER:

Q. Let me hand you what's been marked AF-2. There we go.

A. Thank you.

Q. Professor, is AF-2 the expert rebuttal report you submitted in this case?

A. Yes.

Q. Okay. Are all of the expert opinions that you intend to offer in this case included within either AF-1 or AF-2?

A. I don't know what counsel's going to ask me to opine on. I will say in addition to the rebuttal report and the opening report, I have reviewed the rebuttal reports by Dr. [redacted] and by Dr. [redacted] and Mr. [redacted] And I certainly have views on that. So I would include in my answer, in terms of my work, my review and assessment as it relates to me of those opposing expert reports.

Q. Do you intend to submit a supplemental expert report in this case?

A. Sitting here today, I have not been asked to do that.

Q. Other than the rebuttal reports of Dr. [redacted] Dr. [redacted] and Mr. [redacted] have you read any other expert reports in this case?

A. I did review -- I did read, albeit not -- albeit it's not a focal point, I did read the initial report of Dr. [redacted] Obviously I did because I -- I discuss that in my rebuttal. I also read the initial report of Dr. [redacted]

Q. Okay. And you did not provide a rebuttal opinion to Dr. [redacted] opening report, correct?

A. That is correct.

Q. Why not?

MR. KELLOGG: Objection.

A. It wasn't my assignment. It was not work that I was asked to do.

Q. Did you review Dr. [redacted] work papers related to the analysis he performed in connection with his opening report?

A. I don't have a recollection of that. I -- I focused -- again, just to be clear on the record, I did read Dr. [redacted] opening report, but I focused on his rebuttal.

Q. And sitting here today, you can't remember one way or the other whether you reviewed Dr. [redacted] work papers that he prepared in connection with his opening report?

A. I believe the answer to that is no.

Q. Okay. Did you perform any analysis of Dr. [redacted] analysis that he set forth in his opening report?

A. No. It's not -- it was not a focal point. I focused on -- in terms of Dr. [redacted] and what he says, I focused on his rebuttal.

Q. Did you review Dr. [redacted] work papers that he prepared in connection with his rebuttal report?

A. Yes.

Q. Okay. Did you perform any analysis of Dr. [redacted] analysis that he performed in connection with his rebuttal report?

A. Yes.

Q. What analysis did you perform?

A. So one of the things I did with respect to the rebuttal report of Dr. [redacted] is -- two things. One is, he critiques me for using one return for THC -- I forget the exact date -- the THC crypto. So this is one out of approximately 6,700 returns, roughly speaking, that I used in the PCA analysis. He critiques the usage of that one return.

And so I simply reran the model not using that particular return and not using THC to

see if my conclusions are robust to that and I found that they were. It doesn't affect anything.

The second thing I did with respect to Dr. [redacted] in addition to obviously carefully reviewing what he says, is I calculated the alphas -- not the change in alpha, but the alphas -- in his Figure 17, that last page of his report, and whether or not they were statistically significant at the 5 percent level.

So I believe those are the two additional things that I did in addition to just carefully reading what he had to say with respect to Dr. [redacted]

Q. And -- and just for the record, you don't intend to submit any supplemental report reflecting any analysis that you conducted regarding Dr. [redacted] analysis in his rebuttal report, correct?

A. I have not been asked by counsel to submit a supplemental report --

Q. Okay.

A. -- sitting here today.

Q. Other than the deposition transcripts that are listed in your AF-1, have you reviewed any other deposition testimony in this case?

A. No. All the deposition testimony is listed in the materials I listed in the report.

Q. Okay. Other than the rebuttal of Dr. [redacted] opening report that is set forth in your AF-2, are there any other expert opinions that you're rebutting in this case?

A. Yes. Doc -- just to be clear, I did review Dr. [redacted] -- Mr. [redacted] critique of my opening report. And so I obviously reviewed that discussion by Mr. [redacted] as well.

Q. Okay. With respect to your critiques of Mr. [redacted] sitting here today, you don't intend to crystallize those into a supplemental report that you'll be submitting, correct?

A. Same answer as before. I've not -- sitting here today, I have not been asked by counsel to prepare a supplemental report.

Q. Okay. Have you performed any additional analysis pertaining to any of the opinions that you offered in Exhibit 1 since October 4th of 2021 other than anything that might have been encompassed by your previous answers here today?

MR. KELLOGG: Objection.

A. Exhibit 1, is that my opening report?

Q. It is.

A. Okay. So could you repeat the question?

Q. Sure.

Other than any analysis we've already discussed today, have you performed any additional analysis regarding the opinions that you've set forth in AF-1?

MR. KELLOGG: Objection.

A. So I did -- so we talked about Dr. [redacted] We talked -- and my analyses there of his rebuttal. I did -- as I did with Dr. [redacted] in his rebuttal -- take a careful look at Dr. [redacted] critique of my work, as well as Dr. [redacted]

So I would encompass in my answer my review and assessment not just of Dr. [redacted] rebuttal, but those additional rebuttal reports which obviously speak to and concern the issues that I discuss in AF-1.

Q. Did you do any additional analysis outside of what you just described in your last answer?

A. Yes.

Q. What?

A. So just -- just to be clear. So earlier we discussed my work in discussing Dr. [redacted] rebuttal.

With respect to Dr. -- or Mr. [redacted] the one addition -- besides obviously reading and carefully considering what he had to say, the additional work I did with respect to that rebuttal report, or his critique of my opening report, is I did look at non-MoneyGram remittance data for 2020 in connection with reviewing Dr. [redacted] -- Mr. [redacted] critique of my work.

With respect to Dr. [redacted] and his critique, I did a couple additional analyses. One is, my understanding is that he critiques me for including -- as a distribution to a non-Ripple party, he critiques my inclusion in that type of distribution the distribution of XRP to custody accounts.

I don't agree with that critique, but, nevertheless, I also analyzed whether any of my results, the results I report in my opening report, were changed if you just look at distributions that are programmatic, market maker, or -- or sales on to exchanges to see if it's robust to confining the distribution analysis to those distributions. And I found that it doesn't make any difference to my conclusions. So that's one thing that I did with Dr. [redacted]

I should say, also, with Dr. [redacted] before the filing of my report, the report in AF-1, I had run the -- the -- I had run the distributions both in U.S. dollars and in XRP units. Obviously I went with U.S. dollars in my denomination, but I'd already known prior to the filing of my report, the report in AF-1, that that doesn't make a difference. It's obviously one of his critiques.

Another comment along these lines is before the filing of my report as -- you know, the report in AF-1, I had also run the factor model on weekly returns, on 30-day fixed -- you know, 30-day fixed period returns, and on the calendar monthly returns.

Now, as I explain in my report, I felt, and still feel, that 28 days is the best level of frequency for the factor model, but prior to the filing of the report, I knew that it was robust. It was -- the results of the factor model, the results of whether the alpha is statistically significant, were robust to weekly, 30-day, or calendar. So I know that's something that Dr. [redacted] mentions in his rebuttal and so I mention it -- mention that fact here.

One other thing I wanted to say. So Dr. [redacted] distribution analysis; his critique of the frequency of the data. Let me just think here, make sure I give a complete answer.

Oh, one other thing I should mention as long as we're having this conversation about all of the work I've done, including prior to the filing, is prior to the filing of the report in AF-1, I had also ran the factor model just on the CoinMarket return data. And that -- that didn't -- I -- I used CryptoCompare for the reasons I describe in the report, and I think that's the right choice, but I had run the model on just the CoinMarket price return data and that didn't change anything.

Let me just think. Anything else in Dr. [redacted]?

So I know that Dr. [redacted] critiques the use of this -- the square root price impact model. And, you know, I -- I do have comments on that. Obviously that's something I didn't discuss beyond the footnote with the academic citations that I have for that, but I certainly have reactions to his critique of the use of that -- that square root price impact model.

Just give me one more second to think here if there's anything else. I think that's a pretty complete list. Let me just think if there's anything else. Give me a moment if you could.

Q. Sure.

A. It might be helpful to see Dr. [redacted] rebuttal. I'm just trying to think if there's anything else in Dr. [redacted].

Oh, I remember now. I was searching for it and now I remembered.

The other thing that I did after -- this is after the filing of his rebuttal report, just to be clear. The last thing that I did in terms of that work is I recalculated the 1.6 percent price impact number -- let me be a little clearer. The potential price impact number of 1.6 percent, I recalculated that using just top-tier exchanges as identified by CryptoCompare and using just that volume. And it changes the number using that formula from 1.6 to 2 percent.

I believe that's a complete answer to your -- your question.

Q. Returning to the portion of your answer where you described running your factor model on

weekly returns and 30-day fixed returns, did you perform that analysis prior to submitting AF-1?

A. Yes.

Q. Is that analysis described anywhere in AF-1?

A. No. I -- and the reason being -- maybe I'm going beyond your question -- is I felt, and -- and feel -- my opinion is that 28 days is the -- is the best definition, the best return series to use.

So I would rely on the 28-day period that I use for the reasons given in my report. I'm just noting that the criticism by, I believe, Dr. [redacted] of I should have used different frequency data -- again, a criticism I don't agree with -- but it doesn't make a difference.

Q. And did you include within the backup materials that you provided for production to the SEC any of your analysis regarding your -- running your factor model on weekly returns and 30-day fixed returns in connection with your opening report?

MR. KELLOGG: Objection.

A. I don't know offhand. What I relied upon in AF-1 is -- is the -- and what I report is

the 28-day returns. I don't -- but going directly to your question, I don't know offhand.

Q. Okay. You also mentioned, if I understood your testimony correctly, that you also ran your factor model using just CoinMarketCap data prior to submitting AF-1, is that right?

A. That's correct. So when I say "CoinMarketCap data," I mean the prices in CoinMarket, yes.

Q. Okay. When you say "CoinMarket" and I'm saying "CoinMarketCap," are we talking about the same thing or no?

A. I believe we are.

Q. Okay. And does AF-1 mention anywhere that you ran your factor model using only CoinMarketCap data?

MR. KELLOGG: Objection.

A. I do not believe it does because the return series that I used was the best return series, in my opinion, which was the combination of CoinMarketCap and CryptoCompare. That's consistent with the academic literature in my view.

Q. And sitting here today, do you know whether the backup materials that you prepared in

connection with your opening report, AF-1, contains your analysis in which you ran your factor model on CoinMarketCap data only?

MR. KELLOGG: Objection.

A. Same answer as before. I don't know offhand. Obviously what I relied upon in my AF-1 report is -- is the return series that's described in that report.

Q. Focusing just on your preparation of AF-1, is there any other category of analysis that you performed in connection with forming your opinions that are set forth in AF-1 that is not described in AF-1?

MR. KELLOGG: Objection.

A. I believe I've -- I've -- I've mentioned -- I think our earlier discussion encapsulates that -- that other work.

Q. Okay. When were you retained to provide expert services in this case?

A. I don't have an exact date. I know that -- I believe that I started work early last year. I believe February of last year is when I started doing work. I don't know the exact date of the engagement letter, but that's my best recollection.

Q. Were you retained to provide expert services related to this case prior to your retention as an expert witness in this case?

MR. KELLOGG: Objection.

A. Could you repeat the question?

Q. Sure.

Were you retained to provide expert services in this case prior to your retention as an expert witness in this case?

A. My -- my understanding from the beginning was I was going to be an expert. I have no memory of it changing in any way. So my understanding was from -- from the beginning is I would be hired as an expert.

Q. When you say the word "expert" in that answer, do you mean a testifying expert?

A. Yes.

Q. Okay.

A. That was my understanding.

Q. Prior to your retention as an expert witness in this case, did you know anything about Ripple?

A. I had read about it in general market commentary.

Q. What did you know about Ripple prior to

your retention?

A. Well, at a high level, it's a crypto asset. It involves blockchain. It was one of the larger cryptocurrencies earlier in time. I do remember reading about the filing of the SEC lawsuit that's at issue here. So at that level of generality.

Q. Prior to your retention as an expert in this case, had you ever met Mr. Garlinghouse?

A. No.

Q. Prior to your retention, had you ever met Mr. Larsen?

A. No.

Q. Prior to your retention, had you ever met anyone who worked at Ripple to your knowledge?

A. No.

Q. Prior to your retention, had you ever met any of the lawyers representing defendants in this case?

MR. KELLOGG: Objection.

You can answer yes or no.

A. I have a bad memory for this sort of thing. It's entirely -- entirely possible, but I don't have a recollection.

Q. Did -- go ahead. Sorry.

A. I do want to be clear that I'm really terrible at mem -- at remembering this sort of thing. I don't want to offend anybody. I don't have a recollection.

Q. Prior to your retention in this case, had you ever been retained as an expert witness by Kellogg?

A. I don't believe so. I don't have a memory of that. I am involved in cases where there's a number of firms. It's possible that Kellogg was, you know, involved because that often happens. But I don't -- answering your question, I don't have a memory sitting here right now of being retained by Kellogg in other matters. It's possible, but I don't have a recollection sitting here.

Q. Prior to your retention, had you ever been retained as an expert witness by Debevoise & Plimpton?

A. Yes.

Q. How many times?

A. Again, I'm going to be very cautious here. I -- I don't have a clear recollection. I -- I believe it's several times prior to this engagement that I've been retained by Debevoise.

I want to say two, but it could easily be more than that. But I want to say something like one or two times is my best recollection sitting here. Again, with the very important caveat that, you know, I've -- I work with a lot of law firms and, you know, I don't have a list in my mind of the number of times I've worked with this or that firm.

But the answer to your question is, yes, I have been retained by Debevoise before.

Q. When was your most recent retention as an expert witness by Debevoise?

A. Putting aside this matter, I do remember doing a 10b-5 matter with Debevoise. I believe this is a few years ago. That's my best recollection. It's possible that I've done a case since then. I would have to double-check. I know I've worked with Debevoise in the past.

MR. KELLOGG: I'd like to direct the witness not to discuss the nature of any prior representation.

THE WITNESS: Okay.

BY MR. SYLVESTER:

Q. Okay. Prior to your retention in this case, had you read the SEC's complaint against

Ripple?

A. I read it around the time of my engagement. I might have read it contemporaneous with -- with the engagement. I don't know the exact timing of that.

Q. Prior to your engagement, I believe you testified that you had read about the SEC's case against Ripple, is that right?

A. Yeah, as we -- sorry, I didn't mean to interrupt.

Q. Go ahead.

A. Yeah. So I -- I -- I have a recollection of it being reported upon in the press. I don't have a -- I don't -- don't have a recollection of -- of -- I don't have a recollection of reading it -- I believe that's in December of 2020. I think that I read it after that point. So my memory is the complaint was filed in December of 2020 and I read it -- I don't think I read it in December, you know.

I guess I want to leave this open. I -- I read it somewhere in the December-February time frame, if I -- if my memory of the -- of the timing is correct.

Q. And just so the record is clear, are we

talking about the complaint or about press articles about the lawsuit?

A. Well, we -- we have two different questions now lingering. One question is, when did I read the complaint? And with respect to that question, it's somewhere in the December-February time frame. I don't have a specific recollection of exactly when I read the complaint.

The second question that's out there is, when did I read about the SEC filing a complaint? My memory, my best recollection, is I do recall reading in the press that the SEC had filed a lawsuit, is my best recollection.

Q. And with respect to reading in the press about the SEC's lawsuit against Ripple, when did that occur?

A. Same time period. Somewhere in the December-February time period. If I'm remembering correctly when this all transpired, which I believe was December of 2020. That's -- that's my best recollection.

Q. It -- it's fair to say, Professor, that you were familiar with the Howey case prior to your engagement in this case?

MR. KELLOGG: Objection.

A. That's a fair statement.

Q. Okay. Again in the period prior to your retention, what was your opinion, if you had one, about whether the SEC's allegations, if proved, would demonstrate a violation of its securities laws?

MR. KELLOGG: Objection; calls for a legal conclusion.

A. Yeah, that calls for a legal conclusion. I'm not providing an opinion on that.

Q. Perfectly understood. But I think we've established that you understood the Howey test prior to your retention and that you at least may have read the complaint or a press article about the complaint prior to your retention.

So I'm asking if you formed any opinion based on what you'd read --

MR. KELLOGG: Objection; calls for a legal conclusion.

MR. SYLVESTER: I haven't finished my question, Counselor.

BY MR. SYLVESTER:

Q. I'm focusing just on the period prior to your retention.

Based on anything that you read about the case or the complaint, did you form an opinion about whether or not the SEC's allegations, if proved, constitute a violation of securities laws?

MR. KELLOGG: Objection.

A. Well, I would not form a legal conclusion without having read the actual complaint. So the answer to that question is certainly no. And, you know, in terms of reading the complaint, obviously I have views about the economic theory and assertions in the complaint, but I have not formed a legal opinion as to how the judge should rule here. So I'm not -- not providing that opinion.

Q. Again, I'm just focusing on the period prior to your retention in this case.

Did you have any views about the economic theories or assertions in the complaint prior to your retention as an expert?

MR. KELLOGG: Objection.

A. So, again, my memory reading the complaint is -- is in that time frame. So I don't remember whether it is at the same time as the engagement or it was a month, you know, a week earlier, but it's in that time frame that I read

the complaint.

As I said before, I did read general descriptions in the press of the SEC's theory, but I -- you know, quite frankly, I would not form a legal conclusion, even if I was asked to do so, based on secondhand reporting on legal matters.

Q. When you read the complaint, did you form an opinion about whether the facts alleged, if proved, would demonstrate a violation of the securities laws?

MR. KELLOGG: Objection; calls for a legal conclusion.

A. I don't have a view on that.

Q. I'm not sure what that answer means.

Does that mean no or you don't recall or something else?

A. I don't have a -- okay. I -- I am not -- I'm not providing and I don't have a legal analysis of all the legal issues that relate to this dispute; that is, whether, in fact, this constitutes a security as defined by the securities laws. That's -- obviously very capable counsel and -- and the judge and -- and the legal system will decide that. I'm not providing an opinion and I haven't formed a legal opinion on

that.

Q. What was it that you read in the press about the SEC's case against Ripple prior to your retention?

A. I don't -- I don't have a specific recollection. I -- I -- I read a lot of press and I don't -- I don't -- I do have a generalized recollection of reading about it, but I'm not going to be able to give you more particulars.

Q. Do you own XRP?

A. No.

Q. Have you ever owned XRP?

A. No.

Q. Sitting here today, do you have any plans to acquire XRP?

A. No.

Q. Are you charging a fee for your expert services in this case?

A. Yes.

Q. How much is your fee?

A. So my expert fee is 1,250 at the time that I was retained. So that part of my compensation is my hourly rate. Just to have a complete answer for the record, another component of my compensation is I get a percentage of junior

people at Compass Lexecon that work pursuant to my instructions and supervision.

So an example of that would be somebody put -- puts together binders and sends that to me. So junior people at Compass Lexecon working in this matter under my instructions and supervision, I do get compensation based on that as well as my hourly rate.

Q. Is the compensation that you just referenced a percentage of your billables?

A. Yes, but with the important qualification that it's not the billables at large. It's junior staff at Compass Lexecon for which this would apply.

Q. What's that percentage?

A. So I do have a confidential contract with Compass Lexecon. I -- it's -- I just want to make sure I'm not violating any confidentiality.

MR. FIGEL: Give us just a second.

(Pause)

MR. KELLOGG: So if your agreement with Compass is that it's confidential, then you should not reveal it.

THE WITNESS: Okay.

BY MR. SYLVESTER:

Q. Okay. So just for purposes of the record, you're declining to answer my question based on a preexisting confidentiality agreement with a private party?

A. So my understanding, sitting here today, is that my agreement with Compass Lexecon is confidential. That's my understanding sitting here today. And so the answer to your question would be yes. But I do, to reiterate, get a percentage of the junior staff working pursuant to my instruction and supervision in this matter.

MR. KELLOGG: To make it clear, we do not represent Compass Lexecon so we're not forming a legal opinion about the nature of the contract.

MR. SYLVESTER: Understood.

THE WITNESS: And I -- maybe -- so I want to make clear that's my understanding of the nature of the agreement sitting here today, that it's confidential. I -- I can certainly confirm or disconfirm that

my understanding is correct or incorrect.

BY MR. SYLVESTER:

Q. How much have you billed for your services in this matter so far?

A. So I haven't added up the number of hours, but it is substantial. So it's several hundred hours over this period since I've been engaged, so -- but I had not added up the hours.

Q. Is the seven -- strike that.

Is the several hundred hours just your time or you plus any staff assisting you?

A. So my answer to your earlier question is just my time.

Q. Okay.

A. So it would be multiple of, you know, several -- I know "several" has a lack of -- you know, it's -- it's not a specific number, but it is a significant amount of time, my personal time.

Q. And do you have a sense of how many hours any staff working with you in connection with this matter have billed?

A. I do not, no.

Q. Okay. Would Compass Lexecon have those

records?

A. I would assume so.

Q. Okay. And would Compass Lexecon have precise records of how many hours you've billed in this matter?

A. I'm not privy to their recordkeeping system. I would assume so but that -- that's just an assumption.

Q. Have you received any compensation for your work in this case in XRP?

A. No.

Q. Do you have any plans to receive XRP as compensation for your expert services in this case?

A. No.

Q. Did others assist you with providing your expert services in this case?

A. Yes.

Q. Who?

A. So I interacted with -- I'm just going to spell her name -- A-N-D-R-I-A, Andria, van der Merwe. And she is the senior person at Compass Lexecon with whom I interfaced.

Q. What's her title?

A. Executive vice president or senior --

I -- I forget her exact title, but she's a -- a senior person at Compass Lexecon with whom I've worked in the past with.

Q. Is there anyone --

THE VIDEOGRAPHER: Excuse me, Counsel. Your -- your mic is sort of rubbing against your shirt. Sorry for the interruption.

MR. SYLVESTER: No problem.

BY MR. SYLVESTER:

Q. Is there anyone else who assisted you with providing your expert services in this case?

MR. KELLOGG: Objection on work product grounds.

Do not discuss any conversations with attorneys.

THE WITNESS: Okay.

A. So my understanding is that she -- this is the person at Compass Lexecon -- did have assistance from Compass Lexecon staff in terms of work product or analysis. But my interactions were through her, or with her, in terms of -- of my instructions and supervision and so forth.

Q. Who are the assistants that Ms. van der Merwe interacted with in connection

with the preparation of your expert report?

A. So I don't have a list off the top of my head. So I know there was junior staff that were doing different tasks, but I interfaced with her.

Q. Did you ever directly communicate with any of the junior staff that were doing different tasks in connection with preparation of your expert opinion?

A. So my memory sitting here today is just -- my best recollection in terms of Compass Lexecon staff is one other person as -- as best I can remember. Ron -- I'm going to mispronounce his last name -- Lewon -- Lewinski, Lewonski. Ronald Lewonski. Some -- something along those lines.

So in addition with -- to interfacing with her, that's the one other person that I can recall sitting here today.

Q. What is Mr. Lewonski's role at Compass Lexecon?

A. So he's a -- was a statistician.

Q. He's no longer with the company?

A. My memory is that he moved to another company to do something -- some statistical stuff with another company. I -- was it Amazon or -- I

forget which company.

Q. What assistance did Mr. Lewonski provide with your expert opinions?

A. So, again, I interfaced with that -- that one person at Lexecon. He did join in a conversation about the factor model. So it was that one conversation where I do remember he -- he talked.

Q. Did he have any assistance in designing your factor model?

A. Well, the factor model was my -- my instructions and I'm the one that provided instructions on exactly what I wanted done and how -- how it was to be done.

Q. How did Ms. van der Merwe assist in your expert services in this case?

MR. KELLOGG: Objection.

A. So she helped -- you know, a couple different buckets. She helped put together binders of materials for me; kept the flow of materials organized. She -- through her, interfacing with her, there was a lot of data work, merging of data and so forth. And I used Compass Lexecon pursuant to my instructions for that.

So, yeah, it was really -- I worked closely with her in preparing the analyses and the end result of my reports reflected in AF-1 and AF-2.

Q. What was the role of the junior assistants at Compass Lexecon with whom you did not directly communicate in preparation of your expert opinions in this case?

MR. KELLOGG: Objection.

A. So -- so I don't have a breakdown of who did what. I interfaced with this person. I know that she had assistants. But, again, it was pursuant to my instructions and -- and supervision about the ultimate work product.

Q. Was Ms. van der Merwe responsible for the merging of price data between CoinMarketCap and CryptoCompare?

MR. KELLOGG: Objection.

A. So you used the word "responsible." At the end of the day, I'm responsible. She did assist in the merging of the data pursuant to my instructions and supervision.

Q. Do you know how much -- strike that.

Are Ms. van der Merwe and Mr. Lowanski also charging, through Compass Lexecon, defendants

for their services?

A. I have no personal knowledge of that. I assume so, but I have no personal knowledge.

Q. Do you know what their billing rates are?

A. No.

Q. Did anyone at Compass Lexecon provide any comments to drafts of AF-1?

MR. KELLOGG: Objection.

A. The comments or the -- the interactions were -- I certainly discussed with Compass Lexecon what I wanted done. I certainly had their assistance. In terms of the draft itself, my memory of the draft was really reflecting the work product. So I think the discussions, the thinking, the analysis, occurred before the final production of the report. So I certainly had those conversations.

Q. Who wrote the first draft of AF-1?

A. I did.

Q. Okay.

A. But I -- I did have the assistance of Compass Lexecon. So, for example, some -- the exhibits were produced pursuant to my instructions and supervision by Compass Lexecon primarily

because we would still be waiting -- waiting for the report if I were to do these exhibits in a -- in a clean and, you know, properly formatted way.

So I did have the assistance of Compass Lexecon, but the first draft was mine.

Q. Okay. Who are all the individuals at Compass Lexecon who contributed in any way to the drafting of your report?

MR. KELLOGG: Objection; mischaracterizes the testimony.

A. So -- so my interactions with Compass Lexecon in terms of the draft is -- is what I described earlier. I did the first draft. I did have the assistance of Compass Lexecon; they helped put together the exhibits pursuant to my instructions and supervision. And obviously, you know, that was, you know, something that, as I worked on the draft, I continued to have the assistance of Compass Lexecon.

Q. Who were the people that provided the assistance in -- as described in your last answer?

MR. KELLOGG: Objection; asked and answered.

A. It's the same answer as before. I

interfaced, with that one exception that I can recall, with -- with -- with that one person at Compass Lexecon.

Q. With Ms. van der Merwe?

A. Yes.

Q. Did any attorneys provide comments to drafts of Exhibit 1?

MR. KELLOGG: Objection. Direct the witness not to answer. You can answer yes or no, but that's it.

A. What's the pending question?

Q. Did any attorneys provide comments on drafts of Exhibit 1?

A. I don't recall ever receiving comments from counsel on the draft. I certainly talked about -- well --

MR. KELLOGG: Objection. Don't -- don't go into detail.

A. So I -- I don't recall ever receiving comments on the draft from -- from counsel, is my best recollection.

Q. Okay.

A. So, in other words, you know, for -- for example, I did a draft and then there's a markup

of the draft by counsel. I don't recall ever that -- I never recall that happening.

Q. Just a yes or no: Did you ever receive comments orally from counsel on the draft?

MR. KELLOGG: You can answer yes or no.

A. It depends on what you mean by "comments." So I did describe to counsel --

MR. KELLOGG: I'm going to direct the witness not to answer that question.

MR. SYLVESTER: Not to answer whether or not he received comments orally from counsel?

MR. KELLOGG: Yes.

MR. SYLVESTER: I believe -- do you want to strike it from the record? Because he already answered.

MR. KELLOGG: Yes.

MR. SYLVESTER: Okay. So just so the record is clear, you would permit Professor Ferrell to answer the question whether or not he received written comments to his draft, but you object and instruct him not to

answer as to whether or not he received oral --

MR. KELLOGG: I object to --

MR. SYLVESTER: Please let me finish just for the record.

You would object -- object and instruct him not to answer as to whether or not he received oral comments from counsel on his draft expert report.

THE WITNESS: Would this be a good time to take a five-minute break? We've been --

MR. SYLVESTER: That's fine by me. Let's go off the record.

MR. FIGEL: Why don't we finish this --

THE VIDEOGRAPHER: Okay. Thank you. The time is approx -- approximately 10:24. We're going off the record.

(Whereupon, a recess is taken.)

THE VIDEOGRAPHER: The time is approximately 10:44. We're back on

the record. This is the beginning of Media 2.

MR. SYLVESTER: Okay. When we went off the record, we were having a colloquy about Ripple's counsel's instruction not to answer.

Have you come to a position on whether or not he is --

MR. KELLOGG: Correct. I will direct the witness not to answer any questions about conversations or other interactions with counsel about the drafting process of the report.

MR. SYLVESTER: And just for clarity, that includes whether or not such conversations occurred?

MR. KELLOGG: Correct.

MR. SYLVESTER: Okay.

BY MR. SYLVESTER:

Q. And are you, Professor, going to follow counsel's instruction not to answer any questions regarding any conversations you had with counsel about the drafting process of your report including whether or not such conversations occurred?

A. I'm going to follow the instruction of counsel.

Q. Okay.

MR. SYLVESTER: Before we get back to questioning -- questioning, I also want to put a reservation of rights on the record.

To the extent that Professor Ferrell testifies here today about any analysis that he has performed that the SEC has not received or any opinions he has formed that are not set forth in his expert reports, AF-1 or AF-2, we reserve all rights to preclude any such analysis or any such testimony at a later date.

BY MR. SYLVESTER:

Q. Moving on, have you served as an expert witness prior to this case?

A. Yes.

Q. Approximately how many times have you been retained as an expert witness?

A. I don't have an answer for that. I don't have a number.

Q. General terms is fine.

A. I've been retained over the years in a number of securities and capital market cases, but I don't have a number.

Q. Is it north of 50, would you estimate?

A. If the question is north of 50 in my lifetime, yes.

Q. Okay. Is it north of 100, would you estimate?

A. In my lifetime, yes, it would be north of 100. I do want to note that I have been on occasion retained as an expert and the case settled and I effectively do very little or -- if -- if anything.

So north of 100 with that understanding of what an engagement might entail.

Q. Okay. Is it north of 200?

A. I don't believe so, but I -- I don't -- I don't have a specific recollection sitting here. If you're talking about my entire life, I don't -- I don't know sitting here.

Q. Okay. In the entirety of your expert engagements, have you ever been retained by the plaintiff's counsel?

A. Yes.

Q. Okay. Sitting here today, just an

approximate number, what percentage of the time have you been retained by plaintiff's counsel over the history of your engagements?

A. I don't have a specific recollection. A majority is on the defense side. I have on occasion been retained by plaintiffs.

Q. Okay. Prior to this case, have you been retained in a case where a governmental entity was a party?

A. Yes.

Q. How many times has that occurred?

A. So I want to be clear. Is the question that I'd been retained by the government or the government's been involved?

Q. My first question was, is the government -- let me just ask it again.

Have you been retained in a case where a governmental entity was a party regardless of who retained you?

A. Yes.

Q. Okay. Have you ever been retained by the government in any such case?

A. Yes.

Q. Okay. How many times have you been retained by the government as an expert witness?

A. So, you know, just sitting here, the one memory that comes to mind is I was retained by the U.S. Attorney -- U.S. Attorney in the Southern District in a criminal securities case is -- you know, just sitting here today, is the -- is the one case that comes to mind. That was a couple years ago.

Q. Okay. And now backing up to the entirety of cases in which the government was a party and you were an expert witness, approximately how many of those exist?

A. I don't know. It's -- it has happened on occasion, but it's -- it's -- it's relatively infrequent. Relatively infre -- it does happen, but relatively infrequently.

Q. Would you say that number is as high as ten?

A. It's possible. I don't -- I don't have a specific number.

Q. Okay. Would you say it's as high as 50?

A. No.

Q. Okay. Have you ever served as an expert witness in a case in which the SEC was a party?

A. Yes.

Q. How many such cases?

A. I don't have a specific number. It's a small number of cases, is my best recollection, but I don't have a specific number.

Q. Has the SEC ever retained you as an expert witness?

A. No.

Q. So in each of the cases that you've been retained as an expert witness in which the SEC was a party, you've been a witness for the defense?

A. Yes. The handful of times I can recall that happening, yes.

Q. Has your expert opinion ever been excluded by a court?

A. No.

Q. Let me reask a better question related to that.

Has there ever -- has your expert opinion ever been excluded in whole or in part by a court?

A. No.

Q. Okay. Have you ever held any professional licenses?

A. I was a member of the bar for, like, a year in the '90s. So that's -- no other professional licenses.

Q. Okay. Was your bar license ever revoked or suspended?

A. I -- I stopped being a member of the bar because I wasn't practicing law, so...

Q. Have you ever --

A. I let it lapse.

Q. I'm sorry. You said it lapsed?

A. I believe so.

Q. Okay. Have you ever been the subject of any disciplinary action related to your professional activities?

A. No.

Q. Are you familiar with the term "event study"?

A. Yes.

Q. Okay. Have you conducted event studies in the past as part of your expert witness work?

A. Yes.

Q. Approximately how many times?

A. How many -- is the question how many times have I done an event study?

Q. As a part of your expert witness work in the past.

A. A large number of times.

Q. North of 50?

A. Possibly.

Q. North of 100?

A. I don't have a specific recollection. I don't know.

Q. Have you ever submitted a rebuttal expert opinion critiquing an event study conducted by another expert witness?

A. Yes.

Q. How many times have you done that?

A. A fair number of times. I don't have a specific number, but I -- I have definitely done that.

Q. Okay. Would you estimate that as north of 50?

A. I don't have a specific number. I'm not sure if it's north of 50. I don't know.

Q. How about north of 20?

A. My best -- I don't have a specific number. The answer is probably yes.

Q. Okay. Have you conducted event studies in contexts other than engagements as an expert witness?

A. Yes.

Q. Okay. What context?

A. Academic writing and I also teach event

studies.

Q. Are the academic publications in which you've addressed the topic of event studies listed among your publications in AF-1?

A. All my current publications are -- are listed there. Let me just take a quick look. I am -- yes. So my most recent paper is listed in the rebuttal. So I believe this is a complete list of my academic writings.

Q. Okay. Before performing an event study, do you always check whether the market for the considered security is efficient?

A. My best recollection is in the context where I've done an event study, it's been assumed that the market's efficient is my best recollection.

Q. When you say "it's been assumed," is that you doing the assuming or someone else?

A. It's an assumption -- you know, if we're talking about my expert work, it's an assumption of the litigation under -- under Basic versus Levinson or under the -- let me -- let me restate.

That typically when I do an event study in my -- is in a situation where it's been assumed for purposes of litigation that the market is

efficient.

Q. Now moving to your -- strike that.

For event -- event studies that you've conducted in academic contexts, for those event studies, do you always check whether the market for the considered security is efficient?

A. I believe the event studies that I do in my -- in my work is for large publicly traded companies. So I don't -- I didn't run the legal test for efficiency there, but we're talking about, my best recollection is, large publicly traded companies such as listed in the New York Stock Exchange where I don't think there would be a dispute as to efficiency is -- is my sense.

Q. And there are other tests for market efficiency setting aside legal tests, correct?

MR. KELLOGG: Objection.

A. There's certainly academic literature on efficiency going back to Gene Fama's work in the 1960s for sure.

Q. And focusing only on economic tests for market efficiency, before performing an event study in an academic context, do you check whether the market is considered efficient in economic terms?

A. The same answer as before. So my best recollection of kind of the event study factor type analysis I've done academic work for involves publicly traded securities; New York Stock Exchange listed securities, for example.

So, you know, I received it on that basis.

Q. Have you ever performed an event study where the market in your view was not efficient?

A. I don't recall offhand doing that. I'm not saying it's impossible. I don't have a recollection sitting here today of doing that.

Q. When you perform an event study, do you always check for statistically significant abnormal returns on days without any relevant news during the period you're examining?

MR. KELLOGG: Objection.

A. You know, when I run an event study such as, you know, as an expert, the question's always what is the point of the event study and that informs what I look for and what's relevant. So it really depends on the purpose that I'm using the event study for or the purpose that, for example, an opposing expert's using the event study and that informs the questions that I think

are relevant.

Q. If you're conducting an event study in which you're testing the impact of a news event on the price of a security, in that -- in an event study that addresses that question, do you always check for statistically significant abnormal returns on days without any relevant news?

MR. KELLOGG: Objection.

A. Again, it depends on the event study that I'm assessing or conducting. I'd just want to know more context about the purposes of the event study and the facts and circumstances.

Q. Can you recall conducting an event study in which you took steps to determine whether or not there were statistically significant abnormal returns on days other than days on which the relevant news was released?

MR. KELLOGG: Objection.

A. That's at a high level of generality. It's certainly possible, but it would depend on what the relevant economic questions were given the facts and circumstances of the case and given, if we're talking about expert work, what the opposing expert's doing and the purpose for which they're offering the event study. So it would

really depend on the context and the facts and circumstances.

Q. That makes sense, but I'm asking about your recollection of your prior work.

Can you recall taking the steps to determine whether or not there were statistically significant abnormal returns on no news days when conducting an event study?

MR. KELLOGG: Objection.

A. It's possible. I don't have a specific recollection.

Q. Okay. Let's assume that you conduct an event study -- now we're in hypothetical land.

Let's assume that you conduct an event study and you observe a statistically significant abnormal price return following a news event. Let's also say that you observe a number of days without news that also have statistically significant abnormal price returns.

How would your analysis or conclusions about the price reaction to news events change, if it would?

MR. KELLOGG: Objection.

A. I don't have a view. I would have to think about it.

Q. Did you conduct an event study as part of your work in this case?

A. No.

Q. Have you ever conducted an event study that pertained to digital asset prices?

A. No.

Q. Okay. Are you offering any opinion in this case regarding the suitability of event study methodology and assessing whether there exists a link between Ripple news and the price of XRP?

MR. KELLOGG: Objection.

A. I am certainly providing an opinion that the factor model is the appropriate statistical model given the facts and circumstances of this case. So I do have a -- a view as to whether, given the economic theory in the complaint, that -- I do have a view as to whether the event study methodology or the factor model methodology is more appropriate. So that level of generality I do have an opinion.

Q. Are you providing the opinion that the factor model that you employed is the only appropriate statistical model to employ to determine whether there is a link between Ripple news and the price of XRP?

MR. KELLOGG: Objection.

A. I'm providing the opinion that the factor model is -- is the correct statistical model, correct statistical technique, to assess the economic theory as articulated in the complaint.

Q. And what I'm just focusing in on is, is it the only correct statistical technique in your view?

MR. KELLOGG: Objection.

A. Well, you know, there's a panoply of academically peer-reviewed statistical techniques. The question here is, which one of those statistical techniques is appropriate given the facts and circumstances of this case? And my opinion is that the factor model is the correct way, not the event study approach.

Q. Is there any part of your expert opinion that states expressly that the event study approach is the incorrect way to study whether there exists a link between Ripple news and the price of XRP?

MR. KELLOGG: Objection.

A. Sure. So I try to, you know, explain this in detail in my opening report. That is, the

SEC's economic theory articulated in the complaint is -- there's a whole series of events: Statements, distributions, et cetera. There's a whole series of events -- activities; conduct, if you will -- that occurred over this seven-year period, 2013 to 2020, that in aggregate is associated with the price of XRP going up.

So, for example, paragraph 79 to 82 of the complaint. Paragraph 9 of the complaint refers to all the conduct referenced in the complaint as the basis for the legal conclusion.

And so given the facts and circumstances of this case, I felt it was appropriate that one analyze the cumulative effect of the conduct identified in the complaint and whether it is, in fact, associated with excess returns. That is to say, returns that are specific to XRP and are not otherwise explainable by general movements in the -- in the cryptocurrency markets.

I would also say, to give a complete answer, that for the event -- that another virtue of this approach -- that is, the factor model approach -- is one can analyze the entire time period. I also analyzed, obviously, 2015 to 2020, as well, separately. That has the virtue of

capturing the entirety of the price return series versus a situation where even if you observe a short-term correlation between a news event and an XRP change in price, even assuming that were true, there's still the further question of whether that gets reversed later.

Again, this -- this sort of speaks to market efficiency and the need to know and the impact that the efficiency of the market has on how one -- whether you can meaningfully interpret the results of an event study given that, you know, you're not -- you may not be able to identify the appropriate event window.

So, again, for those reasons, the reasons articulated in my report, I believe the factor model is the appropriate statistical test in the facts and circumstances of this case.

Q. When was the last time you read the SEC's complaint in this matter?

A. Last night.

Q. How many times have you read the complaint?

A. Many times.

Q. More than ten?

A. Probably.

Q. More than 20?

A. Probably not.

Q. Okay. And just for the record, you read the complaint approximately more than ten times in connection with preparing your expert report in this case?

A. Yes.

Q. Okay. As part of -- part of forming your opinion in this case, you conducted a principal components analysis, is that right?

A. Yes.

Q. Okay. As I understand it, the purpose of conducting the principal components analysis was to describe the main drivers of general cryptocurrency markets, is that right?

MR. KELLOGG: Objection.

A. It's a way of capturing the information in the non-XRP cryptocurrency markets that I then use in the factor model.

Q. When you say "capturing the information," what information do you mean?

A. Well, there's the 91 tokens that I use for the 2015 to 2020 period. There's the 9 crypto assets that I use for the full period. And so there's a covariance matrix associated with that.

And the PCA analysis is a way to extract information embedded in the covariance matrix of the cryptocurrency assets that I'm using, extract into the principal components that I then use in the regression analysis or in the factor model analysis.

Q. As part of your previous engagements as an expert witness, have you ever conducted a principal components analysis?

A. I don't recall either way.

Q. Setting aside whether or not you conducted a PCA -- strike that.

If I say "PCA" throughout the day, I mean principal components analysis. Okay?

A. Understood.

Q. Okay. Setting aside whether or not you conducted a PCA in your prior engagements, have you ever been called upon to opine as to whether a specific factor or event influenced price returns?

MR. KELLOGG: Objection.

A. I -- I mean, going back to our earlier questions, I have done event study analyses in the past.

Q. And so that I understand your answer,

I -- strike that.

In your prior expert engagements when you have been called upon to opine as to whether a specific factor or event influenced price returns, the expert analysis that you conducted was an event study, is that right?

MR. KELLOGG: Objection.

A. That's not quite right. So I have used event studies in -- in the context of thinking about prices. I've also used factor model as well in other contexts. So it depends on the facts and circumstances of the case, including the efficiency of the market.

Q. Prior to this engagement, how many times have you used a factor model to opine on the question of whether a specific factor or event influenced price returns?

MR. KELLOGG: Objection.

A. I don't have a specific recollection. I have used it in the past, but I don't have a number.

Q. Under ten?

A. Yes.

Q. Under five?

A. Probably. I'm not sure.

Q. Can you recall sitting here today any of the matters in which you've used a factor model to opine as to whether a specific factor or event influenced price returns?

A. So I do remember -- I'm not going to remember cases. I do remember there's been matters where the claim is that there's been leakage of information into the marketplace that affected the returns over a period of time. And I do remember using a factor model in that context.

So, again, a claim concerning events spanned over a period of time where the claim is that it's impacting the price return series.

Q. Do you recall the security at issue in the case you just described?

A. I believe it was a publicly traded security, is my memory. A publicly traded stock.

Q. Prior to this case, have you ever offered an expert opinion that an asset was or was not a currency?

A. No.

Q. Prior to this case, have you ever offered an expert opinion that an asset was or was not a virtual currency?

A. No.

Q. Prior to this case, have you ever offered an expert opinion that an asset did or did not function as a store of value?

A. No.

Q. Prior to this case, have you ever offered an expert opinion that an asset did or did not function as a unit of account?

A. No.

Q. Prior to this -- prior to this case, have you ever offered an expert opinion that an asset did or did not function as a medium of exchange?

A. I don't believe so.

Q. Okay. Have you ever --

A. So these are -- just to be clear on the record, this is my best recollection sitting here today.

Q. Have you authored any academic articles that addressed the topic of whether an asset is or is not a currency?

A. No.

Q. Have you authored any academic articles that address the topic of whether an asset is or is not a virtual currency?

A. No.

Q. Have you authored any academic articles that address the topic of whether or not an asset functions as a medium of exchange?

A. I don't believe so.

Q. Have you authored any academic articles that address the topic of whether an asset functions as a store of value?

A. I don't believe so.

Q. Have you authored any academic articles that address the topic of whether an asset functions as a unit of account?

A. I don't believe so.

Q. Have you written any publications pertaining to digital assets?

A. I don't believe so.

Q. Have you taught any classes that cover the topic of digital assets?

A. Yes.

Q. What classes?

A. I cover it in corporate finance and I cover it in my securities regulation class. Oh, and it also comes up in my law and finance class on start-ups.

Q. What topics do you cover related to digital assets in your securities regulation

courses?

A. So I -- so the securities regulation class is a -- is a class at the law school although I incorporate economics and finance into that. And so the securities regulation class, I do cover different issues relating to the application of securities laws and -- and digital assets have come up in that context, such as ICOs or, you know, tokens, where, for example, there's some right associated to -- with profits or earnings of the entity that's issuing them to -- to raise capital.

So that would be the securities regulation class. It comes up in that context. Kind of the panoply of instruments that you observe in the marketplace.

In corporate finance, I talk about it as sort of a new -- new-ish, I should say, financial asset. So just sort of the characteristics of this -- of this space of crypto assets.

And then the law of finance seminar, we do talk about start-ups including start-ups in the -- in the block up -- in the blockchain space.

So it comes up in different ways in -- in -- in these different courses.

Q. Have you ever taught -- strike that.

Have you -- strike that.

When you teach your securities regulation class, do you teach case law?

A. Yes.

Q. Have you, as part of your securities regulation class, ever taught any cases in which the SEC has brought any claims against a digital asset issuer?

A. I don't believe so. Now, the case book that I use I do think mentions -- might -- I'd have to look back. It's possible the case book mentions those cases in passing, but I don't have a recollection of specifically assigning those cases.

Q. Have you ever taught a class in which you address the topic of the SEC's case against Ripple?

A. No. No. I have mentioned in the context of securities regulation crypto assets. I don't remember ever assigning a case or a complaint to the class. So I do mention the issue in class, but, again, I don't have a recollection of ever assigning an SEC complaint or -- or a case. So it's really at that level of generality.

Q. Setting aside the SEC's case against Ripple, have you ever taught any class in which you discussed Ripple or XRP?

A. I don't think I've ever gotten into the allegations in this case, no. I do mention -- I have mentioned securities regulations. It's mentioned in the case book as well, I believe. You know, the -- the policy issues around crypto assets and how they interact with the securities laws. So at that level of generality, yes.

Q. Prior to this case, had you been retained as an expert in any case involving digital assets?

A. I don't believe so.

Q. Prior to this case, had you ever conducted any analysis of price movement of digital assets?

A. I don't believe so.

Q. Are you offering any opinion in this case on the informational efficiency of the XRP market?

A. No.

Q. Okay.

A. I'm not providing an opinion on that except to say -- except referencing my earlier

comments about the event study approach versus the factor model.

Q. Turning to Appendix B of your opening report, AF-1.

A. Appendix B?

Q. That's right.

A. Yes.

Q. Labeled "Materials Considered."

Do you see that?

A. I do.

Q. Did you personally review each of the materials listed in Appendix B?

A. I did.

Q. You know what a Wells submission is, is that right?

A. Yes, I do.

Q. Okay. Did you review any of defendants' Wells submissions in this case?

A. I don't believe I reviewed the Wells submission is my best recollection. That's my best recollection sitting here.

Q. Okay. Let's turn to paragraph 90 of AF-1 on page 39.

A. Page 39?

Q. Yes.

A. Paragraph 90?

Q. That's right.

A. Okay.

Q. The second sentence, you refer to "the economic reality that Ripple's efforts do not impact XRP prices."

A. I don't -- I don't see that. Page 39?

Q. 39, paragraph 90.

A. Yes.

Q. Sentence 2. I'm quoting the latter portion of sentence 2. Your reference is to "the economic reality that Ripple's efforts do not impact XRP prices."

A. I do. Okay. I didn't realize you were reading a portion of the sentence. Okay.

MR. KELLOGG: Sorry. Mark, where are we?

MR. SYLVESTER: The second sentence of paragraph 90, latter portion.

BY MR. SYLVESTER:

Q. Okay. Is your view, Professor, that the economic reality described in this sentence -- sorry. Strike that.

Is your view that the economic reality

that Ripple's efforts do not impact XRP prices based on your analysis that you describe in Section III of your report?

MR. KELLOGG: Objection.

A. Well, it does reflect the -- the analysis in Section III, but I -- you know, I would also, you know, reference all the work in the report, including my review of the contracts. You know, the contracts are also referenced in the complaint as well.

But I am including as a basis here the factor model, that's true.

Q. Okay. And can we shorthand the -- the analysis performed in Section III.C of your report as your factor model? Is that fair?

A. Well, I -- I have a factor model in III.D as well.

Q. Okay.

A. So I -- I wouldn't confine the factor model just to III.C if what you're interested in is the factor model.

Q. Maybe it's easier if I just distinguish throughout the day your two analyses by referring to the analysis that you performed with respect to Sections III.D and III.C of your report. Would

that work?

A. If you want to refer to the analysis in III.C, I have no problem with that.

Q. Okay. All right. And in III.C you describe the statistical analysis you performed?

A. One of the statistical analyses, yes.

Q. Right.

Did you design the analysis that's described in Section III.C to answer the question of whether Ripple's efforts impact XRP prices?

MR. KELLOGG: Objection.

A. Well, a full answer to that is it's designed to assess the economic theory articulated in the SEC complaint; i.e., there's a whole series of events, including distributions, but not limited to distributions, that had the effect or associated with XRP price increases over that time period, the time period being 2013 to 2020.

So the factor model is the appropriate statistical test to assess that economic theory.

Q. In your last answer you referenced a whole series of events including, but not limited to, distributions.

What other events are part of that series of events?

A. I would just reference the complaint. So the complaint identifies various statements, tweets, I believe, distributions, that in the SEC's view over this time period are -- is associated with XRP prices increasing. And, again, I would reference the complaint for the full list of the various events, distributions, news -- statements that the SEC believes in aggregate is associated and helps explain XRP price increases over this time period, the 2013 to 20 -- 2020 period.

And, again, my view is the factor model is the appropriate way to test whether that's accurate or not.

Q. In your view the factor model is the appropriate way to test whether all of the items that you just listed had an impact on XRP's price, is that right?

MR. KELLOGG: Objection.

A. It's the appropriate way to assess whether over this time period the events -- events defined as the conduct identified by the complaint -- had or are associated with excess returns of XRP; i.e., returns of XRP that are not explained by general movements in the non-XRP

cryptocurrency markets.

Q. Let's look back to paragraph 90. At the very bottom of page 39 --

A. Yes.

Q. -- you reference your "empirical analysis of long-run XRP price return."

Do you see that?

A. I do see that portion of the sentence at the bottom of page 39.

Q. Okay. And is that phrase that I just read a reference to the analysis that you performed that's described in Section III.C?

MR. KELLOGG: Objection.

A. I am referencing the analysis in III.C, but I -- I would note that I also have a factor model that is relevant to my opinion here in III.D.

Q. Okay. The top bullet, still on paragraph 90, but on page 40 now, says "Variation in long-run XRP price return can be explained by exogenous cryptocurrency market factors that are outside Ripple's control."

Do you see that?

A. I do.

Q. Okay. What does the term "long-run"

mean in this sentence?

A. It -- it's a reference to the estimation periods that I -- I looked at.

THE REPORTER: What period?

A. It's a reference to the estimation periods that I used and there's two: The 2013 to 2020 period, and then my Estimation Period 2, which is 2015 to 2020.

Q. Did you perform any analysis to evaluate the question of whether Ripple's efforts impact XRP prices in the short run?

MR. KELLOGG: Objection.

A. The answer to that is yes in the sense that if there were news events -- I'm going to -- I'm going to use the phrase "events" to reference the complaint's identification of what the SEC feels or believes is impacting, is relevant to the -- to the XRP pricing.

So, again, I just want to be clear. When we're talking about events, I'm assuming that we're talking about the events deemed relevant by the complaint, but you can tell me if I'm misunderstanding.

Q. I think it's fair to make sure we're talking about the same thing.

So the complaint makes a number of allegations about Ripple's actions. Fair to say?

A. Yes.

Q. Okay. So when you use the word "events," are you talking about the various types of Ripple's actions that are alleged in the complaint?

A. Yes.

Q. Okay.

A. The distributions, the statements, the various events so identified by the complaint. And I -- and I do analyze, you know, the short term in the sense that if these events had an immediate -- for example, had an impact on XRP pricing that was permanent, didn't get reversed because the market is inefficient, then that would be picked up in the -- in the factor model.

So events that have permanent price effects that don't get reversed, for example, would -- would show up in the XRP return and it would show up in whether the excess returns, the returns specific to XRP, are statistically significant or not.

Q. Other than the one set forth in Dr. [redacted] opening report, are you aware of any

event study that evaluates the question of whether news of Ripple's actions had any correlation with XRP price returns?

MR. KELLOGG: Objection.

A. Not sitting here. Nothing that I -- I recall.

Q. Okay. Focusing just on your analysis set forth in III.C, did counsel ask you to make any assumptions in connection with the analysis you performed as described in III.C?

MR. KELLOGG: Objection.

You can answer yes or no.

A. No.

Q. Okay. Are you expressing any opinion in this case about whether or not Ripple's efforts affect daily or intraday XRP prices?

A. I am in the sense that I described earlier, which -- which is to say, if Ripple news, the various things that the SEC identifies in the complaint, if those events had an immediate -- let's say a same-day price effect, just hypothetically, and that price effect was permanent, it didn't get reversed because the market's inefficient. So it doesn't get reversed 11 days later. It's a permanent price effect,

whether it be intraday or at the end of -- end of the closing day, whatever your time interval is. Those permanent pricing effects would show up in the returns that I analyzed and would show up if it's -- if it's XRP specific in the excess returns that I'm analyzing in the factor model.

So in that way I am analyzing that question, again in the context of the time series, over my estimation period.

Q. Setting aside that analysis that you just described, did you perform any other analysis pertaining to the question of whether or not Ripple's efforts affect daily or intraday XRP prices?

MR. KELLOGG: Objection.

A. That would be my answer to the question.

Q. Okay.

A. Which is, the short term can matter to the long term if the short term is permanent and, therefore, would show up in the re -- the price series.

If the -- if one -- you know, just to take the opposite hypothetical, if, for example, there's a correlation between a news event and a change in XRP price, as a hypothetical, and that

gets reversed, hypothetically, nine days later, then that would not -- and -- and all that's occurring within my 28-day window, that would not show up in the return by definition. It might show up in the weekly, but not in the -- the 28-day period.

So, again, I am -- I would be picking up in my factor analysis events that -- that affect the -- the return versus, you know, some news event that might be reversed by the market.

Q. Sitting here today, do you know whether the hypothetical that you just described occurred? Meaning there was a news event, there was a Ripple news event, there was a change in XRP price, there was a reversion, and it wasn't picked up in your factoring analysis?

MR. KELLOGG: Objection.

A. No. So the prob -- one problem in my view and one reason why the factor model is a better approach is I have not seen any -- I'm not aware of, I should say, Dr. [redacted] addressing how his event study can -- can -- can adjust for that.

So, again, it goes back to my reason for why the factor model is better. We're talking about XRP in 2013 and -- and going forward. We're

talking about the long-term price series given the allegations in the complaint. And so I just view that as this is the better way to go.

Q. Is it possible in your view that there was a Ripple news event and a resulting change in XRP price, the XRP price then reverted within your 28-day window, and that did not show up in your factor model?

MR. KELLOGG: Objection.

A. So in your hypo, if the price increased and decreased within the 28-day period, I think it follows that it would not be in the -- the 28-day period. It may -- it might be in the week period, depending on the timing of those events, but a complete price reversal within that time interval by definition would not be -- wouldn't be, A, a permanent price effect; and, B, wouldn't be in the time series; and, C, wouldn't explain why XRP price is going up over time.

Q. Okay. You've mentioned in your testimony a few times, I think, the phrase "because the market is inefficient." And I just want to clarify for the record. Are you offering any opinion in this case about the efficiency of the XRP market?

MR. KELLOGG: Objection.

A. I am not.

Q. Okay.

A. I -- I -- I'm saying that if the market is in -- inefficient, the market for XRP, for example, in 2013 or some time period, then in that scenario the event study is going to have this problem of what the appropriate event window is. That is to say, how do you control for or adjust, when thinking about price impacts, for reversals or whatever it is that renders the market inefficient?

So I was really talking in terms of that scenario.

Q. And you haven't done any analysis to determine one way or the other whether the XRP market is or is not inefficient?

MR. KELLOGG: Objection.

A. Correct.

Q. Okay. Are you expressing the opinion in this case that XRP would have performed as it historically did irrespective of Ripple's actions?

MR. KELLOGG: Objection.

A. That's not -- that's not quite the way I would frame it. The way I would frame it is

there's no excess returns. There's no XRP specific price returns -- there's no price returns specific to XRP that -- above and beyond the general cryptocurrency market movements.

Q. And does that mean in your view -- in your view that XRP would have performed as it did irrespective of Ripple's actions?

A. It -- well, the -- that test and that finding is -- does directly speak to the SEC's claim in its complaint that Ripple's efforts caused the price to increase or is associated with a price increase, you know, over this time period.

So it -- it's really addressing the economic theory articulated in the complaint; that is to say, there's Ripple-specific efforts that help explain or are associated with an XRP price rise. And it's really that proposition that I'm testing.

Q. Who collected the data that you used for your factor analysis?

A. Compass Lexecon.

Q. Do you know who personally conducted the data pull?

A. We're -- we're going to just go back to our earlier conversation. I interfaced with

Ms. van der Merwe at Compass Lexecon. I gave instructions on the type of analysis I wanted to do, including the data pull and where to pull the data. And so I would just reference our earlier discussion in that regard.

Q. Did you personally do anything to check the quality of the data that you used in performing your factor analysis?

A. You said "personally." Sure. I went over the data with Compass Lexecon. I talked about where I wanted the data to be pulled. So, yes, a lot of work went into that including myself personally.

Q. What data quality checks, if any, did you perform?

A. Well, so, I reviewed the academic literature about where the academic peer-reviewed finance literature pools return data. The academic literature is quite clear that CoinMarketCap and CryptoCompare are widely used in the peer-reviewed academic research. And so I guess I began my data collection by grounding myself in the accepted approach in the academic literature. So I guess that's the main starting point.

As I said earlier today, I also ran before the filing of the report all the time series on CoinMarketCap just as a robustness check. I think the data sources that I use in the report are the correct ones. But it was really, I guess answering your questions, following the academic literature on this.

Q. Returning to the data sources that you used underlying your opinions in the report, in addition to referencing the academic literature, are there any other data quality checks that you performed?

A. Well, sure. I mean, I went over the data collection process, how they're pulling the data, I looked at the data. So, yes, this was a process that unfolded over time. So it wasn't simply, you know -- you know, just reading academic finance papers but, rather, making sure that that was properly implemented in how the data here was put together.

Q. Why did you -- excuse me.

Why did you opt to use price data from two sources?

A. Well, if you look at the academic peer-reviewed literature, CryptoCompare is widely

used in the peer-reviewed academic research -- academic peer-reviewed literature as a source of -- of price return data.

Now, you do run into the following issue, which is CryptoCompare does not go back to 2013. So another source that is also used in the academic literature is CoinMarket. So CoinMarket -- CryptoCompare doesn't go back to the beginning and, therefore, I relied, consistent with the academic literature, on -- on CoinMarket for that time period.

Q. Does CoinMarket cover the entire period from 2013 to 2020?

A. I believe so. And that's why I was able to run it, as I discussed earlier, just on CoinMarket. But I felt the better way to go is to use CryptoCompare because that is used as a data source in peer-reviewed academic research.

Q. For clarity, for the opinions underlying your report, you used both data sources, is that right?

A. Yes.

Q. Okay. Is there any academic literature you can think of sitting here today that uses two sets of data sources for pricing?

A. I haven't looked at that specifically. I mean, not sitting here today. I can say that the academic peer-reviewed literature uses both and uses CryptoCompare for later time periods. That's simply not possible to use for the earlier period because it doesn't exist in CryptoCompare.

So, you know, sitting here today, both are used in the academic research literature. As I said earlier, even if you just run it on CoinMarket, it doesn't make a difference.

Q. What's the advantage of using two sets of data versus just using CoinMarket data?

A. Well, at the end of the day, it doesn't matter. The results are the same. The excess returns are not statistically significant at the 5 percent level.

That being said, if you review the academic peer-reviewed literature, you do observe papers using CryptoCompare for their analysis.

Q. Right. My question, though, goes to your -- the methodology that you selected for your report.

Was there an advantage in your mind to using two data sources versus just using the CoinMarket data?

A. Again, it doesn't make a difference, but, yes, there is an advantage in the sense that when you read the peer-reviewed academic research literature, and the literature is analyzing a later time period, a period for which there is CryptoCompare data, you do observe the peer-reviewed academic literature using that data source. Not that it means CoinMarket is bad data, but, rather, you do observe papers using CryptoCompare.

So the Liu paper in the Journal of Finance, or coming out in the Journal of Finance, uses CryptoCompare, I believe if I'm citing the paper correctly, but let -- let me restate that.

There are peer-reviewed academic papers that are using CryptoCompare. Obviously you can't use that in the earlier period here because it doesn't exist in the data set.

Q. Did you do anything to verify compatibility of price data from the two data sets that you used?

A. Yes. So I did CoinMarketCap and I ran it on that, as I said, as well as reviewing the data. And as we discussed earlier today, I know that Dr. [redacted] has -- I'm going to put aside the

fact that he identifies three date -- three returns that I don't use, where he claims I didn't do due diligence on data that I didn't use. I'm going to put that aside.

He does identify one return out of the 6,700 I used that looks, I think, abnormally large. And so I did rerun it dropping that and it doesn't -- doesn't affect anything.

Q. Let me limit my question to any steps that you took prior to submitting your expert report in AF-1.

A. Okay.

Q. Prior to submitting AF-1, did you do anything to verify the compatibility of the price data in the two data sets?

A. I would go back to my earlier answer. I -- I ran everything on CoinMarket; didn't make a difference. I visually inspected the data. I instructed Lexecon where to pull the data from based on the academic research. You know, went over the data with them -- or with her in conversation and on looking at the data.

So, again, it was a process that I undertook in constructing the factor model and the data inputs to it.

Q. You've referenced a few times Dr. [redacted] reference to the token THC in your data set, correct?

A. Yes.

Q. Prior to reading Dr. [redacted] rebuttal report, were you aware of those unusual price spikes of THC within your data set?

A. So you just used the word "spikes," plural, in your statement. My understanding -- but we could look at his report -- is that he identified one out of the -- I'm approximating now -- one out of the 6,700 crypto returns that I used as, in his judgment, being too large. So it wasn't plural, it was one, if we're talking about the same thing. And, again, it's -- it affects nothing.

Q. Be that as it may, were you aware of the price of the one -- strike that.

Let's look at Dr. [redacted] rebuttal report. Can we look at --

A. I don't have his report.

Q. I will get it for you.

A. I'm sorry. I didn't mean to jump ahead.

Q. Let's look at -- at AF-6, please.

(Whereupon, exhibit is

received and marked SEC Ferrell Exhibit AF-6 for identification.)

MR. SYLVESTER: Thank you very much. Okay. Here we go.

THE WITNESS: I want to give one to her.

BY MR. SYLVESTER:

Q. I'm handing you what's been marked AF-6. This is the expert rebuttal report of Dr. [redacted]

Professor Ferrell, this is the [redacted] rebuttal report we've been discussing?

A. Yes.

Q. Okay. Let's turn to page 19 of that report, Figure 10.

A. Figure 10?

Q. Yes, please.

A. Okay. Oh, we were -- I'm sorry. You ask your question and I'll make -- go ahead.

Q. So my question was, were you aware of the prices of the THC token that Dr. [redacted] identifies as outliers prior to submitting your expert report, AF-1?

MR. KELLOGG: Objection.

A. Okay. So I'm going to read from paragraph 38 of his report where he's referencing

Figure 10.

"As shown in Figure 10, most prices for THC are fractions of a cent, but there are three dates (August 21, 22 and 23, 2017) when THC prices are reported to reach values of over 10 million U.S. dollars per token in the CryptoCompare data." Okay. And then he has Figure 10.

Okay. So my comment on this is this is a little silly because I don't use August 21st, 22nd or 23rd. It's not used in my factor model. I use, as I say, the 28-day period which I believe runs from -- I'm not going to get the exact dates, but it runs from early August to early September.

So he's pointing to data that is not used in my analysis. So, you know, this is -- this is really completely irrelevant.

Q. Commentary aside, were you aware of these -- what Dr. [redacted] characterizes as "outlier prices" on the three dates listed in Figure 10 prior to submitting your expert report in AF-1?

A. I --

MR. KELLOGG: Objection.

A. I don't recall seeing that. Again, completely irrelevant. It's not used in my data analysis. I do appreciate being accused of not

doing due diligence when the data being identified is not actually used by myself.

Q. Were there any outlier price data with respect to the THC returns that did get incorporated into your analysis?

A. I believe -- and we can look at the report. Let me just -- give me one second here.

Yeah. So he -- in addition to these three that we've been talking about in Figure 10, he identifies -- and this is what I was referencing earlier -- a THC return date in paragraph 41.

Q. Okay. So in your view there was one inaccurate price data point for THC that was incorporated into your analysis. Is that fair?

A. I agree that 8,916 percent is a very large return. So this is one return out of approximately 6,700 returns that I used that was in the original data, not the -- not in the -- you know. So this -- this wouldn't be affected by my CoinMarketCap running of the model. But there is one return out of the 6,700 that is this return. And as I said earlier, it makes no difference to the outcome, as one would expect.

Q. So the record is clear, THC is one of

the tokens that's used in your principal components analysis as reflected in AF-1, correct?

A. That's right. It's one of the 9 -- well, let's -- just to be clear, it's one of the 91 tokens that are used in Estimation Period 2, the 2015 to 2020 period. I don't believe THC is in the 9 tokens that's used for the full time period.

So his discussion here is about -- I believe, is focused on the Estimation Period 2 where this is one -- this token or this crypto is one of the 91.

Q. In your report in AF-1, you report the results of your analysis using a 28-day return period, is that right?

A. Yes.

Q. Why did you opt to use a 28-day return period in your expert report?

A. Well, I have a footnote explaining why I think this is the best specification, and that is I'm running it essentially on a Tuesday to a Tuesday. So you avoid national holidays on Mondays. You avoid mixing different days of the week if you were, for example, to run it on a calendar basis. You're running it from a Tuesday

to a Tuesday and you're avoiding weekend effects.

So, you know, for those reasons that I reference in the footnote, I felt a 28-day was the best specification. And, again, I explain all of this in the report.

Q. Is there any advantage in your mind to starting your analysis and ending your analysis on a Tuesday versus a Wednesday, a Thursday or a Friday?

A. So Tuesday is the first day -- I forget exactly when the data starts, but it's after that weekend and Monday. Obviously, you know, I tried to run the model as early as I could with these considerations in mind for that same time period.

But, you know, all the permutations that Dr. [redacted] presents in his report, whether it be running it on a Wednesday or a Thursday or what have you, does not change the result. The result being there's no statistically significant alpha at the 5 percent level.

Q. Prior to submitting your report in AF-1, had you run your factor model starting and ending on a Wednesday?

A. I don't recall the answer to that. I -- what I did do, which is related to your question,

is, as I said earlier, I did run it on weekly and on -- on 30-day and on calendar month. So I don't know whether the calendar month would -- how that would end in terms of days of the week, but I did run those alternative specifications. Didn't change the results. But, again, for the reasons I describe in my report, I felt 28 days was the best specification.

Q. And, again, you ran those weekly, 30-day and calendar month factor models prior to submitting your expert report in AF-1?

A. I did.

Q. Okay. Are there any academic articles that explain any benefits to using CryptoCompare data versus CoinMarket data?

A. So you have to direct me to that, you know, if you have a particular paper in mind. But it is the case that folks -- you know, peer-reviewed literature does use CryptoCompare data for later time periods, although, you know, as I said before, it doesn't actually affect -- that choice of the data set doesn't actually affect the results.

Q. Turning back to a previous question, prior to submitting your report in AF-1, it's true

that you did not use a -- a Wednesday start and end date to run your factor model, correct?

MR. KELLOGG: Objection.

A. I -- as I said before, I would just reference my earlier answer. I forget the start dates for the -- you know, whether -- you know, for example, I forget whether the calendar mixes a Wednesday with -- I just don't remember. I did run it on weekly, 30, and calendar. Again, it doesn't make a difference, as does the permutations, the specifications in Dr. [redacted]. None of it changes the result that the alpha is statistically insignificant at the 5 percent level.

Q. But sitting here today, you don't recall having run your analysis using a Wednesday or a Thursday start date prior to AF-1, is that right?

MR. KELLOGG: Objection; asked and answered.

A. Same answer as before.

Q. I believe you testified earlier that THC was part of your principal components for your Estimation Period 2, is that right?

A. I believe that's correct.

Q. Was it part of PC 2?

A. Well, the principal component analysis is extracting information from the entire covariance matrix. So I do believe it appears -- you know, it is being weighted or reflected in PCA 2. So I think that is -- at that level of generality, I think that's a fair statement.

Q. Okay. Do you recall what were the other tokens in Principal Component Number 2?

A. Oh, I don't. I mean, I have -- you know, all the 91 is extracting all of the information from the covariance matrix. I'm happy to look at -- if what you're referring to is page 22, I'm happy to take a look at that.

Q. Are you referring to page 22 of AF-1?

A. Oh, I thought you were -- I thought we were discussing Figure 13 of [redacted] where he's talking about PCA 2.

Q. We can look at Figure 13 of [redacted] I was just asking if you -- if you know one way or the other what other tokens in Principal Component 2 there were in addition to THC.

A. Well, the P -- just to be clear, the PCA is extracting all the information from the covariance matrix for all 91. Now, the -- what

that translates into in terms of how different coins get weighted, you know -- yeah, that's a separate question. But, you know, the PCA analysis is extracting, in constructing the PCA components, all the information for the entire covariance matrix of the 91 tokens.

Q. Can we --

A. Or the 91 -- I keep saying "tokens." Ninety-one tokens. I'm using that interchangeably with crypto assets.

Q. Can we look at Exhibit 3 of your AF-1?

A. AF-1?

Q. Yes, please. Exhibit 3.

Exhibit 3 is labeled "Regression of XRP price return on principal components of other cryptocurrencies."

Do you see that?

A. I do.

Q. Okay. Can you explain to me what the difference is between Principal Component 1 and Principal Component 2 on your Exhibit 3?

A. I just explained it. I would reference the PCA analysis, which is extracting -- it's a projection of the covariance matrix into a lower dimension of data. So it's extracting, in the

Principal Component 1, the most information from the covariance matrix to construct PCA 1, which is going to be a weighting across tokens based on where the information resides in the covariance matrix to construct PCA 1 and -- and then so forth and so on.

Q. What was the weight of THC in Principal Component 2?

A. I don't have that memorized. So it is extracting information from the entire covariance matrix. So the 91 by 91 covariance matrix -- you know, I have not memorized, you know, the implied weighting of the PCA 2 across the 91 tokens.

Q. Is the use of a 28-day, Tuesday to Tuesday, return a generally accepted methodology in -- in economics literature studying price returns?

A. I think it is consistent or a reflect of the academic literature for the reasons I state in my footnote.

So, for example, it's established that there's weekend effects with crypto assets. There are -- and so given these concerns about day-of-the-week effects for crypto, in the literature I think it's consistent to do the

28-day as the best specification.

Q. Sitting here today, can you think of any academic literature that uses a 28-day return period?

MR. KELLOGG: Objection.

A. So I believe there's a paper by Chain, C-H-A-I- -- C-H-A-I-N, that uses a 28-day window. That's one that might be most on point with your question. But, again, I would reference the academic literature on day-of-the-week effects for crypto as the reason why I thought Tuesday to Tuesday was the best specification. As I said before, the other specifications have the same result.

Q. Did you cite that Chain paper in your expert report?

A. I don't believe I did.

Q. Did you review the Chain paper prior to preparing your expert report?

A. Yes. Yes, I -- I reviewed a lot of papers. I feel -- felt like it was sufficient, I still feel like it's sufficient, that there are day-of-the-week effects for crypto. And the best specification would incorporate that fact into defining the appropriate window or the appropriate

time period; i.e., the 28 days.

Q. What other papers besides the Chain paper did you review in preparation of your expert report but not cite in your expert report?

A. Well, I've read over the years many crypto papers. I'm not going to have a -- a list off the top of my head.

Q. And I just -- I -- I don't want to interrupt you, but I just want to limit my question to in preparation of your expert report. Just that time period.

MR. KELLOGG: Objection.

A. Again, I'm bringing to bear my knowledge as -- as -- as an academic economist, the literature. I do cite papers for specific reasons in my report, but I am invoking my experience as an academic economist in how I thought and prepared my analyses.

Q. In your view, does your PCA identify the most important economic factors in the crypto market?

MR. KELLOGG: Objection.

A. I don't think that's -- I -- I think that's too broad and too -- I guess I don't agree with that framing. Really, what information that

-- what information are you interested in is a function of what the analysis is that you're doing.

For my analysis, the PCA is extracting in an efficient way the information in the covariance matrix of the 91 or the 9 tokens given what I'm interested in, which is exploring the price movements of XRP in relation to the other cryptocurrency markets. So, again, for my purposes I think it does capture the right information.

I guess I'm hesitant to speak to any -- you know, other potential research questions I would have to -- I would have to think about.

Q. In your view, is the information that's captured from the covariance matrix of the 91 tokens econo -- information about important economic factors in the crypto market?

MR. KELLOGG: Objection.

A. It is extracting information about the -- the times -- the pricing time series in the non-XRP cryptocurrency markets in a very established way. I think the PCA analysis has been around, I think, over a hundred years. So it is a well-grounded, academically peer-reviewed

technique widely used to capture information that might be relevant to a research question or an analysis.

Q. Is there other information about the cryptocurrency market other than price and time series and non-XRP cryptocurrency markets that the PCA provides?

MR. KELLOGG: Objection.

A. I'm not sure what the question's asking.

Q. I'm asking whether or not the PCA provides any other information about relevant factors in the cryptocurrency market other than just the time and price series of the data -- of the underlying data.

A. Well, it --

MR. KELLOGG: Objection.

A. I mean, I guess we have to talk a little bit about what a PCA does. It's projecting higher dimensional data using, you know, the -- the covariance matrix into a lower dimension. So it is extracting in an efficient manner information in -- in the -- in the other non-XRP crypto market return price series.

Q. When you say "information" in that answer, what is that information that's being

extracted?

A. The covariance matrix.

Q. And --

A. So --

Q. Sorry. Go ahead.

A. Yeah. So it's a well-established technique to extract information reflected in the time series of the 91 or the other 9 tokens.

Q. What information does it extract?

A. It extracts -- we have lots of time series for 91 or 9. It's extracting the time series along the dimensions that have the most information about what the -- what the cryptocurrency markets are doing. So typically the PCA is going to work off the eigenvalue of the matrix to project from a higher dimension to a lower dimension the informational content of the data.

So, again, completely standard. It's used in asset pricing models. It's used for other purposes all the time. It's nothing surprising or novel in any way about using a PCA to extract information from -- from -- you know, from a data set.

Q. Did you use --

MR. KELLOGG: Mark, is now a good time for a break?

MR. SYLVESTER: Sure. Fine by me.

THE VIDEOGRAPHER: Okay. Thank you. The time is approximately 11:58. We're going off the record.

(Whereupon, a recess is taken.)

THE VIDEOGRAPHER: And the time is approximately 12:15 p.m. We're back on the record. This is the beginning of Media 3.

BY MR. SYLVESTER:

Q. Professor, did you use the Fama-French factors in your analysis?

A. No.

Q. It's true that at no point you conducted your factor model using daily price data, is that right?

A. Correct.

Q. Okay. This is a hypothetical question. Let's assume the only change to your analysis is that you analyzed the price return data at a daily interval versus your 28-day interval. Let's

assume that other digital assets explain a very small --

THE REPORTER: You're going to have to slow down, Mark.

Q. Let's assume that other digital assets explain a very small portion of XRP price return variation. Say less than 50 percent.

Would that change your opinion in this case?

MR. KELLOGG: Objection.

A. If I understand the question correctly, the question is would I reject the model purely as a function of adjusted R-squared? Again, I guess I would want to see the model and what's going on with the model. Obviously different models can have different adjusted R-squares in terms of the explanatory power of the model.

So I guess in your hypothetical, I would want to do the work to understand the model and -- and see and make -- and make an assessment from there. Given my purposes and what I was testing, you know, I -- I had the specification, I think, that best captures it.

Q. Is your opinion in this case based in part on the adjusted R-squares that your model

produced?

A. Not per se. So the adjusted R-squared for -- for Estimation Period 1, the 90 percent plus, I mean, that is a feature of the model that I use. So in that sense it is part of my analysis because it is the associated adjusted R-squared.

So, yes, going back to my earlier answer, I would say the adjusted R-squared for the model or the models that I'm running is a feature of the model. It's an output of the model. So obviously in that sense it's part of my analysis. It's a function of the model.

But I would also say that, you know, you can obviously not ascertain the statistical significance of the alpha, which is what I'm primarily focused on, by -- you know, by just referencing what the adjusted R-squared is. So I'm more interested in the model's assessment of the statistical significance of the alpha. But that being said, the adjusted R-squared is obviously part of -- it's reflecting what the model is doing in practice.

Q. When you say you're primarily focused on the statistical significance of the alpha, can you explain the relationship between that and your

expert opinion that -- I'm quoting from paragraph 100 -- "variation in long-run price return of XRP can be explained by exogenous, non-XRP, cryptocurrency price returns or, put differently, by factors outside Ripple's control"?

A. Can you remind me what page that is?

Q. Sure, 47.

A. Can you remind me of what you were just reading?

Q. Sure, it's paragraph 100. It starts "In summary..." It's just one sentence.

A. Okay. And what was -- I see the language. Which -- now, what was the question?

Q. The question was you -- your -- a few answers back, I believe that you said that you're primarily focused on the statistical significance of the alpha, is that right?

A. Yes.

Q. Okay.

A. In the context, to be clear, of having a model that appropriately accounts for non-XRP crypto price movements and so forth.

Q. Right. And what I'm trying to do is ask -- strike that.

What's the relationship between the

statistical significance of the alpha and your conclusions that you reached in paragraph 100, if there is one?

MR. KELLOGG: Objection.

A. Right. So obviously I do further analysis after paragraph 100, so I don't want to create the misimpression that my analysis of the price returns ends at paragraph 100. And so I would incorporate the further analysis that I do.

But I am saying that if the SEC's economic theory as articulated in the complaint is true, one would expect to observe excess returns of XRP and that's the alpha. That is to say, there's returns that are specific to XRP, specific to XRP, that are positive, because the SEC is alleging that on the whole these news and activities of Ripple were helping to drive the price up. So that theory would indicate that the XRP specific price return is positive and statistically significant; i.e., it's -- the return is above and beyond what you would just expect based on general cryptocurrency market movements.

Q. Okay. Returning to my hypothetical about running your factor model with daily

interval data, if your factor mod -- if you had done that and under the assumption that other digital assets, non-XRP assets, explain a very small portion of XRP price return variation, would that affect your opinion at all?

MR. KELLOGG: Objection.

A. So your question is some hypothetical analysis that I didn't do, would that affect my opinion? I would have to see what the analysis is. Some hypothetical model using daily prices for a asset pricing model. I mean, I -- one other thing I would say is I do describe in my report the frequency of data that is used for these factor models.

So, anyway, your hypothetical's about a hypothetical analysis. I would need to take a look and think about it.

Q. Would it be possible to run your factor model as described in your report using daily pricing data?

MR. KELLOGG: Objection.

A. Yes, you could do that, I assume. Again, I would be worried about the consistency of such approach with the academic literature that I cite about the frequency of the data used in these

factor models. The monthly or the weekly is basically what you see. So I cite to those asset pricing model papers about the frequency of the data.

But, again, for some hypothetical analysis that I haven't done, what do I think about it? I guess I would want to see it.

Q. Are there academic papers that you cite in your report that do -- sorry, strike that.

Are there academic papers that you cite in your report regarding cryptocurrency returns that do use daily pricing data?

A. Yes. I mean, I think, you know, I cite to one of Dr. [redacted] papers where he uses higher frequency data, I think for different purposes than what I'm concerned with. You know, I'm concerned with the long-run time series for the returns. I believe in that particular paper he was more motivated by looking at trading types.

So, yes, some of the academic papers use a different frequency of data, you know, given the research question that they were interested in.

Q. Why did you elect not to run your model on daily price data for purposes of your opinion?

A. Because --

MR. KELLOGG: Objection.

A. -- the academic papers I cite -- and this is when I've done my own academic work with factor models -- is -- is -- is monthly return data is what you see. I know that, you know, some of the papers I cite also use weekly, but I'm looking over a seven-year period.

So my view is that the monthly -- I'm rounding here from the 28 days -- is consistent with the asset pricing model literature.

Q. When you've used factor models in your own academic work, have you also used a 28-day interval?

A. No, because I've never -- I've never run a factor model in my academic work on -- on crypto, which has these unique features; you know, this -- this feature in the data that you have these day -- these strong day-of-the-week effects.

Q. Let's turn to paragraph 20 -- sorry, strike that.

Let's turn to paragraph 92 of your opening report, page 41.

A. Okay.

Q. The first sentence of paragraph 92 is "There is no consensus in the literature on the

nature or the number of factors that should be used."

Do you see that?

A. I do.

Q. Is it fair to say, then, that it was your own judgment as to which factors would be appropriate to determine the factors that you used in your analysis?

MR. KELLOGG: Objection.

A. No, I don't agree with that -- that -- that characterization. I use an absolutely standard technique, a technique that's been used in asset pricing model literature to construct the factors. So it wasn't a subjective decision. I'm using well-established techniques -- well-established techniques used in the asset pricing model literature to construct the factors.

Q. What academic articles did you rely on in support of your selection of factors for your factor model?

A. Well, I -- I have a number of academic citations in my -- in my report, including academic citations where the PCA analysis is used.

As I said before, I'm also drawing on my general experience as an academic economist and my

general knowledge of the asset pricing model literature, as well as the academic cites that I provide.

Q. How is it --

THE WITNESS: Am I speaking too quickly?

THE REPORTER: Yes.

THE WITNESS: I'll -- I'll slow down.

THE REPORTER: Thank you.

BY MR. SYLVESTER:

Q. How is it that you were able to draw from the literature for assistance with selecting factors given that there's no consensus as to the nature or number of factors in the literature?

MR. KELLOGG: Objection.

A. I think you're mischaracterizing that sentence because what -- the sentences that follow in that paragraph, paragraph 92, you know, are referencing sort of off-the-shelf factors. So for CAPM you have a market index. Often people use the S&P 500. For Fama-French you can go to Ken French's website, you can pull the Fama-French factors. So these are established indices in that space.

So what the sentence is really saying is there's -- there's no such established indices in the sense that you have it for CAPM and for Fama-French in the equity space. That's not to say that there isn't a relevant academic literature. That relevant academic literature is both the use of the PCA as a -- as a well-known statistical technique, the use of PCA in the context of asset pricing models, and the use of factor models more generally in this space.

Q. Okay. So even though, according to your report, there's no consensus in the literature on the nature and number of factors that should be used, you would say, nevertheless, the methodology that you applied here is informed by that academic literature?

MR. KELLOGG: Objection.

A. Don't agree with that. I -- I'm drawing from the academic literature. It's grounded in the academic literature. It reflects the academic literature: The academic literature on the PCA, the -- the academic literature where PCAs are used in asset pricing models, the academic literature on factor models.

Q. Why did you use a PCA for determining

factors that affect digital asset returns instead of constructing a market index?

MR. KELLOGG: Objection.

A. Well, again, I mean, you could -- I mean, I guess I'd just go back to my report, which is there's no established market index for crypto over this time period; that is to say, 2013 to 2020. There is a well-established technique in the academic literature for constructing factors and that is -- that is the PCA. And that's consistent and reflective and grounded in the academic literature.

Q. If you had wanted to construct a market index for digital assets, could you have done so?

MR. KELLOGG: Objection.

A. So I'm not aware -- I guess I would just stick with what I say in my report, that my -- my view of the literature is there's no consensus as there is in the CAPM or Fama-French of an off-the-shelf factor to use. There is a consensus that the PCA is -- is an appropriate technique to construct factors and -- and that's what I do.

Q. Setting aside consensus, which I understand, just from a layperson's perspective, if you had wanted to construct a market index as

an economist for these other digital assets, is that something you would have been capable of doing?

MR. KELLOGG: Objection.

A. I don't even know what a market index would mean in that context. So we're talking about 2013, where we have the very beginning of crypto assets. We have a lot of coins added later. Again, I don't know what the point of that exercise would be if there's -- you know, if that exercise that you're contemplating is not grounded in the academic literature.

Q. Are you aware of any academic literature in which the authors construct a market index for cryptocurrencies?

A. So there are papers that I talk about that do construct factors for later time periods in various ways including using PCA. I'm not aware of a consensus in the literature for a market index over this time period in the way that you do for CAPM and Fama-French.

Q. Setting aside whether there's a consensus, are you aware of any academic papers in which the authors construct a market index for cryptocurrencies?

MR. KELLOGG: Objection.

A. You would have to direct me to the paper. I'm sure that folks have looked at the market generally for crypto. I'm not aware of an established market index for this time period in the way that you do for CAPM and Fama-French. So that's my view of the literature.

Q. Okay. So just for clarity of the record, sitting here today, you can't think of any academic articles in which the authors construct a market index for cryptocurrencies?

MR. KELLOGG: Objection.

A. I'm not saying that. So I'm sure that there's papers that look at market effects of crypto. You know, I have some citations here in my -- I'm trying to find it now.

So, yeah, that's not a fair characterization. There's certainly papers that look at the general market for crypto assets. If you want to call that a market index or not, I don't know. But, again, I would just revert to my earlier characterization of the literature.

Q. What is the -- strike that.

Is the PCA a commonly accepted methodology for identifying factors for an asset

pricing model?

A. Yes.

Q. Did you cite any sources in your report that use a PCA to identify factors for an asset pricing model?

A. So I know this is not a memory test. I believe I do cite such papers. I believe the Hu paper, is my best memory, does a PCA in the asset pricing model. But I do believe I do cite studies and -- let me just see here.

And I will also say, drawing on my general experience as an academic economist, that PCAs are used in the asset pricing model literature. There's nothing unusual or novel or surprising about that.

Q. Is it true that when conducting a PCA, a researcher typically tries to understand what the components mean?

MR. KELLOGG: Objection.

A. Well, I discuss this in my report. I mean, the components -- the meaning of the component is -- is informed by what the PCA analysis is doing. So I guess I would reference our earlier discussion about what the PCA component is reflecting.

Q. Does your report provide any economic interpretation between any particular principal component and the cryptocurrency market?

A. Well, the -- the PCA is extracting the information from the general non-XRP cryptocurrency markets and -- and their price movements and price properties.

Let me just pause here and see if there's anything I want to add to that.

Yeah, and I would also reference paragraph 93 where I talked about this in a little more detail.

Oh, and then paragraph 94 I mention the Hu paper that uses PCA. I mention the Liu paper.

So, again, I think I would go back to my report and answer some of these questions.

Q. Is it fair to say that in your analysis you observed the relationship between Principal Component 1 and XRP?

A. No. I -- in my analysis I believe for the -- if we can just turn to my Exhibit 3, I have four principal components using the BIC criteria for Estimation Period 1 and I have 11 for the second period.

Q. Okay. Can you tell me what the BIC

criteria is?

A. Well, I have the formula in the footnote. I don't have the formula memorized. But it's the Bayesian information criteria. So it's a well-established criteria for how many variables, independent variables, that you add to the model. And then it tells you whether you should -- you know, in my situation, whether you should have three or four or five or -- or so forth.

So it's a criteria that penalizes you for adding a variable, but also you get the benefit of more explanatory power, generally speaking. So the formula for the BIC -- and I'm just going to take a moment to find it in my report because I do have a footnote on it. Give me a second here. It's Footnote 171.

Q. I see.

So Footnote 171 sets forth the Bayesian information criterion equation, is that right?

A. Yes.

Q. Okay. And the -- that's referred to in Footnote 4 of your Exhibit 3 as the BIC criteria?

A. Let me just confirm that -- the footnote. Just give me one second. Yes, that is

correct.

Q. Why did you use the BIC criteria in selecting your number of principal components as reflected on Exhibit 3?

A. Well, the BIC is an objective criteria for how many components you're going to have. So do you include one? Do you include three? Do you include seven? I don't want to have a subjective judgment as to the number of BIC princ -- the number of principal components. The BIC is a well-established criteria for answering that question that's been used in the academic literature.

So, for example, at the end of paragraph -- I'm sorry, at the end of Footnote 171, you know, I cite to a Journal of Financial Economics paper that uses BIC for their P -- PCA.

Q. Is it -- is it in your view important to use objective criteria for determining how many components you need to have?

MR. KELLOGG: Objection.

A. Well, my view is -- I would -- I would have my view be more granular than that; is that the BIC is a well-established criteria for deciding the number of components to use.

Q. And for your purposes in forming your expert opinion, was it important to you to use a methodology that employed objective criteria in determining your -- the number of components to use?

MR. KELLOGG: Objection.

A. Again, the way I would frame it is this is a well-established criteria in the literature that I'm using. So I wanted to ground my selection criteria in the academic literature, which is what this does. So that -- I would describe the motivation in those terms.

Q. Okay. Can we turn to Exhibit 5 of your AF-1?

A. Exhibit 5?

Q. Yes.

A. Give me one second here.

Q. Exhibit 5 is labeled "Regression of XRP Returns on Returns of Largest Market-Cap Coins."

Do you see that?

A. Yes.

Q. I don't see in the footnotes any reference to the BIC criteria.

Did you employ the BIC criteria in making your selections for the components of

Exhibit 5?

A. No, the --

MR. KELLOGG: Objection.

A. The selection criteria here is largest market cap coins. And, again, as I explain in my report, the purpose of Exhibit 5 is just as a robustness check on the PCA and -- and, also, unlike a PCA principal components analysis, you know, which is this implied weighting across crypto assets, you know, Exhibit 5 enables the reader to actually see individual crypto assets.

So, again, it's by way of another, you know -- by way of, you know, moving from the PCA just so that you have individual crypto assets on the right-hand side. But the selection criteria was the largest as, again, as a robustness check on my -- you know, as a -- one additional analysis to my principal analysis that uses the PCA.

Q. Did -- did you attempt to use the BIC criteria to engage in your selection process with respect to Exhibit 5?

MR. KELLOGG: Objection.

A. I've already answered the question.

Q. That's a no then?

A. I told you the selection criteria for

Exhibit 5.

Q. And that did not include the BIC criteria, is that right?

A. That's correct. I chose -- the selection criteria is the largest market cap coins. The coins that were the largest in this time period. So that was the selection criteria for Exhibit 5 and -- and the results -- and the results have been reported there.

Q. Turning back to your Exhibit 3.

A. Yes.

Q. As I understand your analysis, you did observe some relationship between the principal components in your model and XRP, is that right?

A. For some of the principal components.

Q. Okay. For the principal components for which you observed the relationship between those principal components and XRP, what's the -- what's the economic intuition behind that relationship in your view?

MR. KELLOGG: Objection.

A. What I would say is there's a statistical association between the information impounded in that -- that principal component and XRP price returns.

Q. Do you provide any economic interpretation of that statistical association?

MR. KELLOGG: Objection.

A. Sure. That's what I talk about in my report.

Q. Can you point to me in your report where you provide an economic interpretation for the statistical association between certain of your PCs and XRP price returns?

MR. KELLOGG: Objection.

A. Well, I would just refer to my discussion in part 3 where I talk about movements in the noncryptocurrency markets, so the non-XRP cryptocurrency markets, and the relationship to XRP price return data and the meaning of the excess returns.

So, again, that is reflected in this full discussion in Part III.

Q. You say Part III.

Do you have a specific section that you're looking at when you refer me to Part III?

A. Well, I would refer you to III.C and III.D, where I talk about the factor model and what it's doing and what the meaning is. So I would just reference my report for that

discussion.

Q. Let me try to put the question in plainer English that I might understand better.

In your report do you express any opinion or explanation as to why there's a statistically significant correlation between some of your PCs and XRP price returns?

MR. KELLOGG: Objection.

A. So, again, the -- what I'm focused on -- I mean, obviously, I'm building this model -- is, is there excess returns for XRP? Is there positive excess returns for XRP above and beyond what -- the general price movements in the non-XRP cryptocurrency markets? That information in those markets is embedded into the PCA -- or into the principal components that are used on the right-hand side of the equation.

Q. If I'm understanding your answer correctly, it wasn't part of your project to examine the question of why there was any relationship between certain of your principal components and XRP price returns, is that right?

MR. KELLOGG: Objection.

A. I don't agree with that. I mean, I'm -- I'm -- I'm addressing the empirical question of

what is the relationship between XRP and the more general cryptocurrency markets? That's the empirical question that I'm addressing. I didn't know the answer to that before doing the analysis, it's an empirical question, but that is -- that is the question that in part is being addressed here.

Q. And it's fair to say as a result of your analysis, you -- you did observe a relationship between XRP price returns and the returns of other digital assets?

MR. KELLOGG: Objection.

A. Well, again, I would reference Exhibit 3 -- Exhibit 4 -- I'm sorry, Exhibit 3 is just the -- Exhibit 4 is just the list. But, yeah, I would go back -- if we're talking about the factor model, I would go back to, you know, the exhibits that report the outcome of that -- of that analysis.

Q. And did you make any attempt in your report to explain why you observed the relationship that you observed between XRP price returns and the returns of other digital assets?

MR. KELLOGG: Objection; asked and answered.

A. Yeah, I would just frame my inquiry the way I did before, which is it's an empirical question about the relationship between XRP and the broader market of crypto assets and I'm observing that empirical relationship in the way that you would do in any asset pricing model. So it's a very standard type of analysis that you would do when you're thinking about that sort of empirical question.

Q. In economics literature, if a -- if an author observes a price correlation, is it typical that the author provide some possible economic explanation for that correlation?

MR. KELLOGG: Objection.

A. You're speaking at a very high level. I would want to look at the paper, what the research question is, in order to answer that.

Q. It is a high-level question and it's broad, but I'm asking you as someone who knows the economics literature. In the economics literature -- instead of typical, let's say common.

In the economics literature, is it common if an author observes a price correlation that the author provide some possible explanation

for that correlation?

MR. KELLOGG: Objection.

A. Again, it really depends on what the research question is. You know, in an asset pricing model, typically what you're interested in is the empirics: What are the relationships?

But, again, what questions are going to be answered in an academic paper obviously is a function of what is the research question at issue.

Q. Let's look at Exhibit 7 to your report, AF-1. So exhibit 7 is labeled "Regression of XRP Returns on Principal Components of Other Cryptocurrencies and Returns of Other Assets."

Do you see that?

A. I do.

Q. Okay. There's a column on Exhibit 7 that says "Cryptocurrency and S&P 500."

Do you see that?

A. Yes.

Q. The third entry down in that column is negative 0.001 asterisk.

Do you see that?

A. I do.

Q. Okay. What does negative 0.001 asterisk

tell us in this chart?

A. It tells us that there's a statistically significant relationship between Principal Component 1 and XRP price returns.

Q. Okay. Going down that same column, cryptocurrency and S&P 500, if you go down to the row that says "S&P 500 Return," I see an entry of 0.398.

Do you see that?

A. I do.

Q. Okay. What does the 0.398 tell us?

A. Well, this -- this is telling us that there's not a statistically significant relationship in this specification between the S&P 500 and the returns of XRP.

Q. Can you interpret Exhibit 7 to say that if the S&P 500 changes by 1 percent, then the XRP return would change by .398 percent?

MR. KELLOGG: Objection.

A. I would not say that because that point estimate is not statistically significant.

Q. When you say "that point estimate," which number are you referring to?

A. I'm referring to 0.398.

Q. Do you agree with the general maxim that

correlation does not equal causation?

MR. KELLOGG: Objection.

A. Yes.

Q. Do you interpret the results of your analysis, as set forth in Section III.C of your report, to establish correlation between XRP price returns and the price returns of certain other digital assets?

MR. KELLOGG: Objection.

A. The way I would frame it is XRP moves in relation to the general cryptocurrency market as reflected in -- in my statistical analysis.

Q. Is there a distinction between the answer that you just provided and correlation conceptually?

MR. KELLOGG: Objection.

A. You know, maybe this is a nitpick, but the betas typically are, you know -- correlate, you know -- you know, it's a correlation divided by some form of volatility in the market. But I agree with the proposition that what I'm showing consistent with the asset pricing model literature is the XRP returns do move in relation to the general cryptocurrency markets. There is a statistically significant association.

Q. Okay. Do you interpret the results of your analysis set forth in III.C to establish any causal relationship between XRP price returns and the price returns of certain other digital assets?

A. What I would say is what I say in my report, which is the price returns -- that there's no XRP specific price returns above and beyond the statistically significant associations with generalized cryptocurrency market price movements.

Q. Let's go back to paragraph 100 of your report, which is on page 47.

A. Yes.

Q. What does the word -- I'll just read it for the record so we're clear.

"In summary, my empirical analyses show that the variation in long-run price return of XRP can be explained by exogenous, non-XRP, cryptocurrency price returns or, put differently, by factors outside Ripple's control."

Do you see that?

A. I do.

Q. Okay. What does the word "exogenous" mean in that sentence?

A. It means I'm looking at crypto assets other than XRP.

Q. Okay. What steps did you take, if any, to verify that non-XRP cryptocurrency returns were, in fact, exogenous of XRP returns?

A. Well, I --

MR. KELLOGG: Objection.

A. Again, I just told you the definition that I'm using here, which is I'm looking at non-XRP price returns in the data. I'm looking at the general movements, whether it be the 9 or the 91, the general movements as captured by the principal component analysis in those markets. The markets excluding XRP.

Q. Did you perform any analysis to check whether the non-XRP cryptocurrency returns that you examined were affected by changes in XRP price returns?

MR. KELLOGG: Objection.

A. The analysis I did is reflected in the report, which is, are there statistical associations over this time period, the seven years or the five years, between generalized non-XRP crypto market price return behavior and XRP? That's -- that's the analysis that I did.

Q. Is it possible that there is a statistically significant association between XRP

returns and the other digital asset returns that you looked at because XRP affects the prices of those other digital assets?

MR. KELLOGG: Objection.

A. I have not seen any theory or -- economic theory articulated to that effect in this litigation, so I'm not aware of such a claim. But, again, all I can do is reiterate, you know, in response to your question, what I did, which is statistical associations between generalized movements in the cryptocurrency markets, you know, across these 91 tokens or across the 9 tokens and movements in XRP.

Q. Did you undertake any analysis to rule out the possibility that XRP price -- price movements affect the price movements of the other digital assets that you looked at?

MR. KELLOGG: Objection; asked and answered.

A. Yeah. So I'll just repeat what I did in my analysis, which is, what are the statistical associations between generalized non-XRP crypto markets and movements in the XRP price; and, furthermore, are there XRP price returns above and beyond what -- what the statistical associations

would indicate in terms of the movement of XRP price?

Q. So is it fair to say, sitting here today, that you don't have an opinion about whether XRP moved the prices of other digital assets or other digital assets moved the price of XRP?

MR. KELLOGG: Objection.

A. So, again, I'll just reiterate the analysis I did do, which is the statistical associations between generalized market movements and XRP in just the same way that academics have done it in all sorts of contexts, including public equities.

Q. Are you offering an opinion in this case that the price movements in other digital assets caused the price movements in XRP?

A. I wouldn't frame it that way. I would say there's a statistically significant association between these generalized price movements and price movements in XRP consistent with the asset pricing model literature.

Q. Are you offering an opinion in this case that the price movements in XRP caused the price movements in other digital assets?

A. I never say that in my report. Again, I can reiterate what I did, which is, you know, I did an asset pricing model, which is an exercise that's commonly done in the academic literature, looking at the statistical associations between this particular asset, XRP, and more generalized market movements as represented by the 91 tokens or crypto assets and the 9 -- or the 9 for the -- for the longer time period.

Q. Was it part of your assignment in this case to determine whether, or if, XRP price movements moved the prices of other digital assets?

MR. KELLOGG: Objection.

A. So, again, the work that I did and the analysis I did is contained in my reports. And, again, I'm happy to reiterate what I did in the factor model, which is to test whether there's an XRP specific price movement above and beyond what you would otherwise expect given the statistical associations in terms of generalized non-XRP crypto market price movements.

Q. So I think that means you were not asked to determine whether or not there was a causal relationship between the movements in XRP prices

on the one hand and the movements in digital asset prices on the other hand?

MR. KELLOGG: Objection; asked and answered.

A. So that's not -- those words are not in my assignment. My assignment and what I did is what I just described. So, again, I would be happy to state what I did, but, you know, just sort of the way I would summarize it is I used, consistent or reflective of the asset pricing model literature, an asset pricing model here to explore as whether, as a statistical matter, there's XRP price returns above and beyond what these statistical associations would tend to indicate would happen or would, you know -- or the statistical associations reflecting this -- reflecting the results of the factor model.

Q. Let's look at paragraph 102 of your report, which is on page 48.

A. Page 48?

Q. Yes.

The first sentence of 102 states "The factor models and the corresponding results I present in Exhibits 3 through 7 allow me to examine whether, on average, there are additional

XRP price returns after controlling for other non-XRP cryptocurrency market factors."

Do you see that?

A. I do.

Q. Okay. When you refer to "controlling for other non-XRP cryptocurrency market factors," do you mean the use of your PCA?

A. Well, I believe some of those exhibits is just running it on the individual crypto assets that we discussed earlier, but I'm definitely referring to including here the factor models: That is to say, Estimation Period 1, Estimation Period 2., the factor models supplemented by these additional indices such as the S&P 500, as well as -- you know, obviously I also had the distributions analysis, too, although I don't -- let me just -- give me one moment here. Let me just refresh my recollection.

So Exhibit 3 is the PCA; exhibit 6 is for the full time period; and Exhibit 7 is -- is for the five-year period. Let me just -- give me a second here.

Yeah. So the -- the distribution analysis is not in Exhibits 3 through 7. That comes later.

Q. Okay. Did you check to see if your principal components explain the price returns of other digital assets other than XRP?

A. No. That was not -- that was not relevant to the asset pricing model inquiry. I'm constructing an asset pricing model for XRP.

Q. Why did you not include other factors besides other digital assets in your construction of your PCA?

A. Well, I explored that possibility, so I have these exhibits. I'll turn to Exhibit 7. I do explore other factors, sort of standard indices that we were talking about earlier: The S&P 500, the MSC -- MCSI World Index, the Emerging Market Index, the Commodity Index, the gold return, the U.S. dollar, the Japanese yen.

So I -- I do explore some standard indices as well, and consistent with the academic literature, these are not statistically significant.

Q. Did you include, for instance, the S&P 500 in the construction of your principal components?

A. Well, I view Exhibit 7 as part of the work that I did here.

Q. Understood, but I'm asking a specific question about how you constructed your principal components.

Did you include the S&P 500 return within your construction of the principal components?

A. Oh, I misunderstood your question.

No, the principal components, whether it's one, two, three or four, whatever the principal component is, is -- is capturing the information from other crypto assets.

Q. And -- and why was it that you opted not to include, for example, the S&P 500 in your principal components construction?

A. Well, because I -- what I wanted to do -- there's a couple of different questions. One question in my asset pricing model is, do -- the -- the first logical question is, do other crypto assets, like bitcoin, like Ether and so forth -- whether other crypto assets have an association, a statistical association, with XRP returns. And for that, given the lack of a market -- an academic consensus on market indices over this time period, I used the PCA.

So the first logical question is to --

to address that relationship. For the S&P 500, there's an index that we all know that's used commonly in the literature. And I just entered that into the equation on the right-hand side once I had captured the information in the non-XRP cryptocurrencies.

Q. If in constructing your principal components you're attempting to find the best factors to explain XRP price returns, why not include the S&P 500 returns?

MR. KELLOGG: Objection.

A. Okay. So that's a little bit of a misstatement of my approach. My approach was, obviously, in exploring XRP returns, one needs to incorporate what's happening in the general cryptocurrency markets. Just as a -- that's obvious. And so the PCA analysis is the way, consistent with the asset pricing model literature, that I do that.

With the S&P 500, there's an index that we -- we don't have to do a PCA. There's an index that's readily available, widely used. And, so, once I captured the non-XRP cryptocurrency markets, I then entered the S&P 500.

So the PCA is about constructing

components for the non-XRP cryptocurrency markets. That's the point of the exercise.

Q. So in your view in constructing your principal components, there were not any other factors that would be of relevance other than the prices of certain other digital assets?

MR. KELLOGG: Objection.

A. So certainly it could be the case the S&P 500 matters. That's why I test it. Again, consistent with the academic literature, it's not statistically significant. But, again, I needed to be able to test the relationship between XRP and these crypto -- more general non-XRP crypto markets. And so consistent with the academic literature, I used PCA for that question.

Q. Did you perform any sensitivity checks for your PCA results using different sets of digital assets?

A. I used -- well, I used two different sets of digital assets: The 9 for the full period and the 91 for the second period.

The -- so I used all the tokens that I could subject to the selection criteria that I -- I have in my report; you know, i.e., for -- or, for example, I have price return data for those

tokens. And then I allowed the PCA to tell me what's important and what's not.

Q. And -- sorry.

A. So, again, the way I view my exercise is I looked at the tokens that -- for which I had the available data for the seven-year period and then allowed the PCA to tell me what's important in that -- in that universe.

Q. Other than what you just described, did you perform any additional sensitivity checks for your PCA results using different sets of digital assets?

A. I used all the digital assets that I could for the first estimation period and for the second.

Now, I do want to add for the second I did have a minimum market cap criteria. I think it's reflected in the report. But I allowed the PCA to tell me what was important in the universe of tokens that I had available to me.

Q. Let me turn your attention to Footnote 162 on page 42.

A. Give me one second. 162?

Q. Yes.

A. Yes.

Q. This is the market cap criteria that you just referenced?

A. Correct.

Q. Okay. Is it possible that at some point during your period the market cap for an included digital asset could have dipped lower than $100,000?

MR. KELLOGG: Objection.

A. It's possible.

Q. Okay.

A. I don't know if that happened, but it's possible. I don't know offhand -- let me take another -- I don't know offhand that that happened. The criteria here, in Footnote 162, is at least 100,000 in either August or December.

Q. Do you know -- strike that.

In Footnote 4 to your Exhibit 4 --

A. Wait. Wait one second.

Q. Sure.

A. Exhibit 4?

Q. Yes.

A. Exhibit 4. Okay.

Q. You state "XRP market cap on August 11th, 2015 was $274 million."

Do you see that?

A. I do.

Q. Okay. And do you know offhand what XRP's market cap was by December 2020?

A. I don't know offhand.

Q. I think it is in --

A. I think it's in the complaint, but I don't remember offhand.

Q. Let's go to page C-3 of your Appendix C.

A. Where should I go?

Q. Paragraph 6.

A. Of Appendix?

Q. Let me make sure I have the label right.

Yeah, Appendix C, page C-3, paragraph 6 of that appendix.

A. Let me just take a look.

MR. KELLOGG: Mark, can you clarify where we are?

MR. SYLVESTER: Sure.

Q. Professor, do you see where we are?

A. I'm at paragraph 6 at C-3.

Q. Okay. I just want to make sure the copies are right.

MR. SYLVESTER: Yeah, we're at page -- page C-3 of Appendix C.

MR. KELLOGG: Okay. Got it.

MR. SYLVESTER: Okay.

BY MR. SYLVESTER:

Q. So paragraph 6, the -- the last sentence on page C-3 says "For comparison, on those two days, XRP market capitalization far exceeded that cutoff and was $260 million and $23 billion, respectively."

Do you see that?

A. I do.

Q. And I read that $23 billion figure to correspond to December 21st, 2020.

Do you read that the same way?

A. Yes.

Q. Okay. Was it important to your analysis of the relationship between XRP price returns and other digital asset price returns to understand the market caps of XRP and those other digital assets?

MR. KELLOGG: Objection.

A. Well, I certainly report the market cap. I certainly report regressions on the highest market cap coins in Exhibit 5. So I certainly do work on that.

For purposes of the PCA, the PCA will extract the information in the most efficient way

from the entire universe of -- of the tokens regardless of their -- you know, regardless of whether it's 100 million or 300 million or what have you.

Q. In your view, is it -- is it at all likely that a digital asset with a market cap of $100,000 would have an impact on the price of XRP when it has a market cap in the hundreds of millions of dollars?

MR. KELLOGG: Objection.

A. I don't think that's a -- I don't think that -- I think you're miss -- I think your question misunderstands the point of an asset pricing model, which is we have movements, price movements, in the general market. Maybe they're small cap; maybe they're large cap. And the question is, is there a statistically significant association with those movements? And in this instance, XRP.

So I don't think there's anything in the asset pricing model methodology that would exclude the possibility that smaller cap coins have some informational content. Obviously, I employed 100,000 as sort of the minimum, but I don't -- I would not for the purposes of the PCA rank them in

terms of whether they have 200 million or 400 million or something else.

Now, obviously, in Exhibit 5, I do run -- I do run the regression on the largest market cap coins, but that's -- that's not the factor model.

Q. Is there any academic literature that you can think of with respect to cryptocurrency asset prices that uses a minimum $100,000 market cap for inclusion in the model?

MR. KELLOGG: Objection.

A. So I cite in the footnote -- not 100,000, it's a -- it's a different time period for different coins -- that a threshold is being used in their analysis.

Q. What footnote are you looking at, Professor?

A. So Footnote 8.

Q. On C-3?

A. On C-3. So I say "My decision to restrict the sample based on market cap is also supported by the academic literature. See, for example, Liu, 2021, who restricts the coins in their sample to those with a market cap over a million." Journal of Finance.

Q. Why was it that you decided to use $100,000 instead of a million dollars for your model?

A. Right. I wanted to be -- I wanted to make sure that I allowed the PCA to -- to potentially incorporate information on a wide range of coins. It's not that -- and those coins -- you know, the crypto assets' price movements might have a statistical relationship even if they're 200,000 or 500,000 with -- with XRP price returns.

So I used the lower threshold and, hence -- hence, used a larger universe of coins than would otherwise be the case, particularly in -- anyway, particularly in these earlier periods.

Q. And what was the advantage in your view of using that lower threshold?

MR. KELLOGG: Objection.

A. Well, I wanted to allow the PCA to tell me for universal coins for which I had pricing data, you know, to extract that information from -- from the covariance matrix. And then it's an empirical question whether the information so extracted has a statistically significant association.

So if the coins, if the crypto assets that are being analyzed by the PCA, are uninformative about XRP price returns, they're uninformative because I used $100,000 threshold, for instance, then the statistical analysis would tell us that, you know.

So as I report from my Estimation Period 1 -- and I'll go back to Exhibit 3 -- in fact, you know, I have a 91 percent -- a 92 percent adjusted R-squared and I'm finding statistically significant association.

So the information from the token so defined does have informational content in the asset pricing model about movements of XRP.

Q. When you say it has -- strike that.

You just said the information in -- strike that.

I think you just said that the information in the token model -- sorry. Let me start again. Withdrawn.

What information about XRP price returns is provided by your model as reflected on Exhibit 3?

A. I would just go back to our conversation this morning, our conversation about what a PCA

does. So the P -- the principal component analysis is using this universe of tokens, however that's being defined. By "tokens" I mean crypto assets. Extracting the information from that and seeing -- testing the empirical question about what is the statistical association? And, more specifically, are there excess returns to XRP that are not otherwise explained or accounted for by these statistical associations?

Q. Why was it that you decided to construct two separate estimation periods?

A. I know that Ether is an important -- it was a judgment about Ether that started to be traded at this point. Let me just go to my report here. Give me one second.

Yeah. So Exhibit 4 has the largest coins as of August 11th, 2015. Ether is there. It's the third largest, you know, after bitcoin and Litecoin.

So, again, Ether is an important crypto, not -- I'm not saying for purposes of this litigation, but Ether is well known. That's when it began to trade. Also, starting in 2015, it enables one to use a lot more coins or a lot more crypto assets than 2013.

So the virtue of -- of 2015 is I also have more tokens. And so it's just a robustness check on this 2015 to 2020 period, in particular, utilizing through the PCA more tokens than were available as of 2013. So we move from 9 tokens, 9 crypto assets, to 91, I believe, as of August 2015.

MR. KELLOGG: Mark, is this a good time for a lunch break?

MR. SYLVESTER: I think it is, yes. Let's go off the record.

THE VIDEOGRAPHER: Okay. Thank you. The time is approximately 1:16. We're going off the record.

(Whereupon, a luncheon recess is taken.)

A F T E R N O O N S E S S I O N

THE VIDEOGRAPHER: And the time is approximately 1 -- excuse me, 2:04 p.m. We're back on the record.

MR. KELLOGG: Mark, before you start, can I put one thing on the record?

MR. SYLVESTER: Sure.

MR. KELLOGG: Re our discussion earlier about Allen's compensation agreement with Compass Lexecon.

MR. SYLVESTER: Mm-hmm.

MR. KELLOGG: We've reached out to Compass Lexecon and they would not agree to allow Allen to testify on that. But we're happy to continue working with you to get whatever information about that you -- you need.

MR. SYLVESTER: Okay. Thank you.

BY MR. SYLVESTER:

Q. Professor, let's turn back to Exhibit 5 of your opening report. This is your "Regression

of XRP Returns on Returns" --

A. Yeah. I just -- I just want to find the part in my report where I discuss the exhibit. So just --

Q. Sure. Take your time.

A. -- give me a moment here.

Q. And just for the record, I'll read the title again. Exhibit 5 is the "Regression of XRP Returns on Returns of Largest Market-Cap Coins."

A. Just -- I need a second here.

Okay. I'm there.

Q. Okay. Great.

So turning to Exhibit 5, do you have any explanation as to why some of the coins on Exhibit 5 have a statistically significant positive coefficient and others have a statistically significant negative coefficient? I'm looking at Estimation Period 2.

A. So you want me to look at Estimation Period 2.

Q. Mm-hmm.

A. Well, just -- just to be clear, the coefficient on the bitcoin, the negative 0.661, for instance, is conditional on all the other returns in the right-hand side. So it's not the

coefficient on bitcoin as an independent variable by itself, but conditional on the other returns being included, it's a negative 0.661. So I just wanted to be clear about what the coefficient represents, and it represents that coefficient in conjunction with the other coefficients in the specification.

I'm sorry, could you repeat your question?

Q. Sure.

Again, focusing just on Estimation Period 2, do you have any explanation for why there's a statistically significant positive coefficient for some coins and a statistically significant negative coefficient for other coins?

A. Not beyond what I just said, which is it's conditional or a function of the full specification. And this is just empirically what the model indicates or the regression indicates.

So beyond that I don't have any really further commentary on it.

Q. Okay. Turning to your Exhibit 3 of AF-1, why is it in your view that Estimation

Period 1 and Estimation Period 2 produce such different results as to adjusted R-squared?

A. I don't have a specific reason. I don't -- I could speculate as to why the adjusted R-squares are different, the -- the .94 and the .92, but that's the output of the model. The model -- Estimation Period 1 in the model using just 9 tokens, whereas Estimation Period 2 is using 91. That's the -- that's what the statistics tell us.

Q. Okay. As part of your analysis and steps that you took to prepare your expert opinion, did you take any steps to examine the question of why there was such a divergence between the adjusted R-squared in Periods 1 and Period 2?

MR. KELLOGG: Objection.

A. I think we discussed earlier today the additional work that I did in response to the rebuttal report. So all the analyses that I have done is -- is in -- is covered in these reports and in our morning conversation.

Q. Turn with me to paragraph 98 of your report.

A. Wait one second while I get there.

Q. Yeah. And it's going to be the end of paragraph 98 on page 46. I'm looking at the sentence that says "The adjusted R-squared in Estimation Period 1, which includes a period when the cryptocurrency markets were arguably less mature, exceeds 50 percent." And then "The adjusted R-squared in Estimation Period 2 exceeds 90 percent."

Do you see that?

A. I do.

Q. Is there say relationship between your adjusted R-squared finding for Period 1 and your statement that the cryptocurrency markets were arguably less mature during Period 1?

MR. KELLOGG: Objection.

A. I think I would just leave it as it is in the report, which is just the simple observation that in this additional -- you know, the -- the extended period of Estimation Period 1, which begins in 2013, that the crypto markets were arguably less mature, and then I have the citations for that in Footnote 175.

So I think -- I -- I'm comfortable with the way that that is framed in this paragraph.

Q. How would the market's lack of maturity

during Period 1 impact XRP price during that period, if it would?

A. I don't have a view on that. My view is informed by what the statistics show, whether it be for the full period or for the Estimation Period 2.

Q. Does the lower adjusted R-squared for Estimation Period 1 mean that pre-2015 XRP prices were driven by other factors unrelated to cryptocurrency market factors?

MR. KELLOGG: Objection.

A. So I -- again, I just wouldn't compare Estimation Period 1 to Estimation Period 2 just on terms of adjusted R-squared, which I think is an embedded assumption in your question. You would want to look at what the full model is doing in the two periods, including in the PCAs that are being used.

So I would not just simply compare the adjusted R-squares and -- squared and make some sweeping conclusion about that earlier period.

Q. Setting aside the comparison point, what does the adjusted R-squared figure for Period 1 mean? What does that reflect in --

A. Well, I have a footnote where I cite to

this, so I'm just going to take a moment and flip through my report to find -- to find that.

Q. 174 talks about R-squared. I'm not sure if that's what you're looking for. Footnote 174 I mean.

A. Yes. So that's what I was looking for and it's, again, Footnote 174.

Q. Can you explain to me in layman's terms what an adjusted R-squared figure means and what it tells you?

A. Well, I mean, it's one metric, not the only metric, but one metric for the goodness of fit in terms of explaining the variation of the dependent variable. Here, the dependent variable being the returns of XRP.

Again, adjusted R-squared, whether it's high or low or -- or somewhere in between, is a separate question as to whether there's statistically identifiable excess returns for XRP.

Q. Okay. So what does -- focusing just on Period 1 and the actual value of adjusted R-squared, 0.541, what does that tell you about the model's power to explain for Period 1?

MR. KELLOGG: Objection.

A. The power to explain. I mean, it -- the

adjusted R-squared is the percentage of the variation in the dependent variable for that period. That's what's reflected in the adjusted R-squared. That's a separate question, as I indicated earlier, as to whether there's a statistical association between excess returns for XRP and relative to the non-XRP cryptocurrency markets.

Q. What's the dependent variable for Period 1?

A. If we go to Exhibit 3, period -- Exhibit 3 says in the title "Regression of XRP Price Return on Principal Components of Other Cryptocurrencies."

Q. I think your answer means the dependent variable is XRP price return, is that right?

A. Yes.

Q. Okay. So the adjusted R-squared figure for Period 1 tells us that for Period 1 only, your model explains approximately 54 percent of the variation in XRP price returns?

A. Yes.

MR. KELLOGG: Objection.

A. Yeah. So that -- that is -- the 54 percent is the adjusted R-squared and it is the

percentage of the variation in the dependent variable for that model for that period.

Q. Okay. Given that, as I understand it, the adjusted R-squared figure for Period 1 tells us that your model explains 54 percent of the variation in XRP price return, did you take any steps to check to see if any other factors contributed to XRP price return changes during Period 1?

MR. KELLOGG: Objection.

A. Well, I -- I did do the work that we discussed earlier. I mean, I did the regressions in Exhibit 5, which is just the crypto -- the cryptos themselves. I do the work in Exhibit 7, where I explore -- well, this is for the later period. I explore different returns -- actually, I wanted to reference Exhibit 6, where I do additional work for other potential explanatory factors: The S&P 500, the emerging market, commodities, gold, U.S. dollars, yen, euro.

So I do do a -- further explore -- you know, further work to think about factors that might be affecting XRP. And, again, these results, the results reflected in Exhibit 6, are consistent with the econom -- academic literature.

Q. And as I'm reading the results in Exhibit 6, the model doesn't predict any more than the approximately 54 percent of XRP return variations than the model reflected in Exhibit 3, is that right?

A. Yes. The adjusted R-squares at the bottom of Exhibit 6 range from 53 to 54 percent. I'm rounding here. But, you know, what's important really in this exhibit is whether or not the S&P 500 return, the emerging market, the commodities, and so forth, whether they enter into the equation with statistically significant or not.

So my conclusion that the S&P 500 return, for example, you know, doesn't have the statistical relationship with XRP price return is not a function of the adjusted R-squared; rather, it's a function of the fact that the point estimate, which is negative 0.629, is not statistically significant.

Q. Given that for Period 1, your model explains approximately 54 percent of the variation of XRP's price return, did you take any steps to determine whether or not Ripple's actions explained any of the remaining unexplained

variation in XRP price return?

MR. KELLOGG: Objection.

A. Yes, I did.

Q. And what were those steps?

A. The alpha. The constant term. So I want to be very clear about this. The -- the constant -- I'm also referring to that as alpha. They're -- they're used interchangeably. So in Exhibit 6 it says "constant." That's the same thing as alpha.

Alpha represents whether or not relative to -- now here I'm looking at the first column, the "cryptocurrency factors" column -- whether relative to the cryptocurrency markets there is an XRP specific price return above and beyond what the statistical associations would lead you to expect. So that alpha is not statistically significant in all these permutations or specifications.

And, again, the theory in the complaint is that Ripple took various efforts, distributions, and statements and so forth -- I'm not going to reproduce the complaint here -- that over this time period, this seven-year period, resulted or was associated with XRP price

increasing.

And that's a testable proposition and that would be reflected in the alpha. The alpha represents excess XRP returns. Excess relative to the cryptocurrency market. And, again, there's no statistical association.

Q. Are you aware that in 2017 XRP prices increased dramatically?

MR. KELLOGG: Objection.

A. That -- that might well be right. I don't have a specific recollection.

Q. Okay. Did you consider constructing estimation periods before and after 2017 when XRP prices were very different?

MR. KELLOGG: Objection.

A. Well, you know, turning to Dr. [redacted] as we discussed this morning, he has a great point, I believe -- just give me one second here. I'm going to need a second.

Well, my understanding of Dr. [redacted] in his Figure 17 is that he uses as a break point not 2017 as your -- as your question poses, but, rather, he uses the bit -- the BitLicense, which I believe, given his Footnote 47 on page 27 of his rebuttal report, occurred in 2016.

And as I mentioned earlier today, all his alphas -- not the change in alpha, but all his alphas -- using that as a break point, all the post-BitLicense alphas -- which, again, is the middle of 2016 -- are statistically insignificant.

So that would be the most direct response to your question.

Q. Let me ask this question: Did you consider constructing any additional estimation periods beyond the two that you constructed?

A. No. I felt that was adequate given the theory in the complaint which is alleging and identifying events over this seven-year period. As I -- as we discussed this morning, I also looked at Dr. [redacted] specifications which includes alphas for the -- not post-2017, but for the post-2016 period.

Q. Did you conduct your analysis for Period 1 and then conduct your analysis for Period 2 or did you conduct them at the same time or in the reverse order?

A. I don't have a memory of that. I -- I do have a memory very early on of wanting to do the full time period. That was obvious from the beginning. And I also have a memory of wanting to

include Ether as one of the tokens given its prominence.

So my memory is that was my thoughts right from the beginning. I don't remember the exact order.

Q. Why was it that you wanted to include Ether as a token given its prominence?

A. Well, the trading only occurred in 2015, and so I just thought that was another natural break point. Also, as I discuss in my opening report, this is a developing market. It's developing over time. There's more tokens available in 2015. And so I thought that time period would be a useful robustness check on the full seven-year period. So I thought that was helpful to include for those reasons.

Q. Do you know whether your model for Period 2 would produce a similar adjusted R-squared if you excluded or added a few more monthly observations?

MR. KELLOGG: Objection.

A. I'm not -- I'm not sure what you're referring to by -- what -- I don't -- I guess I don't understand the question. What -- what observations are you talking about?

Q. Let me ask a broader question.

Did you check to see how sensitive the adjusted R-squared result was for Period 2 to all of the data inputs that you used?

A. How sensitive the -- I mean, the adjusted R-squared is a measure of the model and the fitness of the model for that time period. So, you know -- and that's the standard statistic to report in tables like this. So -- so I felt that that was consistent with standard academic practice.

If you're referencing -- and I don't know if you are -- Dr. [redacted] discussion in his Figure 3, I'm happy to talk about that. But in terms of my reporting adjusted R-squares, I felt this was -- I -- it is the standard academic practice to do it this way.

Q. Let's look at paragraph 96 of your opening report.

A. Yes.

Q. On page 44 there's a continuation of paragraph 96.

A. I'm sorry, can you say that again?

Q. Sure. Let me rephrase.

If you turn to page 44 --

A. Forty-four.

Q. -- paragraph 96 concludes on page 44, but my question is about the regression equation.

Do you see that?

A. All right. Let me just read the full paragraph. Okay?

Okay. I've reviewed that.

Q. Okay. Is the re -- strike that.

Is the regression equation in paragraph 96 the equation that you used to perform your analysis that's described in Section III.C of your report?

A. Well, it is used in Section III. I do other regressions in Section III as well. So it's in Section III, but there's other regressions in Section III as well.

Q. Fair enough.

Is -- does the equation in paragraph 96 correspond to the regressions that -- the results of which are in Exhibit 3?

A. Yes.

Q. Okay. Looking back at paragraph 96 and looking at the equation in particular, on the right side of the equation there's a lower case "a."

Do you see that?

A. Yes.

Q. That "a" is the alpha, correct?

A. Yes.

Q. Okay. Okay. And reading from the very end of paragraph 96, the alpha is the "remaining average return, after accounting for the exposure to the non-XRP cryptocurrency market factors," is that right?

A. Well, the alpha plus the error term. But the -- you know, so just looking at that equation in paragraph 96, but the error term has a mean zero. But -- but, yes. So that -- the alpha is on the right-hand side of that equation on page 44.

Q. Okay. After the alpha term in the equation on -- in paragraph 96, there's an epsilon "t."

Do you see that?

A. Yes.

Q. What is the epsilon "t" on the right side of the equation?

A. That is the error term.

THE REPORTER: I'm sorry, that is the?

THE WITNESS: The error term.

Q. Okay. And does that epsilon "t" represent the residual return?

A. No. I mean, the residual ter -- I mean, if the -- if you include in the full model the estimated coefficient with alpha, then the epsilon would be -- well, you just -- I guess -- let me restart.

The epsilon would be defined by just moving the alpha to the left-hand side in that equation.

Q. Okay. Let me reask my question in part because I don't understand statistics as well as you.

Is it correct to say that the epsilon "t" is the residual return in the equation?

A. I don't want to use that -- I don't want to -- in terms of the definition of residual, if you include in your calculation of the residual the alpha, the alpha estimate, then definitionally you'll be right. Sometimes people use -- I just want to be clear.

Sometimes people use the phrase "residual return" to not include the alpha. So I think there's a -- semantically people use, in my

experience, the phrase "residual return" in different ways. So I just want to be clear on that.

But the alpha is the excess return on average in the return series. The error term is the error term that you would have in any, you know, kind of a regression.

Q. And when you say "error term," we're talking about epsilon "t," is that right?

A. Yes.

Q. Okay. Do you address the error term anywhere in your report?

A. Well, the error term is just a standard part of any regression. So all the results that I have include, you know, a regression with an error term by definition. You could think about the error term as this bouncing up and down, this volatility of -- that the regression generates when it's generating the coefficients in the model.

Q. What does the error term tell us about the model, if anything?

A. What does it tell us? I mean, it's just part of the -- you know, if we're talking about OLS regression, ordinary least squares regression,

it's part of the model that there's going to be an error term in any given period just by func -- just by function of the fact that you're trying to fit the data into a line or a slope.

Q. Okay. I'm looking for an English translation, if there is one, of -- you know how -- we already discussed the adjusted R-squared. It tells you the percentage in variation of XRP returns that's -- that are explained by the model, right?

A. I do remember that.

Q. Okay. Is there some -- is there some plain English way to explain to me what an -- what this error term tells us about the model?

MR. KELLOGG: Objection; asked and answered.

A. I mean, I don't know what you mean by "tells us about the model." It's part -- like in an ordinary least squares regression, OLS regression, you're going to have an error term associate -- you know, as part of the model. An error term left over, so to speak, after the coefficients. Whether you -- you know, you conclude the alpha in that or not.

Q. Is there any relationship between the

error term and actual XRP returns?

A. I mean, the XRP returns are being regressed on the model that has an error term in it. So the actual XRP price returns are on the left-hand side of the equation. The error term in the regression's on the right-hand side.

Q. Is there any -- other than paragraph 96, is there any paragraph in your report that addresses the error term in your equation?

A. I'm not sure what you mean by "addresses." Everything that I report, whether it's Exhibit 3, any regression that I use and -- and the regression anybody's using, as far as I know, in this case, has an error term in it. So, yes, it is addressed in all my regressions because that's part of the model.

Q. Okay. Let's go to paragraph 102, please.

A. I'm sorry, what was that?

Q. Paragraph 102 on page 48.

So the last sentence in paragraph 102 says "As I explain above, a zero regression constant is consistent with the average monthly Ripple price returns (less the risk-free rate) being explained by the non-XRP cryptocurrency

factors and no remaining average 'excess' XRP price returns that are unexplained by the model."

Do you see that?

A. I do.

Q. Okay. Is the model in that sentence the -- strike that.

What are you referring to when you say "the model" in that sentence?

A. The regression that we were talking -- well, I'm sorry. You know, I would -- the models are -- are what's being referred to in the first sentence of that paragraph. So the first sentence of the paragraph 102 states "The factor models and the corresponding results I present in Exhibits 3 through 7" -- I won't read the full sentence. So that -- that is what is being referenced at the end of that paragraph.

Q. Okay. And I take it from reading paragraph 102 that your conclusion that there are no remaining average excess XRP price returns that are unexplained by the model is based in part on the zero regression constant that's referenced in the last sentence of paragraph 102? Is that right?

MR. KELLOGG: Objection.

A. Zero -- no. That's -- the model -- the regression is what we were talking about earlier in the factor model. The regression that we were talking -- let me just get the actual paragraph.

The regression that we were talking about -- well, one of the regressions being referenced here is the regression in paragraph 96, which does have an error term on the right-hand side, which any OLS -- any regression is going to have. You know, it's going to have this error term in it.

You know, my reference to a zero regression constant is just simply a reference to the fact that the constant, or alpha, if you will, is statistically indistinguishable from zero. I'm not saying that the point estimate in the model is zero. It's, rather, the point estimate for alpha or the constant, it's statistically indistinguishable from zero.

Q. Okay. And the -- just to go back to your Exhibit 3, the point estimate in your models for the alpha for Estimation Period 1 is 0.058 and for Estimation Period 2, negative 0.022, is that right?

A. Yes.

Q. Okay. So when -- when you use the phrase "zero regression constant" in the final sentence of paragraph 102 --

A. Let me just get back to that spot.

Q. Sure.

A. Okay.

Q. When you use the phrase "zero regression constant" in the final sentence of paragraph 102, you are referring, I believe, to your conclusion that the alpha is statistically indistinguishable from zero, is that right?

A. Correct. And I would point you to the immediately prior sentence to that statement. "In other words, one cannot reject the null hypothesis that the constant - the observed average monthly XRP price return after subtracting the risk-free rate - is zero (controlling for non-XRP cryptocurrency market factors)."

Q. Okay. And -- and you reached the conclusion, as expressed at the very end of paragraph 102, that there are "no remaining average 'excess' XRP price returns that are unexplained by the model," correct?

A. Yes. That is to say, there's no excess returns statistically distinguishable from zero.

That is to say, we don't -- one does not observe an extra return that's XRP specific on average for this time period. That is to say, what shows up as statistically significant in the model are the principal components that reflect what's going on in the non-XRP cryptocurrency markets.

Q. Does your conclusion that no remaining average excess XRP price returns remain that are unexplained by the model depend on anything else other than your conclusion that the alpha in your model is statistically indistinguishable from zero?

MR. KELLOGG: Objection.

A. I am working off of the alpha being statistically indistinguishable from zero. But, obviously, to reach that conclusion requires a model; requires, you know, all the work that I did. So I would -- would reference all the work, including Exhibits 3 through 7 that are referenced in the beginning of this paragraph, in -- in thinking about that conclusion.

Q. Is there another result other than -- strike that.

Is there another result obtained from running your model other than the conclusion that

the alpha is statistically indistinguishable from zero that informs your conclusion that there's no remaining average excess XRP price returns unexplained by the model?

MR. KELLOGG: Objection.

A. Well, I have a number of exhibits, not just Exhibit 3, that are -- that generate the same conclusion. That is, there's no statistically -- there's no alpha, there's no constant, that's statistically indistinguishable from zero in those other models. And as we discussed earlier today, Dr. [redacted] alternative specifications also generate the same result.

Q. Just for the record, we've talked about the constant in Exhibit 3. I don't see a constant in Exhibit 4.

A. Well, Exhibit -- Exhibit 4 --

MR. KELLOGG: Objection. Is that a question?

MR. SYLVESTER: I wasn't done, but --

THE WITNESS: Oh, I'm sorry.

BY MR. SYLVESTER:

Q. I'll tell you what. I just -- what I'd like to see -- we were just discussing the concept

that you've concluded that the alpha is statistically insignificant -- lost it.

Can you say it for me again? The alpha is statistically indistinguishable from zero.

A. (Indicating.)

Q. Okay. Great. Which exhibits does that concept show up in appended to your Exhibit 1?

A. Appended to what? Exhibit?

Q. Exhibit 1, yeah.

A. Oh. Well, I mean, you can see that in Exhibit 3. Exhibit 4 is not a regression. It's just a listing of the 20 largest cryptocurrencies. So this is descriptive of that. It's not a regression.

Exhibit 5, this is my regression on the largest MarketCap coins. You see that the alpha or the constant is statistically indistinguishable from zero.

You go to my Exhibit 6 and all the different specifications, that's when I'm adding gold and fiat currencies and what have you, all the constant are, likewise, statistically indistinguishable from zero.

We go to Exhibit 7. Now we're in that second estimation period. And, again, all these

different specifications have the same result; that is to say, the constant -- the alpha is statistically indistinguishable from zero.

Exhibit 10.

Okay. Now we're into Exhibit 11A, which is on page 92. Once again, in this -- I won't walk through it now, but the three specifications I have here, the -- the alpha is statistically indistinguishable from zero.

You go to Exhibit 11B, which is on page 93, that's the second estimation period. Same results: Statistically indistinguishable from zero.

Exhibit 12A, same result.

Exhibit 12B, this is the "Regression of XRP Returns on Ripple XRP distributions - Accounting for Volatility, Estimation Period 2." Statistically indistinguishable from zero.

Exhibit 3 is just -- we're getting into different -- different issues here.

Exhibits 17, 18, 19, 20 are -- and 21 and 22 are the MoneyGram ODL issues.

So I tried to be comprehensive in my answer, but, you know, those are the exhibits that come to mind in terms of answering your question.

Q. Okay. Let's look back at Exhibit 3.

Do you agree, looking at Exhibit 3, that for Period 1 the average monthly return of XRP was 5.8 percent higher than the average monthly return predicted by the principal components in the regression during this period?

A. I don't agree with that in a statistical sense. It's -- there is a point estimate that's positive, but it's statistically indistinguishable from zero. So as a statistician, as an economet -- as a financial economist, and this is -- this would be reflected in standard academic practice, you would view this constant as statistically indistinguishable from zero.

Q. You started your answer with "I don't agree with that in a statistical sense."

Is there any sense in which the answer is different?

MR. KELLOGG: Objection.

A. Well, I agree that there's a point estimate here, which is positive, it's negative in the second period, but you just don't take point estimates. The point of doing statistical analysis is whether this is statistically in the data or not. And as we've been discussing, this

point estimate, as is true for the point estimate in Estimation Period 2, the negative 0.022, is statistically indistinguishable from zero.

Q. Given the regression for Period 1, isn't 5.8 percent the most likely value of alpha?

MR. KELLOGG: Objection.

A. I don't think that follows from the regression at all. So the regression -- the point of doing statistical analysis is whether we can identify on a reliable basis the -- you know, whether a point estimate is statistically distinguishable. Here, we're testing it against the null being zero.

So, again, you know, using -- the point of the statistical analysis is to identify whether an estimate is statistically reliable or statistically present in the data.

Q. Do you base your conclusion that the constant is not statistically distinguishable on the "t" statistics?

A. Well, I ran it on the Huber-White, so there is -- you know, obviously I'm working off of the standard errors to calculate the statistical significance at the 5 percent level.

Q. Do you know how standard errors are

calculated?

A. Yes, but I'm not going to be able to recall off the top of my head.

Q. Okay. Would you agree that, all else equal, if the residuals in the regression were smaller, the estimated standard errors would also be --

THE REPORTER: Repeat.

Q. Would you agree that, all else equal, if the residuals in the regression were smaller, the estimated standard errors would also be smaller?

MR. KELLOGG: Objection.

A. I don't know what you mean by "residuals" in your question.

Q. If -- let me reask that question using the phrase "error term."

Would you agree, all else equal, if the error term in the regression were smaller, the estimated standard errors would also be smaller?

MR. KELLOGG: Objection.

A. Are you -- you're talking about the error term and not the constant in your question?

Q. That's right.

A. Can you repeat the question?

MR. SYLVESTER: Bridget,

would you mind reading that one back?

(Whereupon, the record was read back.)

MR. KELLOGG: Objection.

A. Yeah, I -- I -- I don't want to answer that off the top of my head. I would want to think about that and go back to the formula.

So what I can say is based on the standard errors that I actually calculate, this is -- this is what one finds statistically.

Q. Would you agree that, all else equal, if the error terms in the regression were all zero, the estimated standard errors would also be zero?

MR. KELLOGG: Objection.

A. I want to be careful. I want to think about that. I don't want to answer the application of the standard error formula off the top of my head.

What I can say is based on the standard errors that I actually calculate for this model, it's not statistically significant.

Q. What's the "it" in that sentence?

A. The constant. The alpha. So just to be clear, I calculate the standard errors, the statistical significance, for these various

models, these various specifications that I'm running. And based on those standard errors, the alpha, the constant, is not statistically significant. Not statistically distinguishable from the -- from zero, which is the null hypothesis.

Q. Are you familiar with the concept economically significant?

A. I've heard that phrase.

Q. Okay. What is the difference between something that's economically significant and statistically significant?

MR. KELLOGG: Objection.

A. So the context where I've seen this is somebody finds a statistically significant result -- so they have a point estimate, they find a statistically significant result, and then the question becomes, how big a deal is this?

So we find an effect of X on Y or a statistical association of X on Y. And then the -- and then -- so the person reports the results of their statistical analysis. There is a statistical relationship.

And then the question that one might ask, and sometimes is asked, is, okay, there's an

association here, but is this economically meaningful? Is this something that we should care about or how much should we care about it? So it really goes to the question of magnitude once we are assured that there is a statistical relationship in the data.

Q. Is it possible for a result to be statistically insignificant but economically significant?

MR. KELLOGG: Objection.

A. That is not -- not -- I would need to see the context of where that claim is being made.

Q. What context would you need to answer that question?

A. I'm really not sure what you're talk -- what your question is asking, I guess is what I'm saying.

Q. I'm just talking about the, sort of, conceptual level in economics literature. If there's a difference between economically significant and statistically significant, is there a possible situation where a result is statistically insignificant but economically significant?

MR. KELLOGG: Objection.

A. I mean, that's a very broad statement about all of economics. Again, I would just repeat my earlier answer. The context that occurs to me sitting here about economic significance is really your -- you do data analysis. You find that there's a statistical association, so it's in the data in that sense. And then you can ask, is this economically meaningful or how economically meaningful?

So, again, that's the context that comes to mind, you know, in this -- with regard to this issue.

Q. Let's look back at your Exhibit 3. If you replaced the insignificant .058 constant with zero, would your model still predict XRP returns equally well?

MR. KELLOGG: Objection.

A. So if I ran a different model, what would be the outcome? I would have to run the model. So if -- so as I understand, your question is you -- your question is if I put an a priori restriction on a model, that the intercept term, the constant term, has to be zero, would it do a better or worse job? I don't -- I'd have to think about it. I don't have a view.

Q. Whether it would be better or worse, would it be different than what we're looking at in Exhibit 3?

MR. KELLOGG: Objection.

A. Well, if I understand your question correctly, it would be different in a trivial sense in that, again, if I understand your question correctly, your -- in your hypothetical, you, as an a priori matter, are setting the intercept term, the constant term, to zero.

So that is -- that is different than what I'm doing, which is I'm interested in whether there's alpha to begin with.

Q. Okay. Let -- let's consider a hypothetical. So during a given month, a company announces a new product and, following that announcement, its share price increases by 50 percent that day. Later that month the same company announces it will recall an existing product and, following the announcement, its share price drops by 50 percent that day.

In that circumstance, the average monthly return and the alpha are zero, correct?

MR. KELLOGG: Objection.

A. That's not actually right. So I'm going

to nitpick here. In your hypo -- let's call the price 100. It goes up 50 percent. That's 150. If it falls 50 percent, that's 75. So the price doesn't remain the same.

Q. Let's use absolute price terms. Let's say -- let's adjust the hypothetical to say that the price goes from 100 to 120 and then falls from 120 to 100.

In that circumstance, where it's 100 at the start and 100 at the end, would the average monthly return in alpha be zero?

MR. KELLOGG: Objection.

A. Not necessarily. So in your hypo it's 100 and 100. I agree with you that in that hypo that's a zero return. I think we can all -- you know, I think we can agree on that. Whether that's a -- that's related to a negative or a positive alpha or -- or -- or an alpha that's statistically indistinguishable from zero is an entirely separate question.

So what if the al -- the -- the instrument that we're talking about that goes from 100 and stays at 100 at the end of the day is underperforming the market and it has a beta of 1? So in that situation staying constant would

actually result in a negative alpha.

So, again, in response to your question, whether something has a positive or negative alpha is a function not just of the price returns of that instrument, but how is it doing relative to the factors that you have found to be statistically associated with -- with price return behavior?

Q. Let's look back at your paragraph 102 again.

MR. KELLOGG: Sorry, which paragraph?

MR. SYLVESTER: 102 on page 48.

A. Just give me a second here.

Q. Sure.

A. Okay. I'm there.

Q. Okay. Great.

Looking again at the last sentence, that we've now read through a few times together, is the standard way to measure excess price return with a constant or -- or is it with the error term that's left unexplained by the model?

MR. KELLOGG: Objection.

A. Well, I mean, the error term is going to

be, you know -- it's going to be bouncing around, up and down, depending on what the returns are doing that month and what the other factors are doing.

The alpha, the constant, is going to give you that average excess return per month. So it's absolutely standard in the academic literature to look at the alpha. I think Mike Jensen at HBS, Harvard Business School, had a very famous paper in the 1960s on alpha and there's a long literature on the meaning of alpha since then. I've done some work myself on -- on alpha as a measure of excess returns.

So I would say that the academic literature very much supports my focus on alpha in these regressions as a measure of excess returns.

Q. What are the academic papers that you cite in your report that use alpha to measure excess returns?

A. That I would have to go through and take a look at the papers that are cited. But there's many papers that look at alpha as excess returns. I would mention Gomphers, Ishii, Metrick had a paper in the Quarterly Journal of Economics in 2003. The whole point of their paper is alpha, is

their excess returns associated with good corporate governance?

I've done a paper in Review of Financial Studies where we look at alpha as well. So there's -- that's just an example on the literature on alpha.

Again, alpha as a measure of whether or not you're observing not just bouncing up and down, but is there positive or negative excess returns above and beyond what you would expect based on your factor model that you're deploying?

Q. The two papers that you just cited, did you review them in connection with preparing your expert report in this case?

A. I mean, not particularly. I mean, this -- these are papers that I've known for -- well, the Gomphers, Ishii, Metrick, I knew it as a working paper back in -- these are papers -- and one of which I wrote. So these are papers that I've known for, you know, a decade or two decades.

Q. Looking back at your --

A. But I do want to just --

Q. Go ahead.

A. -- put a little closure on this.

It's absolutely standard in the academic

literature to view the alpha, to view the constant, as a measure of excess returns, returns above and beyond -- it could be negative or positive -- relative to the factor model that you happen to be deploying.

Q. And other than your article and the Gomphers article, can you think of any other academic literature sitting here today that supports that view?

A. Oh, I mean, there's many papers that do that. I mean, I just mentioned Mike Jensen's paper in the 1960s that started this whole thing off. I would have to think more to come up with citations off -- off the top of my head, but, you know, those -- those two papers would all be good starting points.

And it's inherent in the model, which is -- right? You have, in the regression model -- going back to paragraph 96, if we go look at the regression model itself, you just think about what the alpha represents. It represents, you know, this sort of constant effect, if any, above and beyond the -- you know, what's in your factor model.

Q. Let's look again to your Exhibit 3 at

the point estimate of your constant for Period 1.

A. Yes.

Q. Okay. Can we conclude, looking at your Exhibit 3, with 95 percent confidence that the true constant is in the range of approximately two standard deviations of .058 in either direction for Period 1?

A. I don't want to agree to a specific confidence interval. I will say the confidence interval includes the zero. That is to say statistically indistinguishable from zero with -- you know, using the 5 percent level of confidence.

Q. Isn't two standard deviations the generally accepted method for determining the confidence interval?

A. Given --

MR. KELLOGG: Objection.

A. Depending on your confidence level, yes.

Q. What's the confidence level expressed in your work in this case?

A. Five percent.

Q. Okay. So is it fair to say, then, that the 95 percent confidence interval with respect to the true constant range for .058 would be two standard deviations in either direction?

MR. KELLOGG: Objection.

A. Sitting here today, I believe that's accurate. I would want to double-check, but I believe that's accurate.

Q. What is it that you would want to double-check?

A. Well, I would want to make sure, you know, sitting here, that I'm not misrepresenting the exact confidence interval. You know, based on the standard error, you know, this is statistically indistinguishable from zero; i.e., the confidence level includes zero.

Q. Right. I guess if I look at -- I'm trying to figure out -- strike all that.

Footnote 2 of your Exhibit 3 says "asterisk indicates statistical significance at the 5 percent level."

Do you see that?

A. I do.

Q. Does that mean that for your results displayed in Exhibit 3, you used a 95 percent confidence level?

A. Yes.

Q. Okay. So why is it that you can't say with certainty that the 95 percent confidence

interval for the true constant value for your Estimation Period 1 is within two standard deviations on either side of .058?

MR. KELLOGG: Objection.

A. So I believe that's accurate. All I'm saying is that I would want to double-check that it's two standard deviations. That's consistent with my memory sitting here, but, you know, I just want to be, you know -- yeah. So I guess I'll leave my answer at that.

Q. What would you check?

A. Well, I would just want to make sure -- you know, I would want to calculate the standard -- the confidence interval, so...

Q. How would you calculate the confidence interval?

A. Well, the confidence interval is a function of the standard error. The standard error is going to tell you how many standard deviations you have for the confidence interval. If you're asking me to perform the calculation sitting here, I'm not prepared to do that.

Q. Why is it that you're not prepared to do that?

MR. KELLOGG: Objection.

A. Because my report has the standard error. It reports the constant. It reports whether it's statistically indistinguishable. I have all the information in this exhibit that's necessary for the conclusions I draw.

I agree with you that the point estimate will have an associated confidence interval associated with it.

Q. And sitting here today, do you know how to calculate the associated confidence interval for the constant for Period 1?

MR. KELLOGG: Objection.

A. So I believe it's two standard deviations. I believe that's accurate. But, again, I'm not going to do new work sitting here in the middle of a deposition.

Q. Assuming that it is two standard deviations, what's the calculation that you would perform to determine what the range of values for the true constant are for Period 1?

MR. KELLOGG: Objection.

A. So I'm not going to do new calculations sitting here. So I agree it's two standard deviations, is my best memory. I agree that there's a confidence interval, but I'm not going

to do a calculation sitting in the middle of -- a new calculation sitting in the middle of a deposition.

Q. Okay. Setting aside doing the math of a new calculation, just conceptually, can you tell me how you would go about, with words, figuring out what the confidence interval is for the range of true constant values for Estimation Period 1?

MR. KELLOGG: Objection.

A. I -- I -- I'm going to leave the work that I've done as reflected in the exhibit.

Q. Is that because you don't know how to do it?

MR. KELLOGG: Objection.

A. I don't want to, you know, off the top of my head say something that's inaccurate. So I'm not going to do new work in the middle of the deposition. I'm going to rely on the work that I carefully did over many months. And so -- and that is what forms the basis for my opinion.

Now, I agree with you that my best memory is it's two standard deviations associated with a 95 percent confidence level, or interval, but, again, I'm not going to do new math sitting here.

Q. Understanding that you refuse to, could you?

MR. KELLOGG: Objection.

A. I'm just going to repeat my earlier answer.

Q. Do you know -- assuming the standard deviation is -- assuming that you would use two standard deviations, do you know how to perform the calculation that would give you the range of values for the true constant for Period 1?

MR. KELLOGG: Objection.

A. I -- I would want to think about it.

Q. Okay. You would agree with me that there -- there is a range of values for the true constant for Period 1, is that right?

A. Of course.

Q. Okay.

A. And that confidence interval, as we discussed, includes zero. That's what it means to say that something's statistically indistinguishable from zero.

Q. Could the true value of the constant for Period 1 be as high as 14 percent?

MR. KELLOGG: Objection.

A. I don't know offhand. There will be a

confidence interval on both sides of the point estimate. So I agree with that. So there would be in the confidence interval a number above 0.058. I don't have the exact number.

Q. Okay.

A. But I agree with you directionally that in the confidence interval, there would be a range around the point estimate.

Q. Let's assume -- I'll ask you to assume for the sake of my question that 14 percent is within the range of the true constant for Period 1.

A. Sure.

Q. Do you have any more reason to exclude 14 percent than you do to exclude zero as the true constant?

MR. KELLOGG: Objection.

A. So whenever you do statistical testing, you always need -- you always go into the hypothesis. You don't come up with a hypothesis after the fact. So the null hypothesis, which is the necessary first step before doing any statistical analysis, is, is it statistically indistinguishable from zero or is the true value -- or conversely, is it statistically

distinguishable from zero?

So that's the null hypothesis that I'm testing for the reasons that we discussed earlier today. And it -- you know, it turns out to be statistically indistinguishable from zero.

Again, there's obviously always going to be a confidence interval associated with any point estimate.

Q. Okay. Assuming, again, that 14 percent is within the range of values for the true constant for Period 1, is there any statistical reason to think that it's more likely that zero is the true constant than 14 percent is the true constant?

MR. KELLOGG: Objection.

MR. SYLVESTER: Please let me finish.

A. I don't -- I don't agree with that approach at all. In statistical testing, you have to go into the null hypothesis. You don't create your altern -- you know, a different hypothesis after the fact. So the hypothesis being tested here, the reason for the statistical analysis going in, is whether or not the alpha is statistically distinguishable from zero. That's

the question that's being answered. You don't genie up or create a new hypothesis -- i.e., it's 14 percent -- after the fact. I don't think that's a valid approach. It kind of invalidates the statistical methodology which is you're testing a hypothesis.

So I -- I guess I strongly disagree with what I understand your question to be proposing.

Q. I don't think I'm suggesting that you take this approach. I'm just asking your opinion as an economist and somebody who understands statistics, that if we assume that 14 percent is within the true constant range for Estimation Period 1, can you tell me if it's statistically likelier that the true constant is zero than 14 percent?

MR. KELLOGG: Objection; asked and answered.

A. I just don't agree with that approach. That is, the statistics are designed to answer a hypothesis that you have going in. It does have a confidence interval associated with it, but what I'm testing here, the null hypothesis, sets up the regression analysis that we're doing. That is to say, can we, at a certain confidence interval,

reject the hypothesis that the true alpha is zero?

So, again, in statistical testing, you have to have a hypothesis going in. You don't say after the fact, well, now I think it's -- you know, that's -- that's what I'm testing. I'm not going to change the hypothesis, you know, after the fact.

Q. I totally understand you don't agree with my approach.

Are you capable of answering my question?

MR. KELLOGG: Objection.

A. I've answered it the best way I can.

Q. So am I to understand that you're not capable of telling me whether or not it's likelier that the true constant is zero than 14 percent given the parameters of my hypothetical?

MR. KELLOGG: Objection; asked and answered.

A. I agree with you that there's a confidence interval, but the -- but the statistical model is in service of testing the hypothesis.

Q. Okay. Let's look at Dr. [redacted] rebuttal again, Exhibit 6.

THE WITNESS: So we've been going about an hour. Does it make sense to take a quick break?

MR. SYLVESTER: That's fine by me if it's okay --

THE WITNESS: Thanks.

MR. KELLOGG: Sure.

THE VIDEOGRAPHER: Okay. Thank you. The time is approximately 3:09 p.m. We're going off the record. It's the end of Media 4.

(Whereupon, a recess is taken.)

THE VIDEOGRAPHER: And the time is approximately 3:26. We're back on the record. This is the beginning of Media 5.

BY MR. SYLVESTER:

Q. Professor, are you offering the opinion that because alpha is statistically insignificant, there is no room for any other factors to explain the price returns of XRP?

A. Well, no, I'm not saying that. So if we go to my Exhibit 7, for example, you know, I do add other market factors, potential market

factors, after I had my PCA components, to explore whether those additional market factors, such as the S&P 500, have, you know, a statistical association.

So -- so, you know, I -- I do leave open the possibility, you know, as reflected in this work, that there's other factors that could have a statistical association which I then explore, you know, in the context of looking at these different factors.

Q. Are there any additional market factors that explain XRP returns?

A. Well, I can only report on the work that I've done. And so I would reference the factors that I do look at in my report, which obviously is the non-XRP crypto market factors, the S&P 500, the World Index Return, the Emerging Market, the Bloomberg Commodity, gold, dollar, yen, euro.

Q. And as to any other additional market factors beyond the ones that you just mentioned, you didn't examine them, so you can't say one way or another whether they affected XRP price returns, is that fair?

MR. KELLOGG: Objection.

A. The work that I did, the factors I

looked at are in my report. What I can say is conditional -- conditional in the pricing effect or association of those factors, there is no excess return so it's statistically distinguishable from zero.

Q. Okay. But it's -- it's possible -- if I understand your testimony, it's possible to have an alpha that's statistically indistinguishly -- indistinguishable from zero and then also have other market factors explain price returns of XRP, is that correct?

MR. KELLOGG: Objection.

A. Well, I mean, I show that in my work, which is there's no excess returns and there's a statistical association between some of these market factors and XRP price return behavior.

Q. Are any of the additional market factors that you identify in Exhibit 7 statistically significant?

A. No. So once we move beyond the -- the non-XRP cryptocurrency factors, again, consistent with the academic literature, these additional factors, such as commodities, has no statistically significant association.

Q. I think you testified that in your work

you show there's no excess returns. I thought what you demonstrated was that there was no average excess returns, is that right?

MR. KELLOGG: Objection.

A. I think you're drawing a distinction that I wasn't making in your -- in your comment. So I would just go back to the report. The alpha is the excess returns over this time period.

Q. Can you show me where you're reading from, please?

A. Okay. I haven't found the spot, so give me one second.

Okay. So I would just point to my third bullet point on page 40, as the way I characterize it in the report, where I say "On average, XRP price returns are not statistically different than zero, controlling for cryptocurrency market factors, over which Ripple has no control."

Q. And is that conclusion the same or different from the conclusion that you articulate in paragraph 102, where you say "In each of the Exhibits, 3 to 7, in all columns, none of the constants - which are estimates of the average monthly XRP price" --

A. I'm sorry, I don't -- I don't know where

you're reading from.

Q. Paragraph 102.

A. Okay.

Q. About mid paragraph it starts "In each..."

A. Yeah.

Q. Okay. "In each of the Exhibits, 3 to 7, in all columns, none of the constants - which are estimates of the average monthly XRP return after subtracting the risk free rate and controlling from non-XRP cryptocurrency factors - is statistically significant at the 5 percent level."

So I guess my question is, is there a distinction between excess returns and average monthly excess returns?

A. I'm not drawing that distinction in my report.

Q. Why not?

A. Because I'm referring to the same thing. I'm referring to the constant in my exhibit. So the discussions that we've been having is referring to exactly the same regression. So obviously they're referring to the same thing, which is the alpha, the constant term in these exhibits, such as Exhibit 3.

Q. Okay. So let's turn back to the bullet you pointed me to. I think that was page 40, is that right?

A. I have to find it again. Yes.

Q. So when you say in the third bullet on page 40 that you read to me that begins with "On average," that's a different way of saying what you're saying in paragraph 102, is that right?

A. I don't know what -- what you mean by "different way." I -- I am using different words. It's not exactly the exact phrase that I use on page 40. It's explain -- it's referring to the same alpha estimates in my exhibits. It's referring to the same thing, which is it's monthly returns -- ergo, the excess return, if any, is going to be a monthly return -- that's going to be reflected in that alpha term in the exhibits.

Q. And would an excess return include the error term in addition to alpha?

A. The excess return that I'm referring to here is the alpha -- is the -- is the alpha in the equation that we looked at earlier. So let me just go back.

So the alpha that's being estimated is the alpha in the regression term on page 43,

paragraph 96.

Q. Okay. Okay. Let's look at Dr. [redacted] rebuttal report again.

A. Okay.

Q. AF-6. Let's turn to page 14, please. Page 14 has a Figure 6 labeled "XRP 28-Day Net Return Unexplained by Dr. Ferrell's Model (Estimation Period 1)."

Do you see that?

A. Yeah, I see the Figure 6 heading.

Q. Okay. And then on the next page, there's a Figure 7 and that heading is "XRP 28-Day Net Return Unexplained by Dr. Ferrell's Model (Estimation Period 2)."

Do you see that?

A. I do.

Q. Okay. Do Dr. [redacted] Figures 6 and 7 show the error term unexplained by your model?

A. So the way I'm reading this and the way I understand it is that he's using the predicted XRP return. So I'm interpreting him as using the point estimate for the alpha, is my interpretation of that second sentence in paragraph 32. And that he's subtracting the predicted XRP return, which I understand him to be using -- I believe he's using

the point estimate and subtracting the actual return. And then he's plotting the delta over time.

Q. Okay. So in your view, do Dr. [redacted] figures have any relationship to the error term in your equation expressed in paragraph 96 of your report?

MR. KELLOGG: Objection.

A. So -- so if he's using, in his predicted XRP return that's referenced in paragraph 32, the point estimate on the alpha, then, yes. Under that equation in -- on page -- you know, on page 44, if I understand what he's do -- what I understand him saying is he's subtracting -- he's moving that alpha over to the left-hand side and -- and, therefore, what remains is the error term.

If he's not using the point estimate for the alpha, then it would obviously be the conjunction of the two or the combination of the two.

Q. Did you take any steps to determine whether or not it was possible that unexplained XRP returns -- actual unexplained XRP returns reflected on Figures 6 and 7 were the result of

Ripple's actions?

MR. KELLOGG: Objection.

A. Well, I did, in the sense that the model and the various specifications of the model are asking a question: Is there a monthly excess return over this time period? Not just bouncing up and down, but is there an average excess return associated with XRP over the -- over the seven-year period or five-year period?

So I do think the work that I did in the opening report does address that question. Whether or not the error term is bouncing up and down, you know, that's part of -- any regression model is going to have a error term. The regression model is identifying this excess return if it exists.

Q. Is the -- strike that.

Is the phenomenon of the error term "bouncing up and down," to use your words, reflected in Figures 6 and 7 of Dr. [redacted] rebuttal report?

MR. KELLOGG: Objection.

A. Well, again, I would go back to my earlier answer and I just don't remember offhand. But if in his predicted XRP return in paragraph 32

incorporates the point estimate of the alpha, then under equation -- the equation on page 44 of my report, that would be the error term under that assumption.

Q. Okay. The last sentence of paragraph 33 of Dr. [redacted] rebuttal report on page 15 --

A. Thirty-three?

Q. Thirty-three.

-- says "He" -- that's a reference to you, Professor -- "did not perform any testing to see whether Ripple news or actions coincided with any of these unexplained returns," referring to the returns reflected in Figures 6 and 7.

So my question with you is, do you agree or disagree with that statement?

A. I disagree with that statement because the hypothesis that I was testing is the SEC's theory, economic theory, that Ripple took various efforts over the seven-year period -- and also the five-year period -- over the seven-year period that is associated with XRP price going up. So that is the economic theory that I'm testing, that's the hypothesis that I'm testing, and so I did test for that.

The "Ripple news or actions" that he's

referring to in paragraph 33, you know, I assume that's a reference to the SEC's theory in this case that there's actions and news that Ripple undertook that's affecting the XRP price. So I most definitely did test that in my factor model.

Q. What in your view explains the phenomenon of "bouncing up and down" -- again, to use your words -- that we see in Figures 6 and 7 of Dr. [redacted] rebuttal?

MR. KELLOGG: Objection.

A. So in any model, there's going to be a error term. There's going to -- you're never going to get a perfect fit in a model. That's not the nature of statistical testing. But the model can test whether, on average, there's this excess return, whether it be negative or positive, associated with XRP.

So that's what the model is identifying, whether there's excess returns associated with XRP over time. The model does have explanatory power, the adjusted R-squared, if you want to use that metric, but it's never going to be 100 percent.

Q. Professor, a few answers ago you said "I was testing" -- "what I was testing was the SEC's theory, economic theory, that Ripple took various

efforts over the seven-year period -- and also the five-year period -- that is associated with XRP price going up."

Can you point me to the place in your report where you identify the SEC expressing that economic theory?

A. Well, it's the whole basis for why I'm analyzing excess returns, which is the SEC's theory. So I'm happy to flip through my report, but I talk about the complaint in a number of points.

Okay. So I'm just going to walk through my initial report to give a full responsive answer to this.

So in paragraph 7, which is under the title back -- "Brief Background on Litigation," I state in the second sentence "The alleged spec" -- well, I should read the full paragraph. "The SEC's affirmative theory in its complaint for why XRP should be deemed" --

THE REPORTER: One second.

Go ahead.

A. -- "should be deemed an investment contract extensively relies upon its characterization of XRP as a 'speculative

investment.'"

This is -- the next part is the one I wanted to focus on. "The alleged speculation is supposedly driven by the hope that Ripple's efforts would somehow find a 'use' for XRP at some point in the future, and that XRP's price would rise as a result of those efforts."

I have various citations and quotes in the complaint here. Let me just keep on going through my report.

Paragraph 13 in my report, I state "In Section III, I will address the SEC's assertion that 'profit' from 'speculating' on XRP's price increasing would primarily follow as a matter of 'economic reality' from Ripple's efforts to manage and develop its business and promoting XRP."

So, again, referencing this theory of the SEC that there's actions, events, that is resulting in -- that's associated with Ripple and its -- and its price.

Let me just keep going forward. I'm going to skip over the contract section.

Paragraph 83 on page 36: "The SEC's claim that the economic reality establishes that XRP is an investment contract because market

actors speculated on XRP's price and, moreover, that Ripple's efforts impacted XRP's price is equally mistaken." Skipping a sentence. "Rather, as I will show in Sections III.C and D" -- that's the sections that include the factor model -- "the economic reality is that" -- "is that XRP's long-run price returns are, in fact, associated with factors outside Ripple's control, namely, price returns of non-XRP cryptocurrencies, and that the XRP returns are unrelated to factors under Ripple's control, including the various distributions of XRP mentioned in the SEC's complaint."

Paragraph 84. I'm not going to read the whole thing, but it talks about speculative demand according to the SEC causing XRP prices to rise. I quote from the complaint extensively in Footnote 141.

Paragraph 90. I think this -- this is the beginning of my factor analysis, the very first sentence. "The SEC alleges that Ripple distributed XRP to create profits for themselves and the purchasers in the form of increased prices" -- I italicize that -- "for XRP." I'm citing to the complaint here.

Paragraph 107 on page 50: "The SEC also points to various efforts by Ripple that purchasers of XRP allegedly relied upon for an expectation of profit (in the form of increasing XRP's price)."

Second sentence of paragraph 108: "The SEC then points to the increase in the market price of XRP as evidence that Ripple's planned distributions of XRP succeeded." I quote -- I cite to the complaint.

I think at this point in -- in Section E, I'm talking about the -- some -- a different set of issues, aren't related issues, but let me just take a quick look.

Paragraph 140, page 67: "The SEC argues that the fortunes of XRP purchasers depend on Ripple successfully executing their XRP strategy." Citation to the complaint. "According to the SEC, the success or failure of Ripple's XRP strategy was contingent on Ripple propelling trading of XRP that drives demand for XRP, which will dictate investors' profits (recognized in increased prices at which they could sell XRP) or losses."

So just flipping through my report, those are the sections I was able to readily

identify.

Q. Okay. Let's turn back to Dr. [redacted] rebuttal report, Figures 6 and 7.

Can you exclude the possibility that the bouncing up and down in XRP returns as observed in Figures 6 and 7 occurred because of Ripple's actions?

MR. KELLOGG: Objection.

A. I can exclude or I can -- I -- I test whether Ripple's actions as identified by the SEC over this time period generated excess returns for XRP. So that's what I tested. So I can -- that -- that's a question I addressed.

Q. As to any actual XRP price returns unexplained by your model, can you exclude the possibility that those actual returns were because of Ripple's actions?

MR. KELLOGG: Objection.

A. Again, if the claim is that Ripple's actions caused Ripple's -- caused XRP price to increase over this time period by virtue of the actions and the expectations that those actions caused in the marketplace, I do -- I do address that issue.

Q. Let's assume that all of the unexplained

XRP returns reflected in Figures 6 and 7 of Dr. [redacted] rebuttal report were, in fact, the result of Ripple's actions.

Would that affect your expert opinion at all?

MR. KELLOGG: Objection.

A. That's such a -- a fanciful hypothetical I'm having trouble with it. You know, if that was somehow shown, I -- I would need to think about it, but it strikes me as a -- I'm having a hard time answering the question given the hypothetical.

I mean, I would go back to my earlier observation that any regression model is going to have an error term in it; that it's never the case that data fits perfectly along a -- a slope if we're talking about an OLS regression, for example.

Q. If Ripple had affected the long-term price of XRP, is it your view that you would have expected to find a statistically significant alpha?

MR. KELLOGG: Objection.

A. I think that that view would lead to the hypothesis that there would be a statist -- that

there would be a alpha. And the test for that is the statistical test that I undertook. That is the reliable methodology in the academic peer-reviewed literature for testing a hypothesis that there is alpha.

Q. Okay. Professor, I want to show you what's been marked AF-21.

(Whereupon, exhibit is received and marked SEC Ferrell Exhibit AF-21 for identification.)

A. Should I put this aside?

Q. For now, yeah. I'll just pass them all to you so you can distribute.

So, Professor, I'm going to represent to you that AF-21 are two tables of data obtained from running the Stata programs that create the results of your Exhibit 3 and that you provided as part of your work papers for your ex -- for your expert report.

A. Okay.

MR. KELLOGG: I object to the use of this exhibit.

MR. SYLVESTER: Why?

MR. KELLOGG: Because it's something that you've created separate

and apart from any of the expert reports.

MR. SYLVESTER: That's not true. I just represented to Professor Ferrell that this exhibit was created by running the programs that he produced as part of -- or that counsel produced as part of his backup to his expert report. This is part of -- this is the output of the analysis he produced to us.

MR. KELLOGG: But there's no way for him to check that in looking at this sheet of paper.

MR. SYLVESTER: Well, there is one way for him to check it. Let's see if he's seen the data before.

May I ask him a question?

BY MR. SYLVESTER:

Q. Professor, I understand you haven't physically seen AF-21 before today. Be that as it may, have you seen the data that's displayed in AF-21 before today?

A. Well, I'm looking at the first linear regression and it is the -- you know, I'm just

lining it up with the Estimation Period 1. And, you know, it is the results in that Estimation Period 1, the coefficients and the constant return in that linear regression.

I can -- and let me just check the second linear regression here.

Same answer.

Q. Okay. So it's fair to say that you recognize the data displayed in AF-21, the top panel, as the regression output for Period 1 and the bottom panel as the regression output for Period 2?

MR. KELLOGG: Objection.

A. That -- that appears to be correct.

Q. Okay.

A. Without reproducing it on the spot for myself.

Q. Understood. We don't have the computer program here with us today.

Do you understand -- okay.

So turning to Panel 1 first, the top panel, do you see on the right-hand side where it says "Root MSE"?

A. Yes.

Q. Okay. Do you understand that to be Root

Mean Square Error?

A. Yes.

MR. KELLOGG: Objection.

Q. Okay. Are you familiar with the concept of Root Mean Square Error?

A. Yes.

Q. Okay. You can see for Period 1 that the Root Mean Square Error --

A. So are we -- are we still looking at the first linear regression?

Q. Yes.

A. Okay.

Q. And I understand the first linear regression to correspond with your Period 1 regression, is that right?

A. Yes.

Q. Okay. So looking at the first linear regression that corresponds with Period 1, the Root Mean Square Error is .53246.

Do you see that?

A. I do.

Q. Okay. That Root Mean Square Error figure means that the typical monthly unexplained XRP price return in the regression for Period 1 is approximately 53.2 percent, is that right?

MR. KELLOGG: Objection.

A. I think that's correct.

Q. Okay.

A. And that -- this is going to, you know, be a function of running the regression and fitting these values on the -- the PCAs and the constant term.

Q. Okay. Turning now to the bottom panel, which I understand to be the linear regression employed for Period 2, do you see that the Root Mean Square Error value is .34178?

A. I do.

Q. Okay. And that means -- that Root Mean Square Error figure means that the typical monthly unexplained XRP price return in the regression for Period 2 is approximately 34.2 percent, is that right?

MR. KELLOGG: Objection.

A. I believe that's correct.

Q. Okay.

A. Or that would be one -- yes, I believe that's correct.

Q. Okay. Let's turn -- actually, before we turn to anything else, let me just ask you a question.

Do you agree that Ripple's distributions could have an impact on XRP price only if those distributions actually entered the market through trading?

MR. KELLOGG: Objection.

A. Not necessarily. So it depends on, you know, the market views about when distributions are -- I mean, it depends -- I would want to know more about market expectations.

So certainly one mechanism for distribution to have an effect is -- is the sale of those distributions into the marketplace, but also the effect -- the fact that there is distributions occurring, even if they end up, say, for instance, in a custody account, could potentially affect market pricing as well. As I explain in my report, you know, increasing supply, all else being equal, could lead to an equilibrium, a lower price.

Q. So if I understand your answer, another mechanism for a distribution to have an impact on prices in addition to trading is if there is market awareness of that distribution, is that right?

MR. KELLOGG: Objection.

A. Right. So the market views supplies increasing over time, that could affect market pricing, too. So, you know, you would want to think about expectations. You would want to think about supply in the marketplace. So all these things obviously are going to be part of the overall picture in thinking about distributions and the increase of supply that the sales or the distributions can represent.

Q. In your analysis of Ripple's distributions that's set forth in -- in Section III.D of your report, did you check to see if the distributions that you considered were actually used for trades?

MR. KELLOGG: Objection.

A. I'd have to see what you're referring to in my report. So should I go to III.D?

Q. Sure. I don't -- I don't have a specific paragraph citation for you. I'm just asking a general methodological question.

A. Let me just make sure I have the right -- let me just make sure I have the right section that you're referring to.

Q. Absolutely. Yeah. I'm talking about the analysis that you performed that you summarize

in III.D.

A. Yeah. So in III.D, as I explain -- let me just get the exact place where I talk about this. Well, let me go to the exhibits.

So in Exhibit -- Exhibit 11A, there's the distributions and lag distributions. So for the specification where there's distribution or lag distribution, I believe that would encompass 56 days.

Q. Okay. And how does your answer that you just provided relate to my question of whether or not you checked to see whether or not the distributions you analyzed were actually traded in the market?

A. Well, that's not how I'm defining distribution here. So I define distribution, as I say in my report -- let me just go to the -- is -- let me -- I think it's in the appendix actually.

So on page C-7 of Appendix C, I define the data distribution and the data. So I'm now reading the third sentence: "For transfers involving a reserved or custody account, the date on which the transfer first occurred is used. I understand this is also consistent with how Ripple reports its data."

So, anyway, there's a lot more discussion about how the distribution data was put together, but that is one of the definitions of a distribution that I use. That is to say, moving from Ripple, if Ripple's what we're talking about, to a non-Ripple account, an account under the control of a party other than Ripple.

Q. Mm-hmm.

And after that XRP moved from Ripple to a non-Ripple party, did you do anything to -- to determine whether at that point the XRP entered the market?

MR. KELLOGG: Objection.

A. No, I did not. In terms of the definition of distribution, whether it's lagged or not, in my analysis, that's how I'm defining distribution.

Now, as I said this morning, given Dr. [redacted] criticism, which I don't agree with, but I also ran the distribution analysis, as we discussed this morning, using just programmatic and market maker and exchange sales and it doesn't affect the results of my analysis. So, anyway, that's something that we discussed this morning and I, you know, would raise it again here.

Q. Turning to the next sentence after the one you just read --

A. Oh, I just closed it. Okay.

Q. It's C-7, paragraph 13.

A. Okay.

Q. You wrote "For example, Ripple may set up and transfer to a custody account one million XRP on January 1st, 2015. The funds may stay in that account until the relevant non-Ripple entity directs Ripple to withdraw the XRP funds from the custody account on May 1st, 2015."

Do you see that?

A. I do.

Q. As far as you know, are there any market participants except for Ripple and the relevant non-Ripple party that would be aware of the funds being transferred to the custody account on January 21st --

MR. KELLOGG: Objection.

THE REPORTER: You're going to have to slow down.

MR. SYLVESTER: Okay.

THE REPORTER: Repeat.

BY MR. SYLVESTER:

Q. As far as you know, are there any market

participants besides Ripple and the non-Ripple party aware of the funds being transferred to a custody account on January 1st, 2015?

MR. KELLOGG: Objection.

A. Well, this is a -- this is a hypothetical. Are you assuming -- so if this hypothetical held true, is that -- I'm not quite understanding the question.

Q. Let me reask a different question but same topic.

Did you take any steps to determine, in the circumstances where Ripple transferred XRP to a non-Ripple party, to determine whether or not market participants were aware of the transfer on the date of the transfer?

MR. KELLOGG: Objection.

A. No. I don't have a view on that. I -- I do have a view that it's a distribution in the sense that it's going from Ripple to a non-Ripple party, albeit in a custody account, but it's under the control of the non-Ripple party. And that -- that's how I'm defining a distribution; that is to say, the movement of XRP from Ripple to a non-Ripple party.

Q. In paragraph 14 on the next page, C-8,

you write "Last, in calculating net distributions for use in the analyses, the record level data were adjusted by: One, converting values in fiat currencies to XRP (for a small set of the data)." I just want to pause there.

What was the small set of the data you're referencing?

A. Let me just read this full paragraph.

Q. Sure.

A. I would have to go back to the data to review it. I don't recall offhand.

Q. Okay. Can your model distinguish between the following two possible scenarios of zero monthly net distributions: Scenario 1, no Ripple distributions of XRP at all during the month; Scenario 2, Ripple bought a lot of XRP at the beginning of the month and then sold back the same number of XRP at the end of the month?

MR. KELLOGG: Objection.

A. So -- let me just go back to my report. I think this goes back to the question of net distributions or net outflows, but I want to get the relevant part of the report.

Q. And if you wouldn't mind when you get there directing me to where you're looking.

A. Sure.

All right. So I'm looking at paragraph 113, page 53. And I state, in -- in terms of my analysis, my factor analysis, "First" -- so I'm looking at the second sentence. "First, I include Ripple's monthly distribution of XRP, which is the net outflows of XRP from Ripple over the last 28 days, and, second, I include the one-month lagged XRP distributions to account for timing differences in XRP distributions."

So the answer to your question is I'm looking at net outflows --

Q. Okay.

A. -- for the 28-day period.

Q. Let me reask my question more precisely in reference to paragraph 113.

When looking at net outflows of XRP from Ripple over the last 28 days, does your model distinguish from a 28-day period where Ripple made no distributions of XRP from a period where Ripple bought and sold back the same amount of XRP during the 28-day period?

MR. KELLOGG: Objection.

A. In your hypothetical, the net outflow, if I understand your hypothetical, would be zero.

Q. Okay. And could your model pick up the difference between those two factual scenarios or would it just be zero in those two cases?

A. So in your hypothetical, the net outflow from Ripple would be zero. So on net, the supply of XRP in both of your hypos, hypotheticals, didn't increase at the end of the day.

Q. Okay. So applying your model to both those scenarios, the net monthly outflow would be zero for Scenario 1 and zero for --

THE REPORTER: You're going to have to slow down.

Q. Applying your model to that hypothetical, the net monthly outflows would be zero for my first scenario and zero for my second scenario?

MR. KELLOGG: Objection.

A. Correct, because -- well, because the net is zero. So the net supply of XRP in your two hypotheticals, you know, results in a net increase in supply at the end of the 28-day period of zero.

Q. Okay. I have another two possible scenarios for you. Again, hypothetically. The first scenario is XRP's price does not change at all during the 28-day period, and the second

scenario is that XRP's price declined at the beginning of the 28-day period and rebounded to the same price toward the ends of the 28-day period.

Can your model distinguish between those two factual scenarios?

MR. KELLOGG: Objection.

A. So -- okay. I just want to make sure. We're not talking about distributions now, we're talking about prices?

Q. Yes.

A. Okay. So in the 28-day window, it's looking at price returns over the 28 days. So in your situation, if it's 100 in the beginning -- just to normalize the price to 100 -- and it's 100 at the end, that would be a return of zero for that 28-day increment.

So it is correct -- and I'll point to the footnote on this just to be crystal clear. It will take a second.

(Pause)

Footnote 163 on page 43. So that's the specifics about how the 28-day price return's being calculated. And, again, to answer your question, if the price in the beginning of that

period, the 28-day period, is the same as the end, that would be a price return of zero.

Q. Okay. And I just want to make sure I understand. So there's -- let me pose two different factual scenarios. One 28-day period using XRP is $100. It's $100 the entirety of the 28-day period. It's a flat line.

A. Okay.

Q. Second factual scenario, XRP starts at 100, it goes up to 120 sometime during the month, it goes back to 100 sometime later in the month, end of the month it's 100.

Does your model distinguish at all between the changes -- between those two factual scenarios?

A. The return is the same. So it is 28-day returns. So, yes, I am -- you know, as you can see in the formula in Footnote 163, I'm using price Day T plus 28 and I'm using price in the denominator of Day T -- of Day T. So it is working off of those two prices. To reiterate, price of Day T plus 28 and price on Day T. And that's the return that's being used in that 20-day period.

So in your hypothetical, as I understand

it, in both of those hypotheticals, you're setting price Day T plus 28 equal the price Day T in both scenarios and, ergo, it would have the same return.

Q. The -- the return would be zero for both factual scenarios, correct?

A. Yes.

Q. Okay. Did you have access --

A. Just -- just to comment.

Q. Go ahead.

A. You know, we're talking about returns and then we're -- I just -- the formula in Footnote 163 is in prices that converts it into returns. So I just want to make sure we're clear that in the hypo we're using prices in our hypothetical and then converting them into returns.

Q. Okay. Did you have access to daily disaggregated XRP distributions data, meaning inflows and outflows?

A. So the data that we had was multifaceted. Some of it was on a monthly basis. I would just refer back to the data appendix in all of this and the different data sources because there's a number of different data sources with

different levels of frequency. So give me a second here.

Yeah. So, I mean, this gets pretty complicated in terms of the different data sources that were used to construct the -- the -- the flows, the distribution flows, whether they -- you know, at different points in time.

And so paragraph -- Section F of my Appendix C, starting on page C-6, walks through some of the -- some of the data sources. So there is record -- record level data for some of the -- the distributions or some of the flows. There is monthly account balances.

THE VIDEOGRAPHER: Counsel, I'm sorry, I'm getting some interference with your microphone rubbing against your jacket. Sorry for the interruption. Thank you.

A. And there's monthly changes in balances that supplement the record level data.

So some of the distribution data is monthly and all those data sources were -- were utilized, not just the record level data.

Q. Why was it that you chose to perform your distributions analysis using monthly net

data?

A. Well, I mean, there's -- there's two answers to that question. One is my specification, as we've been discussing, is using a 28-day period. So the factor model that we've been talking about is using these 28-day periods. So if I'm to incorporate the distributions into the factor model, it's natural to also have it be the same increment of time.

The second answer is, and I won't read the de -- the details, but constructing the distribution data was a nontrivial exercise. And using, in addition to the record level data, the monthly account balances, monthly changes in the balances, was part of the process as well as the record level data.

So the data sources have different levels of frequency associated with it. And -- and so that -- that's -- that's, you know, how the data was put together.

Q. Okay. Are you aware of any academic literature that uses dollar value of net distributions to measure the impact of distributions on a stock price?

MR. KELLOGG: Objection.

A. I don't recall either way. I would have to take a look. I -- yeah. I just don't have a specific recollection sitting here.

Q. Okay. Was your original distributions data in number of XRP or in dollars?

A. So I believe a lot of the data was in XRP. So we have reserved accounts that are set in XRP funds. There is another data source that we used, you know, in constructing the data.

I just want to get the exact language here. I know it's here somewhere. I just can't find it right away. Give me a second.

So maybe I'll just point you to the exhibit where the data's reflected.

Q. Perhaps Exhibit 8?

A. What's that?

Q. Perhaps Exhibit 8?

A. Not quite. Yeah, so that's not exactly what I was thinking about.

Exhibit 10. So CoinMarketCap has data on -- on -- on what they label a circulating supply. And so another -- another data source, going to your question for this, which is denominated or in -- in XRP, you can see the Y axis here, is CoinMarketCap circulating supply and

then we obviously have the XRP distributions in XRP here.

So I guess two points here. One is, it's -- it is in XRP units and it's yet another data source in addition to what I was describing later that was utilized to make sure that what we were seeing in the XRP distributions was consistent with this other source of data; that is to say, the CoinMarketCap circulating supply. Again, going to your question, that is in XRP.

Q. Okay. And to convert the number of XRP to dollars for purposes of -- of your analysis, I believe, according to Exhibit 9, Footnote 2 --

A. Just give me one second.

Q. Sure.

A. Let me just familiar -- we're skipping around a lot so let me just take a moment to look at what you're looking at.

Q. Sure. And just to orient us, I'm at Exhibit 9, Footnote 2.

A. Okay.

Q. So I read Footnote 2 to mean that for your distributions analysis to convert the number of XRP to dollar values, you used, depending on the period of time, CryptoCompare and

CoinMarketCap prices, is that right?

A. Yes.

Q. Okay. In your view, could this conversion from number of XRP distributed into dollar values have introduced inaccuracies in the data since you didn't use actual prices at which the XRP were distributed?

MR. KELLOGG: Objection.

A. No. I view this as the market price of the XRP in question. So I don't view it as inaccurate.

Q. And the -- the price of XRP varied substantially in the period from 2013 to 2020, correct?

MR. KELLOGG: Objection.

A. Well, it depends on -- you know, are you talking about over a long period of time or are you talking about on a daily basis?

Q. I meant over the -- the entire period, it sort of increased substantially, right?

A. It -- it definitely changes over time.

Q. And -- and fair to say that change in the 2013 to 2020 period is an increase in price, right?

A. Yes.

Q. Okay.

A. And I think we saw earlier the market cap of -- of XRP, which is not only about price, but about, you know, the -- the XRP units out there. But, yes, it did increase in price.

Q. Okay.

A. Oh.

Q. Go ahead.

A. Let me just -- let me take another crack at my earlier answer, which is the price is increasing and the supply in the marketplace of XRP is increasing, too, as we can see in Exhibit 10. That's -- that's what I was trying to say with my earlier answer.

Q. Okay. So -- so that I understand your distributions analysis, let me introduce another hypothetical. And let's use completely hypothetical price numbers to make the math easier on me.

So let's say in 2015, XRP was trading at a dollar and Ripple distributed one million XRP. Using your distributions calculations, you would convert that to $1 million, correct?

A. Yes, if that's the price in CryptoCompare or CoinMarketCap, depending on

exactly when in 2015 you're talking about.

Q. Okay. So let's say again, totally hypothetically, in 2018, XRP's price --

A. 2018 now?

Q. Yes.

A. Okay.

Q. Totally hypothetically. XRP's price is $5. Ripple distributes again one million XRP. In that case, your distributions figure would be $5 million, correct?

A. Yes. So the -- just to be clear, it's converting to dollars on the date of distribution and it's using the average of the opening and closing price as reported in CryptoCompare.

Q. Okay. And for both of those circumstances in my hypothetical, Ripple was distributing the same amount of XRP, one million XRP, right?

A. Yes. I think that's right.

Q. Okay. Would you agree that the conversion of distributions into dollar values introduces additional variation into the net distributions data that makes it more difficult to detect the relationship between XRP returns and Ripple's actions?

MR. KELLOGG: Objection.

A. No, I don't agree with that. I'm -- I'm -- I'm using the market value of the XRP distribution based on the pricing. And so I view that as an accurate way to track the -- the outflows or the net outflows.

But as we discussed earlier today in response to Dr. [redacted] criticism on this score, not that I agree with it, is I reran the distribution analysis and the -- and the -- and the -- and how it's measured using XRP units rather than converting it into the -- into dollars using market values and it doesn't change the results.

Q. Is it fair to say that in no place in your report are you providing an expert opinion as to Ripple's motivations with respect to any of its actions?

MR. KELLOGG: Objection.

A. Agreed.

Q. Okay.

A. I am not, as an economist, opining on what somebody was thinking, what somebody was feeling, what somebody thought. I'm not a fact witness.

Q. Okay. Let's turn to paragraph 119, please.

A. Let me just familiar my -- familiarize myself with the paragraph --

Q. Sure.

A. -- for a moment.

Okay.

Q. The last sentence of 119 says "The cap on XRP distributions introduced by the escrow is therefore not a binding constraint on the amount that Ripple can distribute per month."

Do you see that?

A. I do.

Q. Can you explain in what way the escrow is not a binding constraint on the amount of XRP that Ripple can distribute per month?

A. Well, I'll just refer to the discussion earlier in that paragraph. So my understanding of the escrow is that they can distribute up to one billion per month in XRP. So that is -- that is the -- the limit, as I understand it, on the escrow. So they can do up to a billion. They don't have to do a billion, but they can do up to a billion as I understand it.

And so, you know, in the sentence that

begins "I analyzed" on page 55, I'm just simply observing that the monthly ratio, you know, ranged, you know, up to 55.8 percent. And then for the next time period, it ranged up to 55.9 percent.

So I'm just making the observation that in the distribution data that monthly limit of one billion wasn't binding because they're doing less than -- less than 100 percent.

Q. Did you calculate the monthly ratio for the years ending 2019 and 2020?

A. I don't recall that offhand. I do have the distribution net outflows in dollar numbers of Exhibit 9. I have the monthly net outflows in XRP on Exhibit 8. So I would reference that for the 2019/2020 period. But, again, this is in XRP units.

You see here in that Y axis of Exhibit 8?

Q. Mm-hmm.

A. There is a one billion XRP. And you can just take a look at the net outflows in XRP in Exhibit 8 for 2019 and 2020. I believe that it's all below that monthly cap of a billion.

Q. Okay. Let's go back to paragraph 1 --

THE WITNESS: How long have we been going? I don't want to take a break too often.

MR. SYLVESTER: It's been about an hour.

MR. KELLOGG: A little over an hour. Do you want to take a break?

THE WITNESS: Yeah. Maybe -- I hate keeping people here in the evening, but maybe a break.

MR. SYLVESTER: It's fine by me.

THE VIDEOGRAPHER: Okay. Thank you. The time is approximately 4:20 -- make that 4:30. We're going off the record.

(Whereupon, a recess is taken)

THE VIDEOGRAPHER: And the time is 4:50 p.m. We're back on the record.

BY MR. SYLVESTER:

Q. Professor, are you familiar with the term "liquidity premium"?

A. I believe so in the sense of a premium -- a potential premium for liquidity. So

in that general sense, yes.

Q. Okay. What is your understanding of the term "liquidity premium"?

A. So the way I just defined it is the idea that, all else being equal, a more liquid asset can have more value than an illiquid asset, all else being equal.

Q. Okay. Are you aware of any economics literature that suggests that digital assets are not subject to a liquidity premium?

A. No.

Q. Okay. Did you do any testing in this case to determine whether XRP's listing on any new digital asset platform had any impact on XRP's price?

A. Yes, in -- in -- in the sense that I -- I framed the hypothesis that I tested earlier, which is the net effect of the actions that the SEC identifies, which includes listing on exchanges, did not have a statistically significant excess return.

Q. Other than the testing that you just mentioned, did you do any additional testing to determine whether XRP's listing on any particular digital asset platform had any impact on XRP's

price?

MR. KELLOGG: Objection.

A. So the work I did is reflected in -- in those regressions.

Q. Okay. Over the period of 2013 to 2020, has Ripple sold XRP every year?

MR. KELLOGG: Objection.

A. So in your question you used the word "sold." What I can talk about is distributions in the way that I defined it, and we were discussing earlier. So I think the most responsive answer to your question would be Exhibit 8, which is the net outflows from Ripple. And this is denominated in XRP and -- anyway, you can see the -- the net outflows over time.

Q. You also reviewed Ripple's financial statements from 2014 to 2020, is that correct?

A. Yes.

Q. Okay. Do you recall from that review whether Ripple sold XRP each of those years?

A. I don't have a specific recollection. You know, I do track -- I do track outflows from Ripple and that's reflected in Exhibit 8 and Exhibit 9, as well as Exhibit 10. So that's -- that's the work I did, again, in the context of

distributions based on the data sources that we discussed earlier.

Q. Okay. Let's -- so -- strike that.

Do you have any sense, let's say just for 2020, how frequently Ripple sold XRP? Daily? Weekly? Monthly?

A. You keep -- you keep using the word "sold." So I'm -- I'm looking at distributions, which obviously include sales, and Exhibit 8 does have data for 2020.

So, again, in terms of net outflows, you know, I would again go back to my Exhibits 8 and 9.

Q. Okay. And remind me, Professor, how you define outflows for purposes of Exhibit 8.

A. It's exactly the net outflow -- net distribution outflows that we were talking about earlier.

Q. Okay.

A. So there's various data sources that went into that, including monthly account data, record level -- record level data, checked against CoinMarket circulating supply. So rather involved construction. "Involved" in the sense of multiple data sources to construct what's reflected in

Exhibit 8 and Exhibit 9.

Q. Okay. Let -- let's go to paragraph 141 of your report, please.

A. Let me just -- give me a minute to get the context of the paragraph.

Q. Sure.

(Pause)

A. Okay. I've -- I've reviewed that section.

Q. Okay. The first sentence, you'll see it says "There was no pooling of the funds."

Do you see that?

A. I do.

Q. By "funds," do you mean XRP or dollars or something else?

A. I'm referring to pooling of funds by investors that are then going to be used for the purposes of increasing profits or earnings that then are -- the benefits of which are then going to be shared for the contributors to the pool.

Q. Okay. And the -- the sentence "There was no pooling of the funds" is in passive voice.

Who was it that was not doing the pooling in your view?

A. Well, again, in part, this is a

reference to the earlier discussion of the contracts and was there pooling of funds in an enterprise with then some kind of claim on those funds and some kind of promise, increased profits or earnings.

Q. Okay. And I want to go back to your previous answer where you said you were referring to pooling of funds by investors.

Are you talking about sales of XRP? Like, I want to locate this in the facts of this case. When you say there was no pooling of the funds, do you mean funds that XRP purchasers paid to receive the XRP?

MR. KELLOGG: Objection.

A. No. I mean -- again, you know, maybe it's helpful to go to the -- the next paragraph. 142 I think helps elucidate what I'm -- I'm talking about here, which is that there's not a pooling of funds by investors who receive the XRP where those investors now have some sort of right to enjoy the benefits of that pooling as a result of -- of that relationship.

So, again, I think what I'm talking about 141 is elucidated by -- you know, is clar -- you know, elaborated upon in paragraph 142.

Q. Are you expressing an opinion in this case that Ripple did not pool funds it received from its sale of XRP?

A. I'm not providing that opinion.

Q. Okay. Turning back to paragraph 141, you'll note, Professor, there's not a citation.

Can you tell me where you --

A. I'm sorry, I -- what paragraph are we on?

Q. 141.

A. Okay.

Q. There's not a citation in that paragraph.

Can you tell me how -- how or where you obtained the information for -- in paragraph 141?

A. Well, 141, as I explained, is elaborated upon in 142. So it referenced back -- it references back to my economic analysis of the substance of the contracts we viewed in Section II and then it also references the factor model in Section III. So, again, it's referencing that earlier work that I did in separate sections of the report.

Q. Okay. So let me just ask specific to the sentences. You write "Specifically, Chris

Larsen, Jed McCaleb and Arthur Britto collectively held the remaining 20 billion XRP units and gave 80 billion XRP units to Ripple."

Where did you get that information?

A. The 20 billion and 80 billion?

Q. The contents of that sentence.

A. So that's my understanding. I believe it's in the distribution data, this 20 billion/80 billion. That's -- that sentence, that second sentence, is my understanding of the -- of the basic facts of this case; that there's a total of 100 billion XRP units, 80 billion with Ripple and then later obviously there's an escrow account for -- involving XRP.

So that second sentence is -- you know, is my understanding of sort of the basic background facts of the case, but the analysis is -- you know, I would point to paragraph 142, which invokes work that I did in earlier sections of the report.

Q. Turning to the last sentence of 141, you write "Furthermore, Chris Larsen, Jed McCaleb, and Arthur Britto did not pool their XRP holdings and were free to behave independently from each other and independently from Ripple."

Do you see that?

A. I do.

Q. What is your basis for that sentence that I just read?

A. So when you look at the distribution data and the exhibit, Appendix C, you know, the -- the distribution data from Ripple, the outflows from Ripple, it is not incorporating these individuals and what they decide to do with their -- their XRP.

And there might be something -- just give me one second here.

(Pause)

And I would also reference in the context of this discussion Footnote 54 on page 15 in my report, where I say -- and now I'm just reading from the report -- "I was informed by counsel that distributions by Founders and the bounty program identified in the complaint are outside the scope of my assignment."

So I would -- and then there's a citation to the complaint referencing the -- you know, the -- with a reference. So, anyway, you know, I would also point to that -- that definition of my assignment.

Q. Did you have distributions data for Mr. McCaleb or Mr. Britto?

A. It was just something I wasn't focused on. I -- I don't recall offhand if that's in the distribution data or not. I mean, the distribution data that I was using is reflected in the appendix. So I'll just go back to that. Give me one moment.

So, you know, for the distribution data -- and now I'm on page C-6 of my appendix. And, you know, I'm talking about the monthly account balances for Ripple's accounts and sort of how -- and, also, I'm looking at the financial statements of Ripple.

So those data sources are about Ripple's distributions. My understanding of that is that doesn't include what these individuals independently might be doing.

Q. So how is it that you formed the conclusion that they did not pool their XRP holdings and were free to behave independently from each other and independently from Ripple?

A. So that's my understanding of the background, which is the individuals are separate entities, so to speak, from Ripple. They're in --

I mean, I don't -- that Ripple's distribution data and how it dealt with its XRP, how it dealt with the escrow account, were issues for Ripple. There's nothing in the Ripple distribution data that has anything, in my memory, about, well, we're going to tell this or that individual what to do with their own separately owned XRP.

So the distribution data that I had about Ripple was about their XRP. I don't recall offhand that Ripple was treating their holdings as part of their holdings for purposes of these different data sources such as Ripple's monthly account balances.

Q. Other than whatever access to Ripple's distribution data that you had, do you have any other basis for the statements you make in the third sentence of paragraph 141?

A. Well, as I said, the -- the -- that first sentence in paragraph 141 -- you know, 141 more generally, is elaborated upon in 142, which is invoking earlier work with the academic and data sources that I use there.

The fact that XRP had 80 billion and these individuals had 20 billion is just a basic understanding of the facts of the case. I didn't

understand that to be at issue. It is my basic understanding. And of course the 80 billion is reflected in that Ripple data that I did use for the construction of -- of the distribution data.

Q. And my question is, how did you obtain the understanding that Mr. Larsen, Mr. McCaleb and Mr. Britto did not pool their XRP holdings and were free to behave independently from each other and independently from Ripple?

A. I gave you the -- the answer, the basis for that, which is the Ripple -- how Ripple treated its XRP. My recollection is that the private holdings of these individuals was not treated as Ripple XRP for those purposes, for the distribution purposes.

My understanding is that they had 20 and Ripple had 80. That's a basic background understanding of the facts of the case. And that -- I guess the last thing I would add is that they're individuals who own the XRP and, you know, didn't have -- my understanding, and I haven't seen anything to the contrary, that Ripple somehow owned or controlled the 20 billion that they had.

So, again, part of this is just sort of basic background to the case; that is, the 80 and

20 billion division. I would also reference the Ripple treatment of XRP and its internal data and the data sources that are used. And then, obviously, the work that is referenced in paragraph 142.

Q. I'm struggling to see how any of the data sources you just named would inform you as to what Mr. Larsen, Mr. McCaleb and Mr. Britto actually did with their XRP holdings or were free to do with their XRP holdings.

Can you identify any data sources that you have with respect to Mr. Larsen, Mr. McCaleb or Mr. Britto's combined actions with respect to their XRP holdings?

MR. KELLOGG: Objection.

A. So as I mentioned before, I explicitly state in Footnote 54 that the distribution by the founders identified in the complaint are outside the scope of my assignment. So it is true that I did not analyze the distributions of these individuals; rather, I was focused on the distributions of Ripple.

So part of this has to do with the scope of my assignment.

Now, I -- I do want to add -- obviously

I do, in my rebuttal to Mr. [redacted] I do talk about some hop analysis and that does get into a set of issues there. But here, in this initial report, I don't claim to be doing a distribution analysis by -- let me just go back to the relevant paragraph -- by Mr. Larsen, McCaleb or Britto.

Q. Okay. Let's move to paragraph 143, further down on the page. The second-to-last sentence is "In fact, a majority of XRP are not purchased directly from Ripple but are traded anonymously at the cryptocurrency exchanges."

Do you see that?

A. I do.

Q. Is that statement true for the entire period of 2013 to 2020?

A. Give me one moment. I just want to check one more thing and I'll get back to you to get to the relevant -- we're skipping around in the report a little bit.

So, yeah, as I discuss in my report, I do agree that the trading volume was definitely lower earlier in the time period, you know. And I would reference here Exhibit 14 on page 97 where I talk about the number of exchanges. You know, there's a little bit of a bump in 2015 and then it

starts, you know, to visually -- 2017 it starts to go up at a -- at a -- at a decent pace.

You know, if you look at, you know, trading volume, which is reflected in velocity on Exhibit 15 -- so, again, velocity is being defined as trading volume divided by the circulating supply.

It is true in the early period it is low in that Exhibit 15 and picks up around, you know, starting at 2016 or so. Yeah, so I definitely agree earlier in the period the trading volume is lower, significantly lower. The -- listing on exchanges or exchange trading is -- is definitely lower.

Q. And was it true earlier in the period that a majority of XRP were not purchased directly from Ripple?

A. What paragraph are we on again?

Q. 143, the second-to-last sentence.

A. Yes. So this is -- this is -- this is a statement about looking at it over the entire period. And, obviously, in the last sentence of 143, in particular the later period. So I'm not making that representation about trading anonymously for cryptocurrency exchanges confined

to 2013 or 2014.

Q. Okay. Let's go back to the pooling of funds in 141.

A. Yes.

Q. I want to make sure I understand your testimony.

When you say there was no pooling of the funds, are you referring to people's holdings of XRP?

A. Well, again, 141 is talking about the pooling of funds. And then the next, you know, two sentences in that paragraph are talking about these three individuals that own 20 billion XRP, 20 percent of the total supply, and that their -- their holdings of XRP are separate from that of Ripple. So that's point one.

And then point two would be the other issues that I reference in paragraph 142 that is, again, referencing work that I had done earlier.

Q. Okay. So with respect to the reference to pooling of funds in 141, you're referring to Mr. Larsen, Mr. McCaleb and Mr. Britto's funds, is that right?

A. Well, as -- as the sentence says, they have 20 billion of XRP. My understanding is that

was not treated as part of Ripple's XRP. That is, it was treated, at least in the data that I saw in the distribution sources, that these are treated as private holdings by these individuals.

So in that sense, there's no pooling in the sense that they have XRP and are -- are independent of -- of XR -- are independent of -- forgive me, what was the question again? I got a little distracted.

Q. It's okay.

Let me reask it because -- strike that.

When you write "There was no pooling of the funds" in your first sentence of 141, are you referring to Mr. Larsen's, Mr. McCaleb's and Mr. Britto's XRP?

A. Yes, in part, but I also then talk about the issues in one -- in paragraph 142.

Q. And -- and will you explain to me, if there is another meaning of "there was no pooling of the funds," other than reference to Mr. Larsen's, Mr. McCaleb's and Mr. Britto's XRP, what is that other meaning?

A. Well, there's a broader discussion now in paragraph 142 about, you know, the operation of Ripple and whether any XRP, any XRP purchases,

create a pooling of funds where there's been a contractual obligation on the part of Ripple to expend efforts, a contractual obligation on the part of Ripple to increase XRP's price, a contractual obligation to share in any profits from the management of the enterprise.

Q. Okay. Let's move to paragraph 144 on the next page.

A. So just give me a moment to situate myself.

Q. Sure.

(Pause)

A. Okay.

Q. Okay. The first sentence of paragraph 144 says "Some parties that received XRP directly from Ripple sell rather than hold XRP." And the second sentence, "For example, market makers use their XRP to quote bids and offers, and improve market liquidity," and it goes on to talk about ODL customers.

My question is, isn't it true that Ripple employs market makers to sell XRP programmatically on its behalf?

A. There -- there is programmatic sales on behalf of Ripple, is my understanding. And I

would reference back to my discussion of various contracts, including the section on programmatic sales. Let me just get the exact section here.

So I would reference you back to -- well --

Q. One place --

A. Well, paragraph 42, page 18, I state "Ripple also entered into contracts with programmatic sellers," and then I -- I have some discussion of that, including GSR. I also, in paragraph 46, on page 20, talk about market makers.

So, yes, there is programmatic -- contracts governing programmatic sales.

Q. Okay. And in those contracts governing programmatic sales, Ripple is employing, for instance, GSR to sell XRP on its behalf, correct?

A. That's my understanding. And, you know, I would reference paragraphs 43 through 45 where I believe I talk about that particular issue.

Q. And do you have a sense over what period of time Ripple employed GSR to sell XRP programmatically on its behalf?

A. I do -- I do -- we -- I did -- I'm trying to remember the dates. You know, I know

that in 2017 -- and, obviously, Dr. [redacted] report is focused on programmatic sales by GSR.

Give me one second here.

So I'm returning to my rebuttal report where I discuss -- I think I have that data there. It's in the latter period, I think, including 2017, but let me give you a specific answer. This may take a moment.

Yeah. So back -- yeah, in 2016 and 2017 there's GSR activity. Let me just make sure there's nothing else I want to say on this.

(Pause)

Yeah. So just to elaborate on my earlier answer. So that -- was the question is Ripple using GSR?

Q. Do you have a sense over what period of time Ripple employed GSR to sell XRP programmatically on its behalf?

A. Okay. So in terms of GSR when it was active, you know, I would reference Exhibit 6B in my rebuttal. Now, this includes acting for non-Ripple entities, including Mr. Larsen. So I believe it's 2017 is my best recollection. The contract that I reference between Ripple and GSR in my report is dated June 2nd, 2017.

Q. Do you know if Ripple ever stopped employing GSR to sell XRP on its behalf?

A. Stopped employing GSR. I know there's a termination provision with the GSR programmatic contract that I talk about in the report, paragraph 44, but I don't know if that was, in fact, terminated or not.

Q. Okay. Let's move to the first sentence of paragraph 145 in the same section.

A. Oh, I'm sorry. Just to give a complete answer, there's also a contract in 2019 with GSR and Ripple that I reference in paragraph 49 actually dated July 1st, 2019. And this is using GSR as a -- as a market maker.

Q. Okay. Let's turn to paragraph 145. The first sentence says "In contrast, Ripple holds XRP over a long-term horizon."

Do you see that?

A. I do.

Q. What do you mean by "long-time horizon"?

A. I would reference here the net outflows from Ripple reflected in Exhibit 8. And we look at this later time period, you know, we see distributions far less than a billion in a month. We looked at the net outflows in dollar amounts

reflected in Exhibit 9.

So I would reference that data for the proposition that -- that Ripple is holding XRP for long periods of time, multiple years. It is, obviously, engaged in net outflows, but it's far -- it's just a fraction in any given month of the total holdings.

Q. Okay. But at least according to your Exhibit 9, it is engaged in net outflows at least from late 2013 to late 2020, is that fair?

MR. KELLOGG: Objection.

A. That is fair. So the monthly net outflows from Ripple, there is a little bit of blue early on denominated in U.S. dollars. And the net outflows in Exhibit 9 are -- at least when denominated in dollars, is larger in the later period.

Now, when we look at the XRP units, you don't see that spike in the later period looking at Exhibit 8.

Q. And turning back to paragraph 145, the same sentence, "In contrast, Ripple" --

A. One second. Let me just get there.

Q. Sure.

A. Okay.

Q. Same sentence. "In contrast, Ripple holds XRP over a long-term horizon."

When you write "In contrast," are you contrasting Ripple with other market participants who hold XRP?

A. The contrast is with the velocity calculation that I discuss in the prior paragraph, paragraph 144, and is reflected in Exhibit 15.

Q. Are Ripple's programmatic sales included within your velocity calculation in paragraph 144?

A. So the Exhibit 15 -- so this would be all trading volume. So as reported by -- with the top tier or with the CryptoCompare volume data. The actual distributions by Ripple we know from those earlier exhibits.

Q. What steps, if any, did you take to disaggregate Ripple's trading from the rest of the market's trading to compare velocity?

A. Well, I did disaggregate it in the sense that I identified, both in dollars and XRP, exactly the quantum of distributions by Ripple whether it's via GSR or some other entity. So I do have that disaggregation.

The trading volume here is going to be all the -- the entire trading volume for the

market as reported by CryptoCompare or as reported by these top-tier exchanges.

Q. So your trading volume figure described in 144 would include any Ripple trading that took place on digital asset platforms, is that fair?

A. If -- if there were sales by -- by Ripple that enter the trading volumes, it would be reflected in the calculation of the velocity, you know, just by -- you know, in terms of the trading volume if it's being reported into the -- into the -- into these figures.

Now, again, the point of comparison is we know exactly how much distributions are actually happening in total and that's reflected in Exhibits 8 and 9.

Q. Does your velocity figure tell us anything about how many non-Ripple XRP holders are holding their XRP over a long term?

A. Exhibit 15 is not about on a per-person basis. It's on a per-XRP basis. So that is consistent with how velocity is normally defined.

Q. Okay. If I understand your answer, I think that means that your velocity analysis does not exclude the possibility that some XRP purchasers hold their XRP over a long-time

horizon?

MR. KELLOGG: Objection.

A. That's correct. So paragraph 144 says "a higher velocity means that the asset is traded, (turned over) or used more often."

So it's not at the individual trader level, I don't -- I'm not aware of data that would enable one to do that. It's, rather, how often does the asset -- here XRP -- get turned over? So very standard traditional method of looking at, you know, turnover in the market.

Q. Can we flip back to the heading on page 67? This is Section F. We talked about this briefly earlier in the day.

A. Page 67?

Q. Yes. Section F, the heading is "Economic Assertions for Commonality are Fundamentally Flawed."

A. Yes.

Q. Do you see that?

And "commonality" as used in the heading for Subsection F is referring to the commonality element of the Howey test, is that right?

MR. KELLOGG: Objection; calls for a legal conclusion.

MR. SYLVESTER: Let me finish my question, but okay.

Q. Go ahead.

A. Calls for -- I'm not providing a legal opinion. So the answer to your question is, no, I'm not opining on "commonality" as that phrase is used in the Howey decision, but rather the SEC's economic assertions in this portion of their complaint.

Q. Okay. Are you opining on the SEC's economic assertions in the commonality portion of the SEC's complaint?

A. Well, we should turn to the complaint. I do have citations here to paragraph 291 of the complaint, paragraph 317 of the complaint, 291, 293 of the complaint. Yeah. So I would just at least point to the portions of the complaint that I actually cite here in this particular section.

Q. Okay. And at least in your quoted citations, I don't see the word "commonality."

So am I to assume that the word "commonality" is drawn from the SEC's complaint?

A. We would have to -- I mean, I would like to see the complaint to refresh my recollection on that. But it is these particular paragraphs that

I'm referencing here in terms of the subject matter of this section.

Q. Particular paragraphs of the complaint you mean?

A. Yes. So I identify different portions of the complaint in the context of the first paragraph in this section and what I'm going to discuss.

In other words, the economic assertions by the SEC is reflected not just in the citations to the complaint, but in that first paragraph where I lay it out, lay out in quotations what the S -- SEC is saying here.

Q. Let's turn back to paragraph 145. The second sentence of paragraph 145 says "Because of the differences in both the timing and the duration of holding periods between Ripple and direct and indirect purchasers of XRP, their exposure to XRP price volatility and therefore to risk is different."

Do you see that?

A. I do.

Q. Okay. Does that sentence that I just read bear on the question of whether the SEC's economic assertions for commonality are

fundamentally flawed?

MR. KELLOGG: Objection.

A. I think it is part of my analysis of the economic assertions by the SEC.

Q. Can you explain how in your view, if I understand you correctly, the statements in that sentence undercut the SEC's economic assertions?

A. Well, I would go to the third sentence in paragraph 140 on page 67. And now I'm just reading from my report. "The SEC also argues that the 'fortunes' of XRP purchasers were aligned with each other and with Ripple because Ripple 'pooled the funds it raised in the offering.'"

So there's this assertion, economic assertion, that XRP purchasers at large are aligned with Ripple. And the point here is that, you know, if your holding periods for a volatile asset are different, you're differently situated, you know, in that respect.

Q. In your view, are Microsoft shareholders in a common enterprise with Microsoft?

MR. KELLOGG: Objection.

A. Calls for a legal conclusion if what you mean by "common enterprise" is you're invoking the Howey test.

Q. Okay. I mean, I didn't hear an instruction not to answer. So in your view, are Microsoft shareholders in a common enterprise with Microsoft?

MR. KELLOGG: Objection; calls for a legal conclusion.

A. If you're asking me for my legal conclusion as to whether Microsoft stock is stock, I believe the answer is yes. I'm not here to opine on that. The word "stock" appears in the definition of security in the '33 Act, so I'm not here to provide that legal opinion, but I do agree that it's stock if you're asking me the question and want -- want my view on it.

Q. From an economic perspective, are Microsoft shareholders in a common enterprise with Microsoft?

A. Well, I would -- common -- well, I would -- I guess I would want to explore exactly what you mean in your question about common enterprise. My earlier response was simply agreeing that it is stock, for what it's worth. But in terms of the economic substance of that relationship, I guess I would want to know more about how you're defining common enterprise in

your question.

Q. Is there a generally accepted definition in the economics literature of the term "common enterprise"?

MR. KELLOGG: Objection.

A. Not as such, no. I mean, there are academic economic literature on velocity, on different time horizons, but I would not say commonality or common enterprise is a -- you know, is a -- is a phrase that's used in a way like asset pricing models are. It does have a strong legal connotation.

That's not to say you can't talk about economic assertions that underpin the claim of commonality.

Q. Okay. And, again from an economic perspective, are Microsoft shareholders in a common enterprise with Microsoft regardless of whether they're day trading or long-term holders of the stock?

MR. KELLOGG: Objection.

A. So, again, what I'm doing in this section is the economic assertions by the SEC. If you're asking me -- I guess in your question, I would want to know how you're defining "common

enterprise" for -- you know, in your question.

I don't need to -- you know, the commonality that I'm dealing with in my report is really working off of the economic assertions that the SEC makes in the context of commonality. I'm not directly opining on commonality as such.

Q. Okay. Let's move to --

THE WITNESS: May I ask how much time we have on the record? Just kind of pace -- pace myself. I'm sorry to interrupt.

THE VIDEOGRAPHER: We have about 57 minutes left.

BY MR. SYLVESTER:

Q. Okay. Let's move to your rebuttal report, AF-2.

A. Rebuttal? Oh, okay. AF-2?

Q. Yes.

A. So I might take one last break just so I don't fade.

Q. Do you want to take it now? That's fine.

A. It sounds like we're at a natural break point.

Q. Fine by me.

A. Does that make sense? So, yeah, maybe take a break just to stretch my legs.

THE VIDEOGRAPHER: Okay.

Thank you. The time is 5:36. We're going off the record.

(Whereupon, a recess is taken.)

THE VIDEOGRAPHER: And the time is approximately 5:55 p.m. We're back on the record.

BY MR. SYLVESTER:

Q. Professor, when you address the pooling of funds in Subsection F of your opening report, is there any portion of that section that addresses whether Ripple pooled funds it received in its sales of XRP?

A. So paragraph 141, that first statement, is referring to, A, the fact that there's individuals that own XRP that are not Ripple, that owned the 20 billion XRP units. So there's these separate holdings of XRP. Again, this is a basic background assumption of the case as I understand it. That is to say, these individuals held 20 billion, whereas Ripple had 80 billion.

And the second point on the pooling is really what I referred to in 142. There's not

pooling and sharing of the benefits of that pooling with the XRP purchasers in the sense of a contractual relationship or obligation or distribution of the profits thereby generated.

Q. Okay. Focusing just on dollars Ripple received from its sales of XRP, does any part of Subsection F discuss whether or not Ripple pooled the dollars it received from sales of XRP?

A. No.

Q. Okay.

A. Again, with the caveat that -- I mean, there's a couple -- I want to be clear on the record about this. I think there's a couple different senses of pooling floating around here that might create a lack of clarity in the record.

I am addressing whether this pooling by Ripple of the funds that it receives in the sense of it's pooling these funds received and the XRP purchasers then get the benefit in the form of a distribution, the benefit in the form of a claim, on whatever profits, if any, are generated by that pooling.

So if we're defining pooling in that way, I most certainly do talk about it, as paragraph 142 indicates. So I just want to be

clear on the record about -- you know, to be clear on what is meant and what is not meant by "pooling."

Q. I don't quite understand your answer. You're opining, I think, if I understand it correctly, on whether or not Ripple pools funds and that pooling results in certain rights in XRP purchasers that you identify in paragraph 142, is that correct?

MR. KELLOGG: Objection.

A. Well, to be clear, I'll just read the relevant portion of paragraph 142. "That these contracts" -- such as the programmatic sales contract. "That these contracts do not have any contractual rights entitling these counterparties to a share of Ripple's profits if Ripple is successful in its ongoing efforts to manage and develop its business operations. There are no such contractual rights and no ongoing obligations for Ripple to expend efforts to increase XRP's price." The first part of that sentence is I -- I reference the work that I did in Section II.

So, again, if that's what is meant by "pooling" -- that is, funds are put together and then there's these rights in the pooled -- in the

profits, if any, that are generated by the pool -- then that is addressed and I do have an opinion on that and that's reflected in paragraph 142.

Q. Okay. Let's use a hypothetical. Same -- same pooling concept. Let's say Ripple sells $10 worth of XRP on Tuesday and then sells $10 worth of XRP on Wednesday.

Is your opinion expressing any view as to whether or not Ripple pools that $20 of XRP -- $20 of proceeds from its XRP sales?

A. If what you mean by "pooling" is ignore -- you know, is just putting the money together or not putting the money together in an account or accounts, I'm not providing an opinion on that. If what is meant by "pooling" is that those relationships, those contractual relationships, pursuant to which Ripple gets those funds, the $20 in your example, whether those contractual relationships create a right to a portion of the profits if Ripple's successful in its ongoing efforts, then I do have an opinion on it.

Q. Does the company have a fiduciary obligation to its shareholders to maximize the value of its assets?

MR. KELLOGG: Objection;
calls for a legal conclusion.

A. Yeah, that's a legal opinion.

Q. Be that as it may, do you know?

A. So under Delaware corporate law, there are fiduciary obligations of the directors that run to the corporation, as I understand it, which would, you know, involve acting in the best interests of the corporation.

Q. And in your view as an economist, would acting in the best interests of a corporation include maximizing the value of its assets?

MR. KELLOGG: Objection.

A. So as a policy matter, if you're asking my personal view on this as an economist, that is a -- assuming that we're talking about a for-profit organization, sure, maximizing assets would be certainly something that you would want to think about in terms of a fiduciary obligation by a corporation to its shareholders. So I'm -- or to its claims on the firm's assets.

So, you know, again, obviously what fiduciary obligations a corporate board has is ultimately a question of Delaware corporate law assuming it's incorporated in Delaware.

Q. Okay. Let's turn now to your -- AF-2, your rebuttal report. I want to start with paragraph 7, please.

MR. KELLOGG: I'm sorry, where are we?

MR. SYLVESTER: Paragraph 7.

MR. KELLOGG: Of the main report?

MR. SYLVESTER: Of the rebuttal report.

THE WITNESS: Do you have a copy?

MR. KELLOGG: Of the rebuttal?

MR. SYLVESTER: You should have it.

MR. KELLOGG: Yeah.

THE WITNESS: I'm at paragraph 7.

BY MR. SYLVESTER:

Q. Okay. Great. The first sentence of paragraph 7 is "I have been asked by counsel for Ripple to assess the claims, summarized above, made in the [redacted] report."

Do you see that?

A. Yes.

Q. Okay. So my first question is, was your assignment with respect to your rebuttal opinion limited to assessing the claims made in the [redacted] report?

MR. KELLOGG: Objection.

A. Yes. So this rebuttal report is a rebuttal to his -- his report, so it is assessing the opinions reflected in paragraph 6.

Q. Okay. Can --

A. I would also note that, you know, obviously I read the entire report and, as we discussed this morning, I did consider his -- this isn't -- I'm sorry.

I was just going to note that Dr. [redacted] has a rebuttal report, you know, a report where he criticizes me. Obviously I have views on that. But here, in this -- so -- but in this rebuttal report, I was asked to assess these opinions in his initial report.

Q. Okay. Turning to paragraph 8 on the next page.

A. Just give me a second to read it.

Q. Sure. It's probably worth reading the entire thing because most of it is just one

sentence.

(Pause)

A. Okay.

Q. So my question is, did Dr. [redacted] opine that any of the XRP price movements he observed resulted in any sustained impact on the market price of XRP?

A. So it was -- reading his report, it was unclear about whether he thought it was -- his -- it is fair to say that his report -- and I think I mention this later -- just give me one second here. He does reference short term -- let me just get the language here. Just give me one more second.

(Pause)

So the way he characterizes his findings I think I, in part, summarize in paragraph 10, where he uses language like it's "consistent" with Ripple attempting to influence prices or the actions "coincided" with price changes.

As I understand from his deposition, he -- he -- and it's consistent with this summary or this -- these statements that I make in paragraph 10, quoting him, is that he's making no

claim of causation. That is to say, as I understand his position -- and, again, it's consistent with this language here -- he's not making any claim that the actions that he analyzes, in fact, caused an XRP price change, let alone an XRP price change that's permanent.

So that's my best understanding of -- of what his position is.

Q. Did -- did you read Dr. [redacted] deposition transcript?

A. I did not.

Q. Let's go to paragraph 9 of your report. I'm looking at the second sentence. That says "As an initial matter, Dr. [redacted] does not (and cannot) explain why a handful of trades on just a few cherry-picked dates would have resulted in any long-term impact on the market price of XRP, much less caused purchasers of XRP to have any reasonable expectation of profits from Ripple's conduct."

Do you see that?

A. I do.

Q. Did Dr. [redacted] opine on the reasonable expectations of XRP purchasers?

A. He opined -- I don't think he uses that

phrase. He opined -- you know, he's discussing XRP price changes, which obviously XRP price changes do reflect the expectations of the marketplace. But I don't believe he used that particular phrase.

Q. Can you explain what you mean by "XRP price changes do reflect the expectations of the marketplace"?

A. Well, XRP has a market price, right? It trades in the markets and has a market price that changes over time. And the market is going to have a -- a view, a consensus view, as to the market value of that asset, just like it does for any asset.

So the market value is going to reflect the market consensus at that point.

Q. As part of your assignment for your rebuttal report, did counsel ask you to examine the relationship, if any, between Dr. [redacted] opinions and the reasonable expectations of XRP purchasers?

A. What counsel asked me to do was -- is reflected in paragraph 7.

Q. Okay. I don't see any reference to the reasonable expectations of XRP purchasers in

paragraph 7., is that right?

A. That's correct. So, again, the expectations of the market, you know, is going to be reflected in the price of XRP; that it's going to reflect the consensus view as to the market value of this particular asset, XRP, and he does analyze or discuss XRP prices.

So it's only in that sense that, you know, this -- that it intersects with Dr. [redacted] analysis.

Q. Okay. So when you refer in your report to "reasonable expectations of profits from Ripple's conduct," are you talking about -- strike that.

When you refer to "reasonable expectations of profits from Ripple's conduct," is that limited to any such expectations that might show up in XRP's market price?

A. Yes.

MR. KELLOGG: Objection.

A. So any reference to "reasonable expectations of profit" -- and we can certainly look at other parts of my rebuttal where that phrase might be used -- is solely focused on conducting the assignment in paragraph 7. That

is, his actual analysis.

Q. Okay. Let's turn to paragraph 11 on page 6. And there are some dark bullets and some clear bullets. I want to look at the first clear bullet. The last sentence of the first clear bullet is "The fact that market actors attempt to minimize the price impact associated" --

A. Oh, I'm sorry. I'm in the wrong place. Where -- where should I be?

Q. Paragraph 11, page 6. Do you see how the first two bullets are filled in and the remaining three are clear?

A. Yes.

Q. So the first clear bullet.

A. Oh, I see. Okay.

Q. And the last sentence of that first clear bullet is "The fact that market actors attempt to minimize the price impact associated with their sales is hardly surprising or novel, and does not support an opinion that XRP is a security."

Do you see that?

A. I do.

Q. Did Dr. [redacted] offer any opinion as to whether or not XRP is a security?

A. I think he avoided opining directly on that, as -- as I am -- as I am. I'm only -- the reference in this bullet is just to the -- the idea that best ex, best execution, is something that occurs in many different markets, many different asset classes.

I am not opining anywhere, whether it be in the rebuttal or my initial report, on whether or not XRP is a security. It's a legal question. Nothing that I've written should be construed as providing an opinion on that ultimate legal question.

Q. Let's look at the next page. We're still on paragraph 11. There's the first full bullet on paragraph -- sorry, on page 7, that says "As the factor analysis presented in my opening report shows, the long-run prices of XRP were influenced not by the efforts of Ripple, but by the changes in the value of cryptocurrencies generally; focusing, instead, on a handful of select days does not constitute a reliable scientific methodology."

Do you see that?

A. I do.

Q. Okay. So when you say "not by the

efforts of Ripple," are you expressing an opinion here that Ripple's efforts in no way influence the long-run prices of XRP?

THE REPORTER: You're going to have to slow down.

MR. KELLOGG: Objection.

A. So I need to hear the question again now.

Q. Sure.

When you say "not by the efforts of Ripple" in the sentence I just read, are you expressing the opinion here that Ripple's efforts in no way influence the long-run prices of XRP?

MR. KELLOGG: Objection.

A. What I'm referencing here, in this particular sentence, is the various -- the factor model and its various specifications that we discussed that are contained in my initial report. That is to say, there's no statistically significant excess return associated -- associated -- associated with XRP above and beyond or separate and apart from general movements in cryptocurrency.

So I want to be very clear on the

record. The hypothesis that I was testing is the null hypothesis: Is the alpha statistically distinguishable from zero or is it -- or is it, in fact, the same as zero, you know, in a statistical sense?

So that -- that's the analysis that I was referencing in this particular bullet.

Q. Okay. Is it possible in your view for someone to take steps consistent with an attempt to influence the price of an asset and yet be unsuccessful in influencing the price?

MR. KELLOGG: Objection.

A. Stated at that level of generality, yes.

Q. Okay. Separate and apart from whether or not it may have been successful, are you offering any opinion that Ripple did not take steps to influence the price of XRP?

MR. KELLOGG: Objection.

A. As I understand your question, you're asking me -- or the question is asking me the motivations of Ripple, the motivations of Ripple with respect to the trading activity that Dr. [redacted] focuses on. And the answer to the question is no. I'm not going to opine on the motivations, feelings, personal thoughts of

individuals.

Q. Okay. Slightly different question.

Again, separate and apart from whether or not Ripple may have been successful in any efforts, are you offering any opinion here that Ripple did not take steps consistent with influencing the price of XRP?

MR. KELLOGG: Objection.

A. Same answer. So as I understand the question, the question is ask -- is saying -- is asking, am I going to opine on the motivations of individuals, such as individuals at Ripple, and what their thought processes were? And the answer to the question is no.

Q. Do you disagree with any of the Dr. [redacted] conclusions -- strike that.

Separate and apart from Dr. [redacted] analysis of any impact on XRP's price, do you disagree with Ripple -- with Dr. [redacted] conclusions that on certain occasions Ripple employees took steps consistent with influencing the price of XRP?

MR. KELLOGG: Objection.

A. So I want to be careful here. So insofar as you're asking me about these emails and

Dr. [redacted] citing emails to -- and any use of emails to opine on motivations or purposes, I'm not providing an opinion on that. That -- that's not my role as an economist.

I obviously do analyze the particular days that he chooses, but that's using market data, not opining on personal motivations of individuals, whether it be at Ripple or elsewhere.

Q. Okay. You may have anticipated my next question.

Separate and apart from whether or not they may have been successful, are you offering any opinion that Mr. Larsen or Mr. Garlinghouse did or did not take steps to influence the price of XRP?

MR. KELLOGG: Objection.

A. So, again, my understanding of your question is, am I going to opine on the motivations, beliefs, feelings, opinions of those individuals? And the answer to -- answer to that question is no.

Q. Okay. Let's look at -- let's look at Exhibit 1 to your AF-2.

A. Exhibit 1?

Q. Yes.

A. Just give me a moment to situate myself.
Q. Sure.
A. Okay.
Q. The right-hand panel of Exhibit 1 to AF-2 displays data for cryptocurrency exchanges.
Do you see that?
A. I do.
Q. Do you know whether or not any GSR trading is within the volume reflected in the right-hand panel for cryptocurrency exchanges?
A. So this is the crypto -- cryptocurrency exchanges being reported by CryptoCompare. Beyond the -- the net outflows that we were talking about earlier that's reflected in my exhibits and my initial report, I have the same answer that -- that -- from previously when you asked me about trading volume. So I -- I don't disaggregate here, you know, GSR trading -- well, I'm using the full trading volume on the cryptocurrency exchanges. Obviously, I have the GSR XRP Ledger trading on the left-hand side.
Q. Mm-hmm. But to the extent that GSR trading is included -- strike that.
To the extent GSR was trading on cryptocurrency exchanges during this time period,

that trading would be included in the volume on the right-hand side?

A. Yes, I would assume so. Whether, you know, in that -- you know, that would include GSR trading for -- hypothetically would include GSR trading for clients other than -- than Ripple. I'm not saying that happened. I'm just saying it would -- this trading, as I understand the CryptoCompare data, would be reflected in the cryptocurrency exchange volume.

Q. Okay. Let's turn back to paragraph 18 of your rebuttal report.

A. Paragraph O18?

Q. Eighteen.

A. Just give me a moment.

Q. Sure.

A. Yes.

Q. Okay. In paragraph 18 you describe using a square root model.

Do you see that?

A. Yes.

Q. Okay. My question is, did you use the square root impact model that -- you'll have to excuse my pronunciation -- Donier and Bonart used in 2015 referenced in Footnote 33?

A. There's a formula that I used. It, you know, involves the square root of the volume of the trade or the order -- I think it's called the meta order -- over the volume, the trading volume. And there's a parameter that's estimated at 0.9.

Q. And did you --

A. And there's a volatility -- there's a price volatility term there, too.

Q. Did you obtain that 0.9 figure that you just testified about from the Donier and Bonart paper referenced in Footnote 33?

A. Yes. I believe that's from the Bitcoin paper, if that's what you're referring to.

Q. Did you perform any calculations using XRP prices to determine any components of the square root model that you used as described in paragraph 18?

A. I don't understand the question. Is the question is am I using -- am I calculating inputs into the -- into the formula?

Q. Yes.

Did you perform any calculations using XRP prices to determine any inputs that you then used to put into the formula that you found from the paper we've been discussing?

MR. KELLOGG: Objection.

A. Yes.

Q. What -- what calculations do you recall?

A. Well, there's -- in the formula there's the order size. There's the volat -- the price volatility. There's the trading volume. So those are all inputs into the square root calculation.

Q. And you reference the 0.9 figure. What does that refer to?

A. It's a parameterization in the formula. I think it's the Y term in the formula. So that's another component of the formula, which I did get from the Bitcoin paper.

And I want to be very clear on the record. The point of this square root calculation is simply illustrative of the point that I make in the second sentence of Footnote 33, that "total trading volume and price volatility are important when assessing the price impact of a trade." That is to say, these are important factors. I'm using this as an illustrative example of how it could be important.

I'm not saying -- I'm not saying that the price impact is 1.6 percent or 2 percent. It's illustrative of this point that these factors

can be important if one is interested in assessing price impact of a trade. It's illustrative of that general point. It's not a calculation of the actual price impact of any particular trade on any particular -- you know, on this day. And the same comment would hold for the square root estimates that I utilize in the exhibit at a later point.

Q. Okay. I want to make sure I understand your testimony.

You're saying with respect to the concluding sentence of paragraph 18 that you're not opining that the price impact in this particular case is 1.6 percent, is that right?

MR. KELLOGG: Objection.

A. So what I say in paragraph 18 is the potential XRP price impact using the square root model is approximately 1.6 percent. So it's -- and this point, the 1.6 percent, is in service of the general point that total trading volume and price volatility can be important in assessing the price impact. So it's just illustrative of that general point.

I'm not saying for this trade or these trades it is, in fact, 1.6 percent. It's a potential price impact. It's illustrative of the

general point that you would want to think about these factors in assessing price impact.

And the same comment would hold for the illustrative calculations using the square root model that are provided later in the report as well.

Q. Looking at paragraph 20 -- I'll give you a second to read that and then I'll ask my question.

A. Okay. Thank you.

(Pause)

Yes.

Q. Are you offering the opinion that GSR's purchases during the one-hour period described in paragraph 20 were inconsistent with implementation of a price floor as directed by Ripple?

A. Can you repeat the question?

MR. SYLVESTER: Bridget, would you mind reading that one back. Thanks.

(Whereupon, the record was read back.)

A. I guess what I would say is I would reference my paragraph 21. So this notion of a price floor doesn't seem to hold up in the data if

you look at pre-November 1st and post-November 1st.

So, you know, in your question, you were referencing the price floor and that seems inconsistent with the fact that prices were more often below that price floor -- now I'm reading from my report -- in November and December than they were before. So I guess I do view the data as inconsistent or Dr. [redacted] ignores this when he talks about a price floor.

Q. Okay. Again, sort of reverting to our principles. Setting aside whether or not GSR was or was not effective in implementing a price floor, are you opining as to whether GSR's purchases during that one-hour period referenced in paragraph 20 are or are not consistent with the implementation of a price floor?

MR. KELLOGG: Objection.

A. Well, again, I -- just to go to what Dr. [redacted] says, and I quote it in paragraph 21, he says "GSR seems to have succeeded" in this price floor. So, again, I would reference that data.

I'm sorry, what -- what's the question?

Q. I think you answered it. Let -- let's

go to the data. Let's go to Exhibit 2, please.

A. Okay.

Q. My question on Exhibit 2 is, did you examine intraday price data for XRP to prepare this exhibit?

A. These are the daily low price.

Q. Okay. So I think that means, yes, you did examine intraday data, is that right?

A. Yes. My understanding of daily low prices is it would include intraday in that -- in that way, in identifying the low price.

Q. Okay. For each of the day that's included within the blue bars shown in your Exhibit 2, did you conduct any analysis of what percentage of the day XRP's price was below .008 dollars?

MR. KELLOGG: Objection.

A. No. So I believe the -- the data has the close -- the -- the open, the close, and the daily low. Maybe the daily high. I can't remember. So the answer to your question is, no, this is just reporting the number of days where this -- where the low price breached the so-called price maintenance floor.

Q. Okay. Let's go back to paragraph 45 of

AF-2.

A. Forty-five?

Q. Yes.

A. Paragraph 45?

Q. Paragraph 45, page 23. And my question is about the concluding sentence, so it's probably worth you reading the whole paragraph.

A. Yeah.

(Pause)

A. Okay. I've read the paragraph.

Q. Okay. The last sentence says "In order for this claim to be true, the regression coefficient on the prior returns must be statistically significant, and my return regression specification demonstrates that this is not the case."

My question is, why is it that the regression coefficient on the prior returns needs to be statistically significant in order for Dr. [redacted] claim that these sellers on behalf of Ripple sold more XRP when the price of XRP was increasing and relatively less when the price was decreasing on the previous day? Why -- why does your regression coefficient need to be statistically significant in order for that to be

true?

MR. KELLOGG: Objection.

A. Yeah, that's -- that's -- that's a long question. Let me make sure I -- I want to make sure I'm answering it.

So Dr. [redacted] in his report says that -- well, I have the quote here. That "These sellers, on behalf of Ripple, sold more XRP when the price was increasing and relatively less when the price was decreasing the previous day." No, that's not the quote I wanted.

So in his report -- Dr. [redacted] report, that is -- my understanding of what he was saying is that this selling activity, the selling of more XRP, is associated with increasing returns on -- contemporaneously increasing returns. That is, his claim is not just confined to the previous day's returns, but I read him in his report to be making a claim about selling more XRP when the price is contemporaneously rising.

What his regression is about -- and we can talk about his regression -- is he's using lag returns. So I'm making the observation that a lag return coefficient is not going to address the question of whether there was contemporaneous

increases in the prices during the sale activity.

Now, this leads directly into the last sentence of that paragraph, which is "If there was a statistical association in return..." So if returns are falling today, returns are falling on average statistically, then there would be a relationship between that previous return that Dr. [redacted] is using and contemporaneous return. So there might be a -- a basis for an inference there, but there is no statistical association between contemporaneous returns and prior returns.

And, therefore, a lag regression, a regression that's using lag returns, is not going to be able to ascertain whether, in fact, Ripple was selling more when prices contemporaneously were increasing.

Q. Okay. Let's move to Exhibit 8 of AF-2.

A. Exhibit 8?

Q. Yes. This is labeled, for the record, "Examples of Alleged Indirect Transfers of XRP from Mr. Larsen and Mr. Garlinghouse to GSR Traced by Dr. [redacted]

You'll see, Professor, that a number of addresses are noted as belonging to "another party."

Do you see that?

A. Are you looking -- I'm sorry. Oh, okay. So you're looking at the second column. Yes, I do.

Q. Okay. And you say in your note, the last sentence, "When the address I.D. has not been provided, another party is indicated above."

Did you see that?

A. Yes.

Q. Did you ask counsel to supply you with any documents that might answer the question of who controlled these destination addresses?

MR. KELLOGG: Objection.

THE REPORTER: I'm sorry.

Repeat.

MR. SYLVESTER: Sure.

BY MR. SYLVESTER:

Q. Did you ask counsel to supply you with any documents that might answer the question of who controlled these destination addresses?

A. No. I want to be clear here. In this exhibit, Exhibit 8, I'm using -- I'm assessing Dr. [redacted] work. And the address I.D., that second column that we were discussing, is drawn from the identification of the wallets, or the

addresses, from Dr. [redacted] work.

So this is a product of his backup materials that he produced in terms of his identification of the address I.D. And so I'm assessing the work that he did including what's reflected in this table.

So this table is really drawn very directly from his backup. Obviously, I calculated the cumulative number of days from Larsen or Garlinghouse wallet transfer, which is a trivial calculation, but this is a reflection of his -- his work, his backup, and his identification.

Q. Okay. Looking just at the first example regarding Mr. Larsen, the way I read the first row is that Mr. Larsen transferred 20 million units of XRP to the destination address in the first row starting with "[redacted]

Do you agree?

A. Yes.

Q. Okay. And then the next transfer is from [redacted] of 2,083,313 XRP to the following destination address of R -- well, no. Strike that.

This is what I'm having trouble understanding. It looks like, if I'm reading your

chart correctly, the units of XRP traced by Dr. [redacted] goes from 20 million to 2,083,313 and then back up, in the next row, to 2,083,333.

Do you see that?

A. I -- I'm not following you.

Q. Okay. Do you see "Units of XRP transferred, 20 million"?

A. Yes.

Q. Okay. If you go all the way to the right on that same row, do you see "Units of XRP traced by Dr. [redacted]

A. Yes.

Q. Okay. And that value is 2,083,313?

A. Yes.

Q. Okay. So the next entry under "Units of XRP transferred" is 2,083,333.

Do you see that?

A. So I'm supposed to be looking at the second row now?

Q. Yes.

A. Okay.

Q. So my question is, it appears that this chart is suggesting that 20 million XRP were transferred, 2,083,313 were traced, but then the number of XRP units transferred goes back up to

2,083,333.

Can you explain how -- how that works?

MR. KELLOGG: Objection.

A. I think you're make --

MS. PROSTKO: Objection.

A. I think you're mis -- I think you're misreading the chart a little bit, or the -- or the figure or the exhibit, I should say.

Q. Yeah. Please explain.

A. So Dr. [redacted] is -- is tracing for -- first, let me note that I was not provided with his hop program pursuant to which he's doing this hop analysis. So that was a black box that I was not able to access.

According to his tracing algorithm, which I don't have access to, he ultimately traces for this first hop -- the hop -- the first hop consisting of three hops, ultimately traces the 2,083,313. So that's why that number in the second-to-last column is the same because that's what he ultimately ascribes in terms of the hop analysis from Larsen to the final destination, which is GSR.

But as you're pointing out, the units of XRP transferred per hop or per -- or per

transaction does vary. But, really, the question is -- well, what's reflected in that second-to-last column is what Dr. [redacted] ascribes to Dr. -- or Mr. Larsen in terms of the ultimate destination of GSR.

But you are right that the individual hops -- one, two and three -- would -- you know, they're not all the same.

Q. Okay.

MR. SYLVESTER: Can we take five minutes off the record before we end for the day? Is that all right with you?

THE WITNESS: Sure.

MR. KELLOGG: Sure.

MR. SYLVESTER: Great. Thank you very much.

THE VIDEOGRAPHER: Okay. Thank you. The time is approximately 6:39. We're going off the record.

(Whereupon, a recess is taken.)

THE VIDEOGRAPHER: The time is approximately 6:47 p.m. We're back on the record.

BY MR. SYLVESTER:

Q. Okay. Professor, are you expressing the opinion in this case that defined that an instrument was offered and sold as an investment contract, that instrument must entitle its holder to a share of the profits of the company that sold the instrument?

MR. KELLOGG: Objection.

A. So as I understood, if I heard your question that -- the first part was it -- was in order to be defined as a security, am I correct?

MR. SYLVESTER: Do you want to read it back, Bridget? No, you don't want to. You want me to say it. Okay. I'll say it again.

BY MR. SYLVESTER:

Q. I said investment contract, but let me just restate the question.

Are you expressing the opinion in this case that defined that an instrument was offered and sold as an investment contract, that instrument must entitle its holder to a share of the profits of the company that sold the instrument?

MR. KELLOGG: Objection.

A. That calls for a legal opinion. The answer to that question is no.

Q. Okay. Are you expressing the opinion in this case that defined that an instrument was offered and sold as an investment contract, that instrument must require the company that sold the instrument to expend efforts in some way?

MR. KELLOGG: Objection; calls for a legal conclusion.

A. As I understand the question, it calls for a legal conclusion. I'm not providing that opinion.

Q. Okay. Are you providing the opinion in this case that it is not possible for a virtual currency to be offered and sold as an investment contract?

MR. KELLOGG: Objection.

A. As I understand the question, it calls for a legal opinion, so I'm not providing that opinion.

MR. SYLVESTER: Okay. That is all the questions I have for you, Professor Ferrell.

I just want to again -- you know, we've -- this is to Ripple's

counsel.

We've heard today about analysis that Professor Ferrell conducted that was not disclosed in his opening expert report. We've also heard about analysis that he conducted subsequent to reviewing Dr. [redacted] work. I just want to put on the record that we reserve all rights depending on what defendants do or don't do with that information. That could include calling Dr. -- Professor Ferrell back. That's our reservation of rights.

I have nothing further for you. Thank you very much. I appreciate your time, Professor.

THE WITNESS: Thank you.

THE VIDEOGRAPHER: May I close out the deposition for today?

MR. KELLOGG: You may.

THE VIDEOGRAPHER: Thank you. We are off the record at 6:49 p.m. and this concludes today's testimony by Dr. Allen Ferrell. The total number

of media units used was seven and will be retained by the court reporting agency. Thank you.

THE WITNESS: Thank you.

(Whereupon, the deposition concluded at 6:49 p.m.)

STATE OF NEW YORK)
) ss:
COUNTY OF NEW YORK)

I hereby certify that the witness in the foregoing deposition, FRANK ALLEN FERRELL, III, Ph.D., was by me duly sworn to testify to the truth, the whole truth and nothing but the truth, in the within-entitled cause; that said deposition was taken at the time and place herein named; and that the deposition is a true record of the witness's testimony as reported by me, a duly certified shorthand reporter and a disinterested person, and was thereafter transcribed into typewriting by computer.

I further certify that I am not interested in the outcome of the said action, nor connected with nor related to any of the parties in said action, nor to their respective counsel.

IN WITNESS WHEREOF, I have hereunto set my hand this 25th day of February 2022.

Reading and Signing was:

___ requested ___ waived _X_ not requested.

_____

BRIDGET LOMBARDOZZI, CSR, RMR, CRR

Transcript Word Index

f

g

u

v

[words - zoom]

Exhibit 25

CHAPTER 17A

EVENT STUDY METHODS: DETECTING AND MEASURING THE SECURITY PRICE EFFECTS OF DISCLOSURES AND INTERVENTIONS (NEW)

M. Laurentius Marais, PhD
Katherine Schipper, PhD

CONTENTS

17A.1 INTRODUCTION. A dispute or litigation involving the value of a company often requires analysis of price changes of public securities in response to news about, for example, product recalls, takeover offers, regulatory and legislative changes, and earnings. In particular, substantial litigation arises in the area of

securities fraud: Typically, a class of investors sues a company and some or all of its officers, directors, and professional advisors for losses suffered when the security price declines, usually after the release of adverse information.

When a dispute or litigation requires an analysis of security price changes in response to a news disclosure, it is often appropriate to distinguish two related questions: (1) Does the price history establish that the disclosure caused any price reaction at all?, and (2) if so, what was the size and direction of the net price reaction to the disclosure alone, after accounting for the effects of other factors operating at the same time? This chapter describes a statistical approach, often referred to as an *event study*, for analyzing these questions. We outline the creation and interpretation of a generic, market-model-based event study without specifying a particular context or purpose. Chapters 18 and 19 of the third edition of the *Litigation Services Handbook* describe potential litigation contexts for such calculations, such as the quantification of damages by combining event study results with information about trading.

Computing damages in securities cases is an important, litigation-related application of event studies. The literature reviewing the legal and economic theories supporting this application include Gilson and Black (1993), Macey and Miller (1990), Koslow (1991), Cooper Alexander (1994), and Macey et al. (1991). Other articles provide additional details concerning event studies and the translation of an event study result to a dollar damage figure: Cone and Laurence (1994), Furbush and Smith (1994), and Gould and Kleidon (1994).

(a) Definition of Event Study. An *event study* is an empirical analysis of an intervention in a time series. In its most common form, an event study involves a statistical regression analysis of a time series of security returns, with the objective of identifying and measuring firm-specific effects of identifiable information releases (events). (Unless otherwise noted, we will use the terms *stock*, *share*, and *security* interchangeably). While many event studies analyze common stock or securities, the approach also applies in other contexts, some of which this chapter describes.

(b) Illustrative Example. Exhibit 17A-1 lists the daily closing prices and returns of the shares of the hypothetical Firms A and B for a 51-day period surrounding a hypothetical announcement date. (The data are artificial but illustrate typical patterns.) Exhibit 17A-2 plots the time series of share prices for Firm A shown in Exhibit 17A-1. This display strongly suggests that some event positively affected the price of Firm A's shares at day 0 (zero), the day of the announcement. Day 0 is referred to as the *event day*. Such impressive interventions usually occur only in conjunction with extraordinary events such as receipt of a takeover offer. Large *negative* price adjustments may also occur, for example, in association with unexpected adverse earnings news. [See, for example, Francis et al. (1994) and Kasznik and Lev (1995).]

Simple displays of real-world data do not usually reveal such obvious features. To confirm or refute the hypothesis of an extraordinary intervention in a series, an analyst will usually have to do more than plot and inspect the data. Often, he or she will use formal statistical analysis both to decide whether an intervention has occurred and to measure the size of its effect.

Event Date	Firm A Closing Price	Firm A Stock Return	Firm B Closing Price	Firm B Stock Return	Market Return	Event Date	Firm A Closing Price	Firm A Stock Return	Firm B Closing Price	Firm B Stock Return	Market Return
-25	$50.00	0.01%	$34.00	-2.86%	-1.41%	0	$56.81	12.01%	$39.97	-1.24%	1.40%
-24	$48.03	-3.94%	$34.09	0.26%	-0.57%	1	$57.03	0.39%	$40.25	0.70%	1.41%
-23	$45.22	-5.85%	$35.16	3.14%	1.39%	2	$55.28	-3.07%	$39.72	-1.32%	-0.85%
-22	$47.31	4.62%	$34.69	-1.34%	-0.49%	3	$54.88	-0.72%	$39.47	-0.63%	-0.30%
-21	$46.94	-0.78%	$34.59	-0.29%	-0.53%	4	$54.47	-0.75%	$37.97	-3.80%	-2.00%
-20	$48.34	2.98%	$34.25	-0.98%	-0.78%	5	$53.16	-2.40%	$37.44	-1.40%	-0.75%
-19	$47.72	-1.28%	$34.25	0.00%	-0.09%	6	$53.88	1.35%	$37.03	-1.10%	-0.06%
-18	$47.34	-0.80%	$34.75	1.46%	-0.48%	7	$55.03	2.13%	$37.66	1.70%	1.49%
-17	$47.78	0.93%	$34.69	-0.17%	-0.50%	8	$57.31	4.14%	$37.19	-1.25%	-0.45%
-16	$47.16	-1.30%	$34.81	0.35%	0.67%	9	$56.25	-1.85%	$36.91	-0.75%	-0.92%
-15	$48.16	2.12%	$34.69	-0.34%	-0.35%	10	$57.22	1.72%	$37.22	0.84%	0.63%
-14	$48.66	1.04%	$35.56	2.51%	1.23%	11	$57.59	0.65%	$37.16	-0.16%	-0.44%
-13	$48.34	-0.66%	$36.69	3.18%	1.17%	12	$58.94	2.34%	$37.84	1.83%	1.60%
-12	$47.38	-1.99%	$38.25	4.25%	0.07%	13	$58.97	0.05%	$37.50	-0.90%	-0.66%
-11	$48.44	2.24%	$37.69	-1.46%	-1.33%	14	$59.97	1.70%	$37.53	0.08%	0.81%
-10	$47.72	-1.49%	$37.97	0.74%	0.57%	15	$60.09	0.20%	$37.56	0.08%	-0.34%
-9	$46.91	-1.70%	$38.00	0.08%	0.96%	16	$60.41	0.53%	$36.94	-1.65%	-0.79%
-8	$46.84	-0.15%	$38.28	0.74%	0.79%	17	$61.16	1.24%	$36.91	-0.08%	1.62%
-7	$48.44	3.42%	$37.63	-1.70%	0.19%	18	$61.53	0.60%	$38.38	3.98%	1.33%
-6	$49.31	1.80%	$37.50	-0.35%	-0.10%	19	$60.69	-1.37%	$37.81	-1.49%	-0.31%
-5	$49.47	0.32%	$38.28	2.08%	0.28%	20	$61.00	0.51%	$37.84	0.08%	0.38%
-4	$48.50	-1.96%	$38.53	0.65%	0.18%	21	$60.09	-1.49%	$40.19	6.21%	1.16%
-3	$48.34	-0.33%	$38.63	0.26%	-0.72%	22	$61.97	3.13%	$39.94	-0.62%	1.18%
-2	$50.03	3.50%	$39.75	2.90%	1.42%	23	$62.59	1.00%	$40.13	0.48%	0.13%
-1	$50.72	1.38%	$40.47	1.81%	1.18%	24	$62.41	-0.29%	$40.38	0.62%	0.16%
						25	$60.16	-3.61%	$40.69	0.77%	-0.64%

Exhibit 17A-1. Daily Closing Stock Prices and Returns for Periods of 51 Trading Days Surrounding Announcement Event Firms A and B

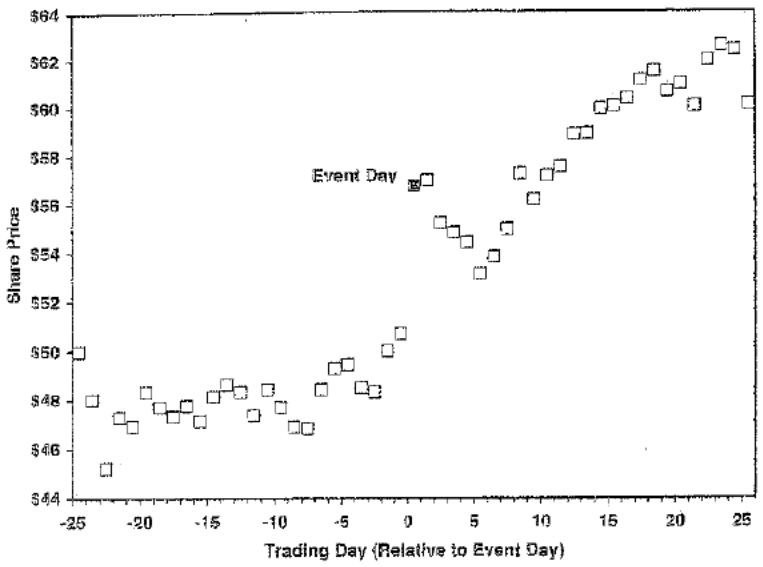


Exhibit 17A-2. Share Price of Firm A: Announcement at Day 0

Even absent specific, identifiable interventions, security price series display variation, as prices move in response to news about the economy in general, specific industries, and individual firms. Statistical methods provide objective interpretations of the evidence for—and estimates of the size of—the effect of a given intervention or shift in a price series, against its background variability. These statistical methods typically provide interpretations of the data that rely on an underlying statistical model which assumes *stationarity*: that each observed data point is drawn (independently) from a probability distribution of feasible values that does not change from one observation to the next. This clearly does not hold true of the prices in Exhibit 17A-2, in that the price on any given day tends to be closer to the prices at nearby dates than to those at remote dates. This indicates that the probability distribution of prices changes over time, in other words, it is *nonstationary*.

When referring to the stationarity assumption, one must distinguish between prices and price changes. Research on the behavior of security prices has shown that successive relative price *changes*, or *security returns*, are approximately independently drawn from a stationary distribution.[1] Thus the distribution of *returns* conforms well to the assumption underlying the statistical methods used in event studies, even though the distribution of *prices* does not. Exhibit 17A-3 shows the series of raw returns corresponding to the price series in Exhibit 17A-2. The return for any given nonevent day in Exhibit 17A-3 is no more likely to be similar to that for a nearby date than to that for a remote date. Thus, the structure of the return

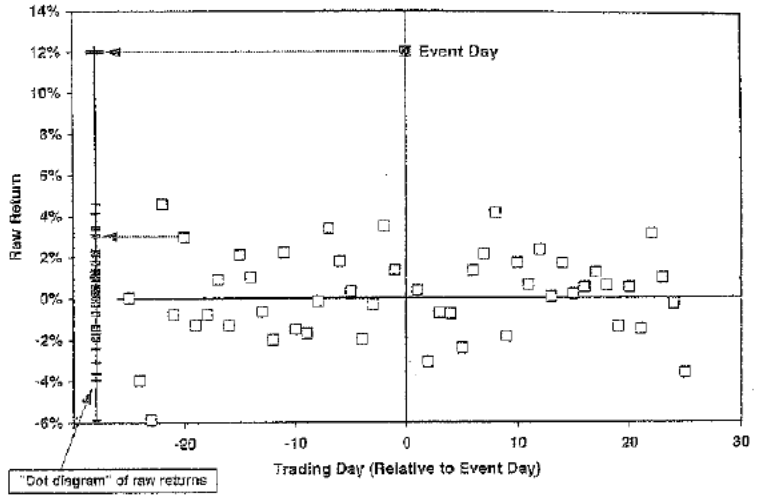


Exhibit 17A-3. Raw Returns to Firm A: Announcement at Day 0 (Dot Diagram of Raw Returns Obtained by Sliding All Data to Vertical Axis)

series is consistent with random sampling from a stationary distribution: the ordering of the nonevent returns in a time series does not relate to their values in Exhibit 17A-3.

The statistical analysis of the Firm A security return on the event day presents a formal method for comparing that return to the range of nonevent returns and their relative frequencies, which provide a benchmark for the range of normal return variation. Exhibit 17A-3 shows a vertical dot diagram obtained by projecting all the return observations onto the left-hand vertical axis, as indicated by horizontal arrows for an illustrative observation at day −20 and for the event date. The dot diagram visually displays frequency by density. An informal comparison of the event-day return to the nonevent dot diagram identifies the event-day return as highly unusual. The analyst can formalize this indication as a special case of a pooled, two-sample *t*-test. The intervention on the event day stands out as impressively in the returns series shown in Exhibit 17A-3 as in the price series shown in Exhibit 17A-2, so that formal statistical analysis will likely confirm what the data display appears to reveal on its face.

Often, analysts cannot easily discern the event-day return, as Exhibit 17A-4 illustrates. The event-day return to Firm B (shown in both the time series plot and the dot diagram in solid black) does not present the most extreme observation in Exhibit 17A-4.

Inspection alone does not reveal whether the event day return to Firm B is so unusual as to offer evidence of an intervention causing a material market reaction

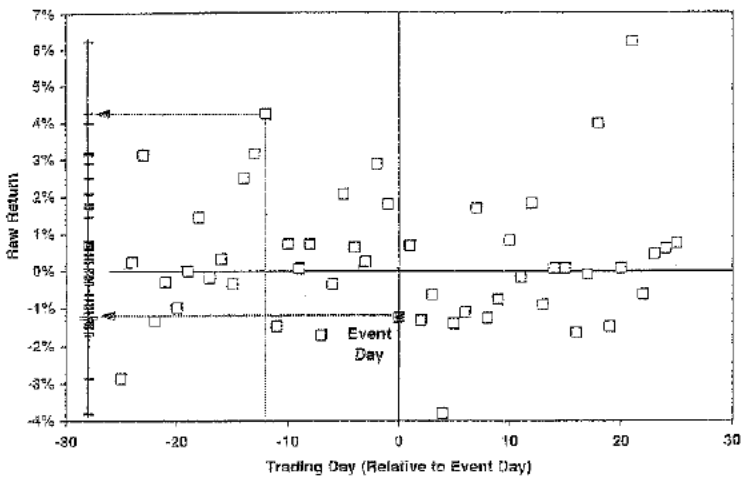


Exhibit 17A-4. Raw Returns to Firm B: Announcement at Day 0

to the announcement. Interpretation of the data underlying Exhibit 17A-4 must therefore rely on statistical inference. Again, assuming that the returns are independently drawn from a stationary distribution, their ordering has no relevance. Thus, the problem of assessing the evidence for a material market effect reduces to that of comparing the event-day return to the nonevent dot diagram of returns obtained by projecting all the data onto the vertical axis. Exhibit 17A-4 illustrates this projection by the horizontal arrows for the observation at the event day and day −12, which we use as an illustrative, nonevent observation.

(c) Inference Based on Market-Model-Adjusted Abnormal Returns. Clearly, security returns react to causes other than the announcement under consideration. To assess the effect of the announcement itself, especially in Exhibit 17A-4, the study should ideally identify those causes and remove their effects from the data. In most cases, however, analysts cannot identify all relevant factors, let alone measure their cumulative effect on each observed return. Instead, analysts could use a more practical approach of comparing the return series under consideration to a benchmark series that the same common causes, other than the announcement, will likely affect. The return to a market index offers such a convenient, theoretically defensible benchmark return series. Any factor that affects all securities in the market, including those of the subject firm, will be reflected in the market index return series as well as in the return series under consideration.

Exhibit 17A-5 shows a scatterplot of Firm B returns against those to a market index. Each observation reflects the intersection of the firm return (shown on the

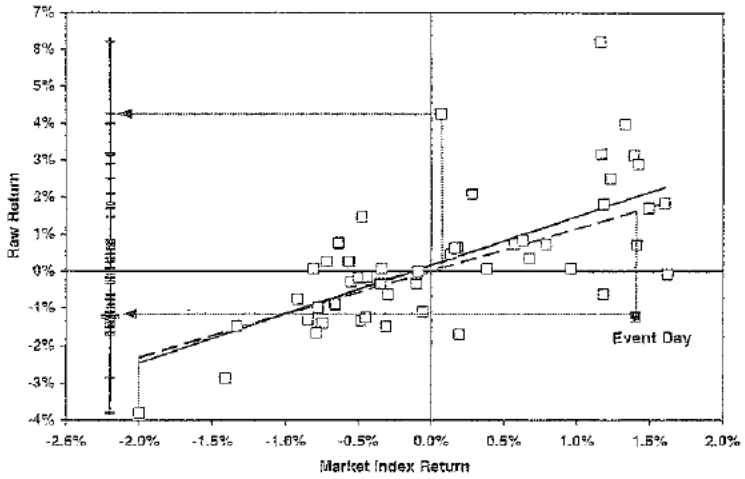


Exhibit 17A-5. Firm B Returns versus Market Index Returns

vertical axis) with the market return on the same day (shown on the horizontal axis). Exhibits 17A-4 and 17A-5 reduce to identical dot diagrams, but they have different horizontal axes. In Exhibit 17A-4, the horizontal axis carried information about which day (relative to the event day) related to a given return; this information bears no relevance for inferring the materiality of the event return. In Exhibit 17A-5, the horizontal axis carries information about market returns; the upward sloping configuration of the X–Y graph indicates that the market returns help explain variation in the firm's returns attributable to common, marketwide factors.

The dashed, sloping line in Exhibit 17A-5 shows the underlying, true regression of Firm B's returns on the market return—that is, the straight line that best explains the relation of the two return series. This line also provides a *forecast* of the firm's return, given only the market return and the joint history of returns. This forecast reflects the common factors that the market return indicates. (The solid sloping line in this exhibit reflects the approximate regression line that an analyst would calculate by applying a statistical estimation method to the available data shown in the exhibit. We discuss the distinction between the two lines in section 17A.3.)

An actual event-day return includes the effect of the announcement as well as the effects of the common factors. Therefore, the *difference* between the conditional forecast (i.e., the sloping line) and the actual return more nearly isolates the effect of the announcement alone than does the original raw return. The dotted vertical line connecting the event-day return to the regression line indicates this "residual" difference, which analysts often refer to as the *abnormal return* associated with the

announcement. The most negative nonevent market-adjusted return (in the lower left-hand corner of Exhibit 17A-5, and corresponding to event date +4 in Exhibit 17A-4) clearly becomes much less prominent than its raw return counterpart in Exhibit 17A-4. Exhibit 17A-5 largely attributes the unusual magnitude of this nonevent raw return to the effect of marketwide rather than firm-specific factors. Finally, Exhibit 17A-6 shows the time series and the corresponding dot diagram of abnormal (or "residual") returns to Firm B, confirming an unusual event-day return, once the analysis accounts for market-wide influences. Indeed, the market adjustment shown in Exhibit 17A-5 reveals the event-day abnormal return shown in Exhibit 17A-6 as the most extreme negative value observed during the sample period, unlike the corresponding raw return in Exhibit 17A-5. In contrast, Exhibits 17A-5 and 17A-6 show that the illustrative nonevent return on day −12 is little changed by market adjustment. (The day −12 return—like that on day 20—may or may not be associated with an identifiable disclosure of good news concerning Firm B but is, in any case, not associated with the day 0 event that we assume to be the analyst's focus.)

17A.2 APPLYING EVENT STUDIES TO LITIGATION QUESTIONS. Event studies may serve at least two related purposes in disputes or litigation that involve damages calculations. First, the analysis can address whether, as a threshold question, a statistically reliable link exists between the information event in question and stock price responses. For example, in securities litigation over allegedly defective disclosures, financial experts must link the share-price reaction to the alleged correction of the allegedly defective prior disclosures or omissions. Opposing experts will break this link if they can attribute the price change at the alleged correction

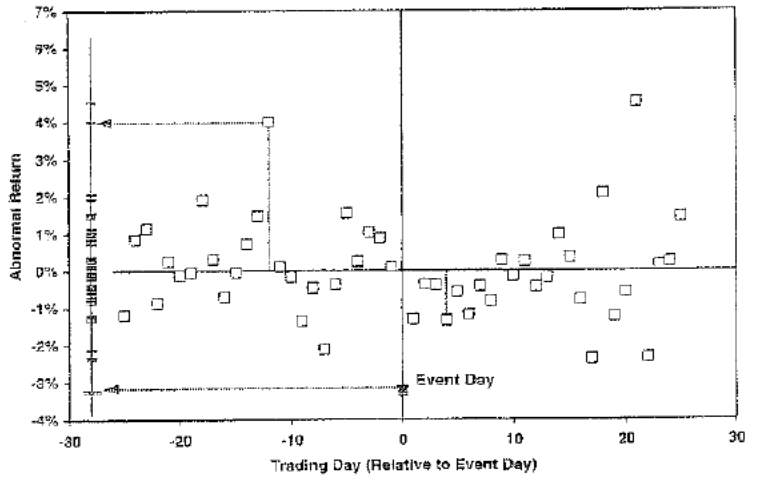


Exhibit 17A-6. Abnormal Returns to Firm B: Announcement at Day 0

date to other information revealed at the same time. Second, the analysis can address the magnitude of damages. An event study in this context proves most useful under the following three conditions:

1. A returns series is available that covers the event at issue and it is long enough to allow estimation of the market model (possibly augmented by an industry index, a size index, or a book-to-market index), including the firm-specific variability of returns (i.e., the standard deviation of returns after abstracting from market and industry effects).
2. The stock trades often enough so that each return covers just one day or at most a few days.
3. The parties can unambiguously identify the event in question with one or more announcements that have relatively certain timing, and the event announcement(s) do not contain a great deal of valuation-relevant information unrelated to the issue in question. Such unrelated information is commonly called *confounding events*. For example, a firm might announce a change in dividend policy concurrently with an earnings release; a study that focuses on the earnings release will have difficulty separating the earnings effect from that of the shift in dividend policy.

(a) Conditions for Using Event Studies in Litigation

(i) Statistical Conditions. As a practical matter, analysts will have more difficulty identifying interventions in return series for a thinly traded security because fewer returns exist and because (for multiday returns) all the news events during the several days covered by each return can affect that return. In addition, the variability inherent in a return series becomes a function of the time period covered by the return: that is, two-day returns have twice the variance of one-day returns and so on. Thus, analysts can most easily perform event studies for exchange-listed and NASDAQ common stocks that trade actively. Such studies become problematic for securities, such as debt and preferred stock, which tend to trade infrequently and at irregular intervals. In addition, analysts will find returns data much more readily available for common stocks than for many preferred stocks and most bonds.

(ii) Theoretical Conditions. Three theoretical conditions underlie the event study approach. First, the security of interest must be traded in an *informationally efficient market:* that is, one in which prices respond quickly and appropriately to valuation-relevant news. In such a market, current price provides the best estimate of intrinsic value for the security, conditional on publicly available information. Without this condition, it becomes difficult to argue that new information drives price changes. One party might propose, for example, that prices change not in response to underlying economic events but rather in response to fads or psychological factors that have little or no relation to economic events.

The efficient market condition provides the foundation of the fraud-on-the-market theory described in, for example, Koslow (1990). Plaintiffs in securities actions can rely on prices as measures of the intrinsic values of the underlying

securities, provided those prices appropriately impound public information. A person or entity that omits or falsifies information violates the integrity of prices; that is, the prices no longer represent intrinsic value. Under the fraud-on-the-market theory, an investor who relied on a price that did not reflect all relevant valuation information because of defective (i.e., false, misleading, or incomplete) disclosures can bring a claim, regardless of whether that person actually read or knew about the filings or other statements that contained the omission or false information. Note that if a defendant were to demonstrate that the security in question was not traded in an efficient market, the plaintiff's analysis would not meet an important condition for relying on event studies.

The second condition is that the analysts' statistical model of the return-generating process must be descriptively valid throughout the sample period. Event studies often use a form of market model as the assumed return-generating process, as illustrated in Exhibit 17A-5. Sections 17A.3 and 17A.4 of this chapter discuss the market model and issues related to the design of studies based on it.

The third condition applies most strongly where the plaintiff alleges that damages stem from a delayed disclosure. To base inferences on an event study of the actual disclosure, the abnormal return at the actual disclosure must be the same or nearly the same as the response that would have occurred had the disclosure happened at some other time. This condition requires stationarity in the reaction of the return series to disclosures, just as the second condition requires stationarity in the relation between the returns of the stock being analyzed and the market and industry index returns.

17A.3 STATISTICAL SPECIFICATION AND ESTIMATION OF EVENT STUDIES.

As illustrated in Exhibit 17A-5, an event study of security returns typically seeks to partition the variation of returns to a given security into two components. This partitioning corresponds to the *market model* equation for security *s*:

$$r_{st} = a_s + \beta_s r_{mt} + \varepsilon_{st} \qquad (1)$$

where

- r_{st} = return to security s on day t
- a_s = market model intercept for security s, that is, the intercept of the dashed sloping line in Exhibit 17A-5
- β_s = market model beta for security s, that is, the slope coefficient of the dashed line in Exhibit 17A-5
- r_{mt} = market index return on day t
- ε_{st} = firm-specific abnormal return to security s on day t, that is, the vertical deviation of the observation for day t from the dashed sloping line in Exhibit 17A-5

The variation over time of $(a_s + \beta_s r_{mt})$, the first component of r_{st}, reflects marketwide effects. Analysts refer to this component as the systematic (or predictable, conditional on knowledge of the market or industry effects) portion of the return. The second component, ε_{st}, is the firm-specific effect, including that for $t = 0$ (the event day), the effect of the intervention in the return series. This idiosyncratic return component corresponds to the dotted vertical line in Exhibit 17A-5; it numerically measures the abnormal return. This terminology has intuitive appeal because the firm-specific return at a given event indeed lies outside the normal expected return predicted by or associated with industry and market factors.

(a) Estimating the Market Model by Statistical Regression Analysis. Analysts compute systematic or predicted returns based on the historical relation between a given stock's return and the returns on one or more market, size, book-to-market and industry indexes.[2] The estimated coefficients obtained by regressing a series of stock returns on returns to the selected index(es) summarize this historical relation. The dashed regression line in Exhibit 17A-5 represents the underlying true regression line; that is, we assume that it is a stable attribute of the process that generated the underlying series of prices but that its intercept and slope are unknown and must be estimated using the available data series. We estimate the intercept and the slope of the regression line by applying a statistical estimation method such as ordinary least-squares (OLS) to a sample of returns taken from an estimation period.

The solid sloping line in Exhibit 17A-5 shows the OLS estimate of the regression line, based on all data in the exhibit except the event-day return. Thus the solid sloped line corresponds to the *estimated* market model equation.

$$r_{st} = a_s + b_s r_{mt} + e_{st} \qquad (2)$$

where a_s and b_s are the OLS estimates of a_s and β_s in (1). Given a_s, b_s, r_{st}, and r_{mt}, we can compute e_{st}, the estimated counterpart of ε_{st}. Whether e_{st} is a *residual* or a *prediction error* depends on whether the estimation sample includes the return for day t. Because the analyst usually needs to estimate the market model as the normal benchmark for assessing the intervention in the return series, the study most often computes the estimated event-day abnormal return e_{s0} as a prediction error. That is, we compute a_s and b_s from an estimation sample without the event-day return, and compute e_{s0} as the deviation of r_{s0} from the estimated regression line shown as the solid line in Exhibit 17A-5:

$$e_{s0} = r_{s0} - (a_s + b_s r_{m0}) \qquad (3)$$

(Note that the dotted vertical line at the event day in Exhibit 17A-5 shows the deviation of r_{s0}, the event-day return, from the *true* regression line, whereas e_{s0} is actually the deviation of r_{s0} from the *estimated regression* line. Both deviations are referred to as "abnormal returns," depending on the context.)

Analyses often specify the market model with a single, marketwide index (such as the Standard and Poor's [S&P] 500 or the value-weighted or equally weighted return on all New York Stock Exchange [NYSE] stocks). Studies can augment this basic model by including an industry index—for example, one composed of firms in the same Standard Industrial Classification (SIC) code which presumably react to the same industry-specific common factors. The resulting *augmented market model*

$$r_{it} = a_i + \beta_{ims} r_{mt} + \beta_{is} r_{it} + \varepsilon_{it} \qquad (4)$$

has two slope coefficients, one for the relation of the stock return being analyzed with the market index and one for its relation with the industry index r_{it}. Both coefficients measure the sensitivity of stock returns to index returns. Fama and French (1992, 1993) have proposed a *three-factor market model*, which augments the marketwide index with indexes based on size (i.e., market capitalization) and book-to-market ratios. Studies include these additional factors (industry indexes, size-based indexes, and book-to-market indexes) to increase the proportion of the variance of total returns (the left-hand side variable) that they explain, thereby reducing the variance of the abnormal returns. Whether it is necessary or appropriate to include such additional factors depends on the context and is generally an empirical issue.

(b) Interpreting the Strength of the Market-Model Relation. Analysts use two measures of the estimated relation between individual security returns and returns to the index (or indexes): the magnitude (and statistical significance) of the regression slope (beta) coefficient(s), and the explanatory power of the regression expressed in terms of R^2, the fraction of the variance of returns explained by the regression.

(i) Beta Coefficient. In the context of the market model, analysts refer to the slope coefficient (β_i in Equation 1) as the security's *beta* or systematic risk. A beta coefficient of 1.0 means that the security returns change, on average, exactly as much as the market index returns in response to the common factors captured in the index. Coefficients greater or less than 1.0 indicate securities whose expected returns vary more or less than average in response to the common factors. Exhibit 17A-7 summarizes the distribution of estimated betas for NYSE/AMEX and NASDAQ securities in the period 1985 to 1999, organized by size decile. Size Decile 1 in Exhibit 17A-7 refers to those 10 percent of exchange-listed firms having the smallest market capitalizations on the indicated exchange; similarly, decile 10 refers to those 10 percent of listed firms having the greatest capitalizations. The second of the three groups of columns of the exhibit summarizes, separately for each firm size group, the range of beta values for that group. Specifically, the exhibit shows the first quartile, median, and third quartile (i.e., the 25 percent, 50 percent and 75 percent points) of the range of calculated beta values. For example, the exhibit shows that the median calculated beta among all NYSE/AMEX firms was 0.67.

In principle, the weighted average measure of sensitivity of stock returns to market returns (i.e., the average beta) equals 1.0: few stocks have zero-or negative estimated sensitivity measures, and few stocks (less than one-fourth) have sensitivity measures substantially greater than 1.0.

(ii) Statistical Significance. The statistical significance of the estimated coefficient measures the reliability of its estimated sign and magnitude, based on the coefficient's standard error. The OLS regression calculations produce a standard error for each estimated coefficient to gauge the size of the discrepancy between the estimated value and the underlying true value. (This discrepancy is the difference between the slopes of the solid OLS regression line in Exhibit 17A-5 and the dashed true regression line.)

Listing	Size Decile	Standard Deviation of Raw Returns (%) Q1	Median	Q3	Market Model Beta Q1	Median	Q3	Market Model R-Squared (%) Q1	Median	Q3
NYSE/AMEX	1	3.0	4.8	6.7	0.24	0.49	0.78	0.2	0.5	1.4
	2	2.3	3.6	5.2	0.26	0.53	0.83	0.4	1.1	2.6
	All	1.7	2.3	3.4	0.37	0.67	1.00	1.1	3.5	9.0
	9	1.6	2.0	2.4	0.64	0.91	1.15	7.2	12.2	18.1
	10	1.6	1.8	2.1	0.81	1.01	1.20	15.2	23.0	28.5
NASDAQ	1	4.3	5.9	7.8	0.00	0.25	0.57	0.0	0.1	0.5
	2	5.0	6.4	8.5	0.12	0.37	0.71	0.0	0.2	0.6
	All	3.3	4.6	6.3	0.25	0.57	0.97	0.2	0.8	2.7
	9	2.5	3.4	4.6	0.55	0.91	1.28	1.6	3.4	5.9
	10	2.2	3.2	4.1	0.78	1.19	1.67	4.1	7.1	11.2

Notes: Data are taken from the files of the Center for Research in Security Prices (CRSP) at the University of Chicago, including Scholes-Williams estimates of market model betas based on the value-weighted CRSP index. Size is measured by market capitalization; the smallest firms are in decile 1. Q1 and Q3 denote the first and third quartiles of the data.

Exhibit 17A-7. Summary Statistics for Estimates of Beta, Standard Deviation of Raw Returns, and Market Model R^2 by Capitalization Decile: NYSE & AMEX NASDAQ Firms, 1985–1999

Statistical theory provides that a confidence interval centered at b_s and extending for two standard errors in each direction will cover the true value β_s approximately 95 percent of the time. Thus a finding that the two-standard-errors interval does not cover zero indicates at a 95 percent level of confidence that the estimated coefficient b_s has at least the same sign as the true coefficient β_s. In many applications, one can restate this condition as that of requiring that the *t ratio*, that is, the ratio of the estimated coefficient to its standard error, equal at least two.

Most event studies have greater interest in the statistical significance of the estimated effect of the intervention (i.e., the significance of the abnormal return) than that of the slope coefficient, as discussed in section 17A.3(c), which explains event parameters.

(iii) Standard Deviation of the Return Series. The presence of return variability that differs substantially across stocks means that a return of a given magnitude may be unusual for one firm and frequently observed for another. A common measure of the variability inherent in a given return series is the *time-series standard deviation* of returns, which measures the typical dispersion of returns around their mean over some time period.[3] Exhibit 17A-7 summarizes the standard deviations of daily returns for NYSE/AMEX and NASDAQ firms, overall and for extreme market-value deciles. These standard deviations decrease as firm size increases (larger firms have smaller variability of returns). The largest standard deviations occur for smaller firms on both the NYSE/AMEX and NASDAQ (with a median of about 4 to 5 percent for the smallest NYSE/AMEX firms and a median of about 6 percent for the smallest NASDAQ firms), while the smallest standard deviations occur for the largest firms on the NYSE (with a median of about 1.8 percent).

Statistical theory shows that approximately two-thirds of all returns should fall within plus-or-minus one standard deviation of the mean, and about 95 percent of all returns should fall within plus-or-minus two standard deviations. Thus, one would observe by chance (i.e., on a day selected at random) a return that exceeded two standard deviations from the mean no more than 5 percent of the time.

We can use this approximate rule and the data in Exhibits 17A-3 and 17A-4 to evaluate the likelihood of observing the event-day returns to Firms A and B by chance alone; that is, on the assumption that the information events had *no* effect on the return series. The sample standard deviations of nonevent returns for Firms A and B in the examples equal 2.13 and 1.84 percent; their sample average returns equal .16 and .35 percent. Firm A's event-day return of 12.1 percent deviates by more than five standard deviations from the average. Thus, we have over 95 percent (indeed, more than 99.9 percent) confidence that the event-day return is not simply a random observation from the distribution of nonevent returns, unaffected by the information event. Firm B's event-day return of −1.3 percent, however, lies less than one standard deviation from the average; one frequently observes returns as extreme as −1.3 percent even when no news announcement occurs.

(iv) Explanatory Power: R^2. The second numerical measure of the estimated relation between returns of a stock under study and the returns to an index or indexes lies in the explanatory power of the regression. The regression's R^2 (R-squared) measures (in the case of a market model regression) the fraction of the variance in

stock returns that the index returns explain. The explanatory power appears as a reduction in the variance of abnormal returns [for example, the e_{st} in equation (2)] relative to the variance in raw returns. For example, the time-series variance of Firm B's raw returns plotted in Exhibit 17A-4 is approximately .000340 (excluding the event-day return), while that of the abnormal returns in Exhibit 17A-6 is .000179. Therefore the R^2 of the regression in Exhibit 17A-5 equals approximately 47 percent (i.e., 1 − .000179/.000340). The greater the R^2, the greater the portion of a given stock's return that one would expect to arise from market and industry forces, as opposed to firm-specific news.

In a market model regression, the portion of a stock's return not explained by the chosen indexes is called *residual variation*. Both the amount of total variation in stock returns and the amount of residual variation in stock returns differ among stocks. Exhibit 17A-7 summarizes the market model R^2 for individual firms on the NYSE/AMEX and NASDAQ. For the largest NYSE firms the median R^2 equals about 23 percent. The overall median R^2 for NYSE/AMEX firms equals only about 3.5 percent, however, and for NASDAQ firms it equals only about .80 percent. Because of averaging effects, stock portfolios have much greater R^2 numbers than those for individual stocks.

(c) Inferring the Effect of the Event: The Event Parameter Approach. The event-day abnormal return of −3.0 percent shown in Exhibit 17A-6 deviates from the mean nonevent abnormal return (.24 percent) by about 2.4 times the standard deviation of the nonevent abnormal returns (1.34 percent). By this measure, the event-day abnormal return is statistically significant at the 5 percent level.

Although similar in form to the assessment of statistical significance for the raw event-day returns as outlined above, the calculation for abnormal returns as presented here is not feasible. In a real event study, analysts will not know the underlying, "true" regression represented by the dashed line in Exhibit 17A-5 and, therefore, will not know the length of the vertical line segment representing the "true" event-day abnormal return. Although analysts will know none of the ingredients of the sample calculation outlined here, they can approximate all of them by using the estimated, solid regression line in Exhibit 17A-5.

Using the *estimated* abnormal returns complicates the problem of statistical inference because the *estimated* event-day abnormal return has two components: (1) the true abnormal return, which includes the economic effect of the information event and an error component attributable to Firm B's inherent, residual return variation; (2) error attributable to the deviation between the known, estimated regression line and the unknown, true line shown in Exhibit 17A-5. Thus a straightforwardly computed t ratio for the event-day abnormal return cannot have the same interpretation as the t ratio for a raw return.

An exact formula exists for adjusting the t ratio for the abnormal return so as to give it the same interpretation as that for the raw return [see Patell (1976)]. The event parameters method provides an equivalent, alternative approach that may prove more computationally convenient for this and other purposes. Specifically, consider the augmented market model

$$r_{st} = a_s + \beta_s r_{mt} + \gamma_{sA} d_{At} \varepsilon_{st} \qquad (5)$$

where d_{At} is an indicator variable for the date of the information event under study; that is, d_{At} equals one on the date of announcement a and zero on all other dates. Analysts often refer to the coefficient γ_{sA} as an *event parameter*, because it measures the sensitivity of returns of security s to information events of type A.

Let g_{sA} be the OLS estimate of γ_{sA} in a regression that includes both the original estimation sample for Equation 2 and the event-date observation. This event parameter g_{sA} equals the prediction error at the event date as defined previously, and its standard error and t ratio account for the effect of the estimation error in the regression line, thus applying the Patell (1976) adjustment automatically.

(d) The Statistical Power of the Event Study Method. The preceding discussion illustrates how one can estimate the market model and use it to adjust a raw return series for market and industry effects that obscure the firm-specific effect of a given announcement. Even if the investigator knew the precise market model coefficients, the residual variation of the return series would still obscure the announcement effect. Exhibit 17A-7 shows, moreover, that the market model has modest explanatory power. (The summarized R-squared data show that among the largest NYSE/AMEX firms the model explains 28.5 percent of the variance of the security returns or more for only one quarter of the firms in that size group.) Thus, one would naturally consider to what extent the market-model adjustment sharpens inferences regarding the presence of an announcement effect.

We can examine this issue by comparing the statistical power of tests for an announcement effect, with and without market adjustment. For a given true economic effect (for example, –2.05 percent, the true value of the "event-related" perturbation in the illustrative, simulated data underlying Exhibit 17A-4), the power of a statistical test is the probability of concluding that an effect did indeed occur. Thus, the power of the rule requiring a t ratio greater than 2 is the probability that a t ratio of this magnitude will actually occur, given the presence of a true effect of –2.05 percent.

Exhibit 17A-8 shows the theoretical values of such power probabilities under several assumptions regarding the R^2 of the market model, the magnitude of the true effect, and the value of the market index return r_{mt} on the event day relative to the mean market return. For example, if the true effect equals zero, then the probability of a t ratio greater than 2 is .046 in all cases. This simply reflects the 95 percent correctness of the approximate statistical rule: The probability of concluding that an effect is not present when, in fact, there is none is 1 – .046 = 95 percent. For a true effect equal to twice the standard deviation of raw returns, r_{st}, the probability of detection ranges from .492 to .788, increasing as the explanatory power of the regression (R^2) increases. Comparing the empirical distributions of R^2 in Exhibits 17A-7 and 17A-8 suggests that for many firms, and in particular for most small firms, the market-model adjustment has little effect on the power of the test. (The benchmark for this comparison occurs when $R^2 = 0$; that is, no market adjustment.) Whether this will hold true in a given litigation setting is, of course, an empirical question.

(e) Confidence Interval for the Price Effect. Given the data shown in Exhibit 17A-5, the estimated event parameter g_{sA} equals –3.49 percent, with a corresponding t ratio of –2.53. (The difference between the true abnormal return of –3.0 percent

		"True Effect" ($\times\ \sigma(r_{mt})$)			
	R^2	0	1	2	3
$\Delta r_{mt} = 0 \times \sigma(r_{mt})$:					
	0%	0.046	0.158	0.492	0.834
	1%	0.046	0.159	0.496	0.838
	2%	0.046	0.160	0.500	0.841
	5%	0.046	0.164	0.513	0.853
	10%	0.046	0.171	0.535	0.871
	20%	0.046	0.187	0.585	0.907
	50%	0.046	0.275	0.788	0.986
$\Delta r_{mt} = 2 \times \sigma(r_{mt})$:					
	0%	0.046	0.149	0.463	0.805
	1%	0.046	0.150	0.467	0.809
	2%	0.046	0.151	0.471	0.813
	5%	0.046	0.155	0.483	0.825
	10%	0.046	0.161	0.504	0.845
	20%	0.046	0.176	0.553	0.885
	50%	0.046	0.258	0.757	0.980

Exhibit 17A-8. Effects of Market Adjustment of Raw Returns on the Power of Tests for Event Responses in Security Returns

and the estimate of –3.49 percent results from the discrepancy between the true and the estimated regression lines at the event date.) The t ratio indicates that the difference of –3.49 percent between the return predicted for the event day by the estimated regression line (2.21 percent) and the event day return that actually occurred (–1.28 percent) is statistically significant at the 5 percent level. Thus the discrepancy will not likely have occurred as a random observation from the distribution of deviations from the regression line that occurred during the non-event period. This result offers evidence of the economic effect of the information event. We can use statistical measures to describe the precision of this evidence. In this example, the 50 percent confidence interval for γ_{sA} ranges from –4.43 percent to –2.56 percent and the 95 percent confidence interval from –6.26 percent to –.72 percent.

Suppose, for example, that the closing price of security s on the day before the information event was $100. Since the total event-day return was –1.28 percent, security s closed at $98.72 on the event day. Given the market return on the event day, the market-model regression predicts a return of 2.21 percent and, accordingly, a closing price of $102.21. The statistical significance of the event parameter shows that we can conclude with 95 percent confidence that the value of security s declined as a result of the information event. Our point estimate of $3.49 offers the

best linear unbiased estimate of the price effect of the announcement.[4] We can also use statistical measures to describe the precision of this estimate. Specifically, given the estimate and its standard error, we can infer with 50 percent confidence that the true price effect (a decline) lies in the interval from $2.56 to $4.43 and with 95 percent confidence that the true effect lies in the interval from $0.72 to $6.26 per share. The wide range of prices in the 95 percent confidence interval reflects the inherent high variability of underlying price movements.

(f) Extensions to More Complicated Settings. One could also extend the event parameter approach to more complicated situations than that illustrated here. For example, an analyst can use the approach to examine the *cumulative abnormal return* (CAR) over multiple event days, as might be the case if the date of a disclosure were uncertain or if the study needed to consider several disclosures [see Marais, Schipper, and Smith (1989)]. In addition, analysts can estimate event parameters for portfolios of firms, weighting such portfolios to highlight various economic features of the securities involved. Examples of such weighting schemes include weighting by income effects of a given accounting disclosure or weighting by tax benefits to be received from an announced tax change. Schipper, Thompson, and Weil (1987) provide both a formula for computing economically weighted portfolios and an application that includes multiple event days. Finally, the regression structure of the event parameter approach can be exploited. Specifically, since the approach focuses on regression coefficients rather than residuals or prediction errors, one can apply a number of standard econometric methods derived for the regression framework.

We have found the event parameter approach relatively more convenient than the residual analysis approach for dealing with securities that are infrequently and nonsynchronously traded, such as bonds and preferred stock. These securities present their own special estimation problems (for an example, see Marais, Schipper, and Smith, 1989).

17A.4 DESIGN ISSUES IN EVENT STUDIES. The event study originated in academic research, so the conventional design features and assumptions of event studies fit academic research questions. They may not, however, fit litigation-based questions. The legal setting may present a problem or issue that seems familiar in the sense that it resembles a conventional research issue. But the special features that a litigation assignment presents may mean that the problem will not submit to conventional formulation. In such cases, the analyst must develop approaches that fit the legal setting. This section describes a number of design issues, some of which occur in both academic research and litigation applications of event studies, and some of which one will generally find only in litigation settings.

(a) Inferences about Magnitude and Statistical Significance. Event studies may serve both to establish whether any effect occurred and to quantify the effect, if any, including the margin of error of the measured effect. In the former purpose, the question of *statistical significance* of firm-specific returns (abnormal returns or prediction errors) becomes fundamental. For the latter purpose, the *magnitude* of such returns becomes the basic input to the measurement calculation, and one can use statistical significance as an indicator of the confidence interval around the point estimate of the effect.

This chapter has already discussed the details of statistical inference. When considering design issues, it suffices to note that inference involves drawing conclusions about the likelihood that the analysis would yield the given result by chance, given assumptions about the data. Thus, if the abnormal return computed at a spin-off announcement is +2.6 percent, one question of inference involves the frequency with which one observes returns this large or larger in the absence of spin-off announcements. Analysts can answer this question by assessing the statistical significance of the abnormal return: one can do this by computing and interpreting a t ratio of the event period abnormal return divided by the time-series standard deviation of non-event period abnormal returns. A related question of inference involves quantifying our uncertainty about the number itself; that is, given the inherent error in any statistical estimate, how likely is it that the true abnormal return was, say, +1.5 percent or +3.2 percent?

It follows, then, that inferences about significance and magnitude are linked to the existence of economic effects. Suppose, for example, the event study produces an announcement-related abnormal return estimate of −.50 percent and the standard deviation of such abnormal returns equals .39. This yields a t ratio of about −1.28, so in larger samples of returns, one would observe abnormal returns of this size or larger in absolute value about 20 percent of the time. In addition, we have approximately 95 percent confidence that the true return lies between −.28 percent and +1.28 percent (that is, plus or minus two standard deviations from the estimated abnormal return). Given these results, one would find it difficult to argue for any discernible intervention in the return series at the event announcement. The most likely firm-specific effect of the event equals approximately zero.

(b) Residual Return for a Single Firm. When one performs an event study in the context of a dispute or litigation, the analysis frequently includes only one firm. In such an analysis, one cannot compensate for the idiosyncratic characteristics of the subject firm's return series as one would in academic studies that use large samples spread over time and industries. The variability in the return series, usually measured by the time-series standard deviation of returns, differs across firms and sometimes over time for a given firm. Trading patterns also differ across time and firms; even on the NYSE some listed firms trade relatively infrequently and, hence, one cannot obtain reliable daily prices.

The technical difficulties arising from the variability of returns are reduced to the extent that the study can attribute a portion of this variability to market or industry factors. The quantitative measure of this explanatory power is R^2, discussed in section 17A.3(b)(*iv*). To the extent the analysis includes market factors, industry factors, or other factors that explain the variance in the stock or security returns being analyzed, *residual* or *idiosyncratic return* variance is smaller than the raw return variance. The measure of residual return is the error term in the (possibly augmented) market model regression. Residual return variability (the portion

of return idiosyncratic to that stock or security) increases the width of the confidence interval around any given abnormal return estimate. The greater the residual return variability, the greater the magnitude of any prediction error or abnormal return required to support the argument that a given information event affected the stock return.

(c) Choice of Event Period. The number of days around any information announcement for which the study will compute abnormal returns defines the length of the event period or event window.[5] One needs to choose an event window that is *both* known for certain to contain the information release of interest and believed to contain no other valuation-relevant information. The first objective implies a longer event window and the second implies a shorter one. The choice may involve trading off more variability in the series from choosing a longer window, against dealing with some uncertainty about precisely when the news in question reached market agents.

In an ideal case, one can trace the announcement to a time-stamped press release, so the study can use a single day as the event window. In other cases, however, a daily newspaper such as the *Wall Street Journal* becomes the source of event information. On any given day, the newspaper carries stories from the previous day; news in those stories will already have been reflected in share prices if the stories emerged during trading hours. News in stories released after the close of trade will affect share prices the day they appear in the newspaper. For this reason, studies conventionally use two-day event windows when a newspaper becomes the source of news announcements. Not all news events appear in newspapers, however. Such potentially important information sources whose contents rarely appear in newspapers include proxy statements containing information about compensation plan changes or antitakeover amendments; Form 10Ks containing detailed income statement information; analyst reports assessing the firm's future probability. Event studies based on such disclosures have used longer event windows.

(d) Choice of Estimation Period. Event studies usually involve the calculation of sensitivity measures (beta coefficients) using a market model, or possibly a market model augmented by some combination of an industry, size and/or book-to-market ratio indexes. Exceptions may occur in special circumstances, however. For example, analysts may occasionally conduct event studies when the available returns data are too limited to permit elaborate statistical estimation; in some such cases researchers and analysts have used the marketwide average sensitivity coefficient of 1.0, in which case they simply subtract the index return from the firm-specific raw return. Also, market model estimation and analysis may reveal that marketwide factors (possibly augmented) explain virtually none of the variance of returns of the series of interest. In such a case all, or nearly all, of the firm's return is idiosyncratic and the effect of extracting marketwide factors using an augmented market model may prove negligible.

If the study will estimate a market model, the length of estimation period becomes a design choice. A long estimation period may yield unstable results,

because the series includes a number of interventions unrelated to the litigation question at hand. Such interventions include major restructurings, write-offs, and acquisitions. A study that uses an excessively short series may lead to an imprecise estimation.

A litigation setting increases the difficulties of estimation period choice if the behavior of returns after the event being analyzed differs materially from that of returns before it, as would be the case, for example, if the firm filed for protection under the bankruptcy laws shortly after the event. In this case, the study cannot include returns after the event in the estimation period. Analysts also cannot include returns during a period of alleged fraud.

Clearly, analysts must consider the specific facts and circumstances of the given litigation question in choosing the estimation period. No specific rule or procedure will likely suit every situation. Based on academic research, however, it appears that estimation periods containing fewer than 50 returns will likely yield imprecise estimates.

(e) Choice of Indexes. A final design issue is the choice of indexes. Using commercially available data sources, one can match exchange-listed firms with an index of like firms and match NASDAQ firms with an index of all NASDAQ firms. The wealth of research demonstrating the effects of firm size on share returns indicates that it may be useful to take account of size explicitly in computing abnormal returns. One can do this either by including as an index a portfolio of firms of about the same size as the firm being analyzed, or by choosing appropriately between an equally weighted market index and a value-weighted market index. The former gives equal weight to all firms, so larger firms do not dominate the index value. The latter strongly reflects the return performance of the very largest firms.

If the study will include an industry index and commercial vendors of data do not provide a suitably specific industry index, a litigation setting may require that the analyst develop a specialized index and prepare extensive explanatory materials supporting the choices made in the development. The SIC code, which provides broad industry membership based on a dominant industry, offers a reasonable starting point. One could obtain a finer partitioning obtained from industry analyses provided by, for example, *Value Line* or *Standard and Poors*. The firm under study may also self-report a peer group in its proxy statement disclosures of performance-based compensation. In any case, the analyst must develop a peer group whose returns one would expect to move with the same industry forces as do the returns of the firm being analyzed. One can then more reasonably attribute the deviations of the subject firm's returns from the industry's returns to the firm-specific news.

Finally, Fama and French (1992, 1993) report that market model betas have relatively modest explanatory power for both cross-sections and time-series of stock returns and time-series of bond returns, relative to the explanatory power of size and the book-to-market ratio (the ratio of the book value of common equity to its market value) for stocks and term-structure factors for bonds. These results suggest that, in litigation settings, one may want to include controls for size and book-to-market ratios for stocks and for term-structure factors for bonds.

17A.5 LINKING THE EVENT STUDY TO PEER-REVIEWED, PUBLISHED RESEARCH. Applications of event studies abound in the finance and accounting research literature, which has long used them as a tool for measuring the shareholder wealth effects of announcements by and about firms, or of government actions affecting firms [see MacKinlay (1997)]. For example, Pincus (1997) performs an event study analysis of the Revenue Acts of 1938 and 1939 to assess the shareholder wealth effects of legislation that permitted last-in, first-out (LIFO) inventory valuations for tax purposes. Other examples of the wide variety of corporate events that the literature has studied include tender offers, spin-off announcements, leveraged buyout announcements, poison pill adoptions, golden parachute adoptions, and announcements of defensive tactics in takeover contests. Some of these published studies may pertain to the issues in a given dispute or litigation. Journals have also published numerous summaries and reviews of such potentially relevant literature: see, for example, Weston, Chung, and Siu (1998) and Binder (1998).

Some articles have extended event study methods to analyze price effects on securities other than common stock [see, for example, Marais, Schipper, and Smith (1989)]. Related methods have also been applied to nonprice effects of various kinds of interventions. For example, several studies have investigated the change in research and development spending after Generally Accepted Accounting Principles (GAAP) were changed in 1974 to require the immediate expensing instead of capitalization of such expenditures [Selto and Clouse (1985) review this research]. Another example is Scholes, Wilson, and Wolfson's (1990) analysis of changes in the municipal bond holdings of banks after changes in tax rules disallowed part of the interest deduction on debt incurred to buy such bonds.

(a) Benchmark Values. Suppose, for example, that the issues in a dispute or litigation involved the market-value effects of qualified audit opinions. This might occur if a plaintiff were suing a CPA firm for failing to issue an audit opinion with a going-concern qualification for a firm that subsequently filed for bankruptcy [see, for example, Carcello and Palmrose (1994)]. The academic literature contains event studies [for example, Dodd et al. (1984)] that document the average effect of qualified audit announcements in large samples of firms overall, that is, without conditioning on firm-specific circumstances. Such research provides an informative benchmark value for the expected effect of a given qualified audit announcement, but for the effects of firm-specific circumstances. An application to a specific litigation setting should, of course, account for any special, case-specific circumstances which might imply an effect different from the averages in large samples.

(b) Adapting Methods for Nonstandard Situations. One could also benefit from consulting the academic research literature because this literature contains peer-reviewed solutions to specific technical problems arising from a variety of special circumstances, some of which may parallel the issues in a given dispute or litigation context. The literature relevant for this purpose includes not only accounting and finance research using event studies but also the broader statistical literature on related methods; for example, see Box, Hunter, and Hunter (1978) on *intervention analysis* and Yao (1993) on the detection of *change points*. An illustration of special circumstances requiring nonstandard methods is provided by Marais, Schipper, and Smith (1989), who implement an event study method for analyzing multiple debt securities of a given firm. One could expect that a given event will similarly (if not identically) affect multiple bond issues of a single firm. Thus, the returns of different bonds of a single firm will likely exhibit cross-sectional correlation. Moreover, several other complications, including irregular and nonsynchronous trading, will hamper analyses of returns of these securities.

APPENDIX: EVENT STUDY TERMINOLOGY

This glossary defines various terms commonly used in the event study literature, including terms used interchangeably to describe the same (or nearly the same) concept.

Abnormal returns: See also *excess return, market-adjusted return, prediction error, residual return.* A firm-specific or idiosyncratic return, usually estimated at an event date or over an event period; the difference between the realized return during a period and the return expected given (1) returns to market (and possibly industry) indexes, and (2) the historical sensitivity of the firm's returns to the index returns.

Augmented market model: A market model with additional right-hand-side variables, such as industry indexes and indexes based on size or book-to-market ratios. See also *market model.*

Beta: Estimated slope coefficient from a time-series regression of common stock returns on market index returns; a measure of sensitivity of stock returns to market index returns. Sometimes called *systematic risk*; a parameter of the market model.

CAR: See *cumulative abnormal return.*

Confounding events: Information releases concurrent with, or very close in time to, a specific news announcement under investigation.

Cumulative abnormal return (CAR): Abnormal returns aggregated over some time interval. Over short periods, such as two or three days, analysts will often sum abnormal returns to compute cumulative abnormal returns. Over longer periods, analysts often use compounding.

Efficient market hypothesis: In its semistrong form, the view that stock prices quickly and unbiasedly move to reflect all relevant public information. Such a market makes arbitrage gains impossible. Alternatively, the view that prices measure intrinsic values unbiasedly (valuation errors, if they exist, are symmetric and centered on zero) and one cannot use public information to infer the existence and magnitude of any given stock's valuation error.

Estimation period, estimation window, estimation interval: Time period (measured in days, weeks, or months) over which returns are taken to estimate the parameters of the market model or augmented market model; can include returns before the event period, after the event period, or both.

Event parameter: An indicator variable included in a market model, taking on the value 1 for event periods and 0 (zero) otherwise. Captures the shift in returns on event days (weeks, months) as a measure of abnormal return.

Event period, event window: Time period (measured in days, weeks, or months) over which the study will compute abnormal returns. The study should choose the length of the period (window) to allow sufficient time for returns to impound information in the event announcement.
Event study: Empirical investigation and analysis of a time series of data, usually stock or security returns, for evidence of unusual behavior associated with identifiable news announcements.
Excess return: This term has two distinct uses. First, it may equal the difference between a firm's stock return and the return on a market index. In this usage, it becomes a synonym for *abnormal return* if the difference is computed as

$$[\text{stock return}] - [\text{beta}] \times [\text{market index return}].$$

Second, it may equal the difference between a firm's stock return or an index return and a proxy for the risk-free rate of interest.
Market-adjusted return: Loosely, any difference between a stock or security return and the return on a market index.
Market index: An equally weighted or value-weighted portfolio intended to proxy for aggregate wealth. Examples include the S&P 500 and the Center for Research in Securities Prices (CRSP) indexes of exchange-listed stocks and over-the-counter (NASDAQ) stocks.
Market model: A time-series regression model where the left side variable is returns to a given stock or security (sometimes a portfolio of such stocks or securities) and the right side variable is returns to a market index. See also *augmented market model.*
Predicted return: Systematic return, or return to a stock or security expected given the stock's (security's) sensitivity to market (and possibly industry) index returns and the realized returns to those indexes.
Prediction error: See *abnormal return.*
Raw return: See *return.*
Residual return: Firm-specific return, idiosyncratic return. Sometimes used as a synonym for *abnormal return;* strictly speaking, however, an estimated residual from a market model regression.
Residual variation: The time-series variability of a return series that one cannot attribute to or explain by movements in a market index (sometimes a market index combined with an industry index).
Return: The holding period return for a given security in the period from $t-1$ to t is

$$([\text{Price at } t] + [\text{Distributions in period } t] - [\text{Price at } t-1]) \div [\text{Price at } t-1]$$

Also referred to as *raw return,* to distinguish it from an abnormal return, or from the continuously compounded form

$$\ln([[\text{Price at } t] + [\text{Distributions in period } t]] \div [\text{Price at } t-1]).$$

Systematic return, predicted return: The return on a stock or security that one can attribute to movements in a market index, or sometimes a market index combined with an industry index.

Systematic risk: Beta (slope) coefficient from a market model regression; measure of return sensitivity to movements in a market index.
***t* ratio:** The ratio of an estimated coefficient or abnormal return to a measure of variability, such as the standard error of the estimated coefficient or the time-series standard deviation of abnormal returns.

NOTES

1. The total return to a share of common stock equals the percentage price change adjusted for cash dividends and for stock splits and stock dividends. Thus, if a cash dividend were paid on a given day, that day's return would include both the price change and the dividend. The percentage return would equal (price change + dividend)/(previous day's price). The treatment of stock splits and stock dividends becomes more complicated, in that these change the number of shares in an initial position. Commercial data services, such as the Center for Research in Security Prices at the University of Chicago Graduate School of Business, provide common stock returns series that fully account for cash dividends, stock splits and stock dividends. In addition, they provide documentation that would permit users to make their own adjustments to a price and dividend series.
2. Both the stock returns and the returns to the industry and market indexes can be raw, sometimes called *unadjusted,* or they can be returns in excess of a measure of the risk-free rate of interest (usually some return on a U.S. government treasury note). Analysts refer to returns adjusted by subtracting a risk-free rate as excess returns. Fama and French (1992, 1993) propose augmented market models which include size and book-to-market indexes.
3. The time-series *standard deviation* of the return series equals the square root of its time-series *variance.* Variance is a statistical measure of the spread or dispersion in a distribution. The mean or average captures the middle of the distribution, while the variance captures the tendency of observations to differ from the mean. A larger variance means a greater spread in the distribution. The variance of a given sample of observations is the average of the squared deviations of the sample values from the sample mean.
4. This is a consequence of the Gauss–Markov theorem; see, for example, Newbold (1984, Chapter 12).
5. This discussion assumes the use of daily returns, both for simplicity and because studies commonly use daily returns. One can, however, measure event periods in terms of other return intervals, such as weekly [see, for example, Pateil (1976)] or monthly [see, for example, Schipper and Thompson (1983)].

BIBLIOGRAPHY

Binder, J. J., "The Event Study Methodology Since 1969," *Review of Quantitative Finance and Accounting, 11* (1998), pp. 111–137.

Box, G. E. P., W. G. Hunter, and J. S. Hunter, 1978, *Statistics for Experimenters,* John Wiley.

Brewer, H. L., and R. R. Miller, "Evaluating the Probable Impacts of International Economic Events on Common Stock Returns: An Empirical Study," *Journal of International Business Studies, 10* (Winter 1979), pp. 53–65.

Brick, I. E., M. Statman, and D. G. Weaver, "Event Studies and Model Misspecification: Another Look at the Benefits of Outsiders from Public Information About Insider Trading," *Journal of Business Finance and Accounting, 16* (Summer 1989), pp. 399–424.

Brown, S. J., and J. B. Warner, "Using Daily Stock Returns: The Case of Event Studies," *Journal of Financial Economics; 14* (March 1985), pp. 3–31.

Brown, S. J., and M. I. Weinstein, " Derived Factors in Event Studies," *Journal of Financial Economics, 14* (September 1985), pp. 491–495.

Carcello, J., and Z. Palmrose, "An Empirical Investigation of Modified Reporting and Auditor Litigation on Bankrupt Clients," *Journal of Accounting Research,* 1994 supplement, pp. 1–30.

Chandra, R., S. Moriarity, and G. L. Willinger, "A Reexamination of the Power of Alternative Return-Generating Models and the Effect of Accounting for Cross-Sectional Dependencies in Event Studies," *Journal of Accounting Research*, 28 (Autumn 1990), pp. 398–408.

Cone, K. R., and J. E. Laurence, "How Accurate are Estimates of Aggregate Damages in Securities Fraud Cases?," *Business Lawyer*, 49 (1994), pp. 505–526.

Cooper Alexander, J., "The Value of Bad News in Securities Class Actions," *UCLA Law Review*, 41 (1994), pp. 1421–1469.

Corrado, C. J., "A Nonparametric Test for Abnormal Security-Price Performance in Event Studies," *Journal of Financial Economics*, 23 (August 1989), pp. 385–395.

Dimson, E., and P. Marsh, "Event Study Methodologies and the Size Effect: The Case of UK Press Recommendations," *Journal of Financial Economics*, 17 (September 1986), pp. 113–142.

Dodd, P., N. Dopuch, R. Holthausen, and R. Leftwich, "Qualified Audit Opinions and Stock Prices: Information Content, Announcement Dates and Concurrent Disclosures," *Journal of Accounting and Economics*, 6 (April 1984), pp. 3–38.

Dyckman, T., D. Philbrick, and J. Stephan, "A Comparison of Event Study Methodologies Using Daily Stock Returns: A Simulation Approach," *Journal of Accounting Research*, 22 (Supplement), pp. 1–33.

Englemann, K., and B. Cornell, "Measuring the Cost of Corporate Litigation: Five Case Studies," *Journal of Legal Studies*, 17 (June 1988), pp. 377–399.

Fama, E., and K. French, "The Cross-section of Expected Stock Returns," *Journal of Finance*, 47 (1992), pp. 427–465.

Fama, E., and K. French, "Common Risk Factors in the Returns on Stocks and Bonds," *Journal of Financial Economics*, 33 (1993), pp. 3–56.

Francis, J., D. Philbrick, and K. Schipper, "Shareholder Litigation and Corporate Disclosures," *Journal of Accounting Research*, 32 (Autumn 1994), pp. 137–164.

Furbush, D., and J. W. Smith, "Estimating the Number of Damaged Shares in Securities Fraud Litigation: An Introduction to Stock Trading Models," *Business Lawyer*, 49 (1994), pp. 527–543.

Gilson, R. and B. Black, 1993, *The Law and Finance of Corporate Acquisitions, 1993 Supplement*, University Casebook Series, Foundation Press.

Glascock, J. L., G. V. Henderson, D. T. Officer, and V. Shah, "Examining the Sensitivity of the Standardized Cumulative Prediction Error as an Event Study Test Statistic," *Journal of Economics and Business*, 43 (February 1991), pp. 49–57.

Gould, J. E., and A. W. Kleidon, "Market Maker Activity on Nasdaq: Implications for Trading Volume," *Stanford Journal of Law, Business & Finance*, 1 (1994), pp. 1–17.

Halpern, P., "Corporate Acquisitions: A Theory of Special Cases? A Review of Event Studies Applied to Acquisitions," *Journal of Finance*, 38 (May 1983), pp. 297–317.

Kasznik, R. and B. Lev, "To Warn or Not to Warn: Management Disclosures in the Face of an Earnings Surprise," *The Accounting Review*, 70 (January 1995), pp. 113–134.

Klein, A., and J. Rosenfeld, "The Influence of Market Conditions on Event-Study Residuals," *Journal of Financial and Quantitative Analysis*, 22 (September 1987), pp. 345–351.

Koslow, J., "Estimating Aggregate Damages in Class-Action Litigation under Rule 10b-5 for Purposes of Settlement," *Fordham Law Review*, 59 (1991), pp. 811–842.

Kwok, C. C. Y., and L. D. Brooks, "Examining Event Study Methodologies in Foreign Exchange Markets," *Journal of International Business Studies*, 21 (Second Quarter 1990), pp. 189–224.

Lockwood, L. J., and K. R. Kadiyala, "Risk Measurement for Event-Dependent Security Returns," *Journal of Business and Economic Statistics*, 6 (January 1988), pp. 43–49.

Macey, J. R., G. P. Miller, M. L. Miller, and J. M. Netter, "Lessons from Financial Economics: Materiality, Reliance and Extending the Reach of *Basic v. Levinson*," *Virginia Law Review*, 77 (August 1991), pp. 1017–1049.

Macey, J. R., and G. P. Miller, "Good Finance, Bad Economics: An Analysis of the Fraud-on-the-Market Theory," *Stanford Law Review*, 42 (1990), pp. 1059–1092.

MacKinlay, A. C., "Event Studies in Economics and Finance," *Journal of Economic Literature*, XXXV (March 1997), pp. 13–39.

Marais, M. L., K. Schipper, and A. Smith, "Wealth Effects of Going Private for Senior Securities," *Journal of Financial Economics*, 23 (December 1989), pp. 155–191.

McAfee, R. P., and M. A. Williams, "Can Event Studies Detect Anticompetitive Mergers?," *Economic Letters*, 28 (1988), pp. 199–203.

McDonald, B., "Event Studies and Systems Methods: Some Additional Evidence," *Journal of Financial and Quantitative Analysis*, 22 (December 1987), pp. 495–504.

McDonald, B., and C. Lee, "An Analysis of Nonlinearities, Heteroscedasticity, and Functional Form in the Market Model," *Journal of Business and Economic Statistics*, 6 (October 1988), pp. 505–509.

Merino, B. D., B. S. Koch, and K. L. MacRitchie, "Historical Analysis—A Diagnostic Tool for Events' Studies: The Impact of the Securities Act of 1933," *Accounting Review*, 62 (October 1987), pp. 748–762.

Morgan, A., and I. Morgan, "Measurement of Abnormal Returns from Small Firms," *Journal of Business and Economic Statistics*, 5 (January 1987), pp. 121–129.

Newbold, P., *Statistics for Business and Economics*, 1984, Englewood Cliffs, NJ: Prentice Hall.

Patell, J. M., "Corporate Forecasts of Earnings Per Share and Stock Price Behavior: Empirical Tests," *Journal of Accounting Research*, 14 (Autumn 1976), pp. 246–276.

Pincus, M., "Stock Price Effects of the Allowance of LIFO for Tax Purposes," *Journal of Accounting and Economics*, 23 (November 1997), pp. 283–308.

Ricks, W. E., "A Comparison of Event Study Methodologies Using Daily Stock Returns: A Simulation Approach: Discussion," *Journal of Accounting Research*, 22 (1984), pp. 31–33.

Salatka, W. K., "The Impact of SFAS No. 8 on Equity Prices of Early and Late Adopting Firms: An Events Study and Cross-Sectional Analysis," *Journal of Accounting and Economics*, 12 (February 1989), pp. 35–69.

Schipper, K., and R. Thompson, "The Impact of Merger-Related Regulations on the Shareholders of Acquiring Firms," *Journal of Accounting Research*, 21 (1983), pp. 184–221.

Schipper, K., R. Thompson, and R. Weil, "Disentangling Interrelated Effects of Regulatory Changes on Shareholder Wealth: The Case of Motor Carrier Deregulation," *Journal of Law and Economics*, 30 (1987), pp. 67–100.

Scholes, M., and J. Williams, "Estimating Beta from Non-Synchronous Data," *Journal of Financial Economics*, 5 (1977), pp. 309–327.

Scholes, M. S., G. P. Wilson, and M. A. Wolfson, "Tax Planning, Regulatory Capital Planning, and Financial Reporting Strategy for Commercial Banks," *The Review of Financial Studies*, 3 (1990), pp. 625–650.

Seaks, T. G., "The Computation of Test Statistics for Multivariate Regression Models in Event Studies," *Economic Letters*, 33 (June 1990), pp. 141–145.

Selto, F. H., and M. L. Clouse, "An Investigation of Managers' Adaptations to SFAS No. 2: Accounting for Research and Development Costs," *Journal of Accounting Research*, 23 (Autumn 1985), pp. 700–717.

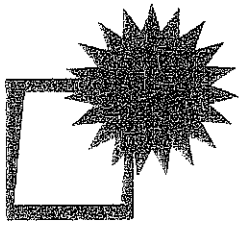
Thompson, J. E., "An Alternative Control Model for Event Studies," *Journal of Business Finance and Accounting*, 16 (Autumn 1989), pp. 507–513.

Thompson, J. E., "More Methods That Make Little Difference in Event Studies," *Journal of Business Finance and Accounting*, 15 (Spring 1988), pp. 77–86.

Thompson, R., "Conditioning the Return Generating Process of Firm Specific Events: A Discussion of Event Study Methods," *Journal of Financial and Quantitative Analysis*, 20 (June 1985), pp. 151–168.

Weston, J. F., K. S. Chung, and J. Siu, 1998, *Takeovers, Restructuring and Corporate Governance* (2nd edition), Englewood Cliffs, NJ: Prentice Hall.

Yao, Q., "Tests for Change-Points with Epidemic Alternatives," *Biometrika*, 80 (1993), pp. 179–191.



Update
Service

BECOME A SUBSCRIBER!

Did you purchase this product from a bookstore?

If you did, it's important for you to become a subscriber. John Wiley & Sons, Inc. may publish, on a periodic basis, supplements and new editions to reflect the latest changes in the subject matter that you ***need to know*** in order to stay competitive in this ever-changing industry. By contacting the Wiley office nearest you, you'll receive any current update at no additional charge. In addition, you'll receive future updates and revised or related volumes on a 30-day examination review.

If you purchased this product directly from John Wiley & Sons, Inc., we have already recorded your subscription for this update service.

To become a subscriber, please call **1-800-225-5945** or send your name, company name (if applicable), address, and the title of the product to:

mailing address; **Supplement Department**
John Wiley & Sons, Inc.
One Wiley Drive
Somerset, NJ 08875

e-mail: **subscriber@wiley.com**
fax: **1-732-302-2300**
online: **www.wiley.com**

For customers outside the United States, please contact the Wiley office nearest you:

Professional & Reference Division
John Wiley & Sons Canada, Ltd.
22 Worcester Road
Rexdale, Ontario M9W 1L1
CANADA
(416) 675-3580
Phone: 1-800-567-4797
Fax: 1-800-565-6802
canada@jwiley.com

Jacaranda Wiley Ltd.
PRT Division
P.O. Box 174
North Ryde, NSW 2113
AUSTRALIA
Phone: (02) 805-1100
Fax: (02) 805-1597
headoffice@jacwiley.com.au

John Wiley & Sons, Ltd.
Baffins Lane
Chichester
West Sussex, PO19 1UD
ENGLAND
Phone: (44) 1243 779777
Fax: (44) 1243 770638
cs-books@wiley.co.uk

John Wiley & Sons (SEA) Pte. Ltd.
37 Jalan Pemimpin
Block B # 05-04
Union Industrial Building
SINGAPORE 2057
Phone: (65) 258-1157
Fax: (65) 463-4604
csd_ord@wiley.com.sg

LITIGATION SERVICES HANDBOOK

The Role of the Financial Expert

Third Edition

2002 Supplement

Edited by

ROMAN L. WEIL

MICHAEL J. WAGNER

PETER B. FRANK

JOHN WILEY & SONS, INC.

Exhibit 26

Event Studies in Economics and Finance

Author(s): A. Craig MacKinlay

Source: *Journal of Economic Literature*, Mar., 1997, Vol. 35, No. 1 (Mar., 1997), pp. 13-39

Published by: American Economic Association

Stable URL: https://www.jstor.org/stable/2729691

Journal of Economic Literature
Vol. XXXV (March 1997), pp. 13–39

Event Studies in Economics and Finance

A. CRAIG MACKINLAY
The Wharton School, University of Pennsylvania

Thanks to John Campbell, Bruce Grundy, Andrew Lo, and two anonymous referees for helpful comments and discussion. Research support from the Rodney L. White Center for Financial Research is gratefully acknowledged.

1. *Introduction*

ECONOMISTS are frequently asked to measure the effects of an economic event on the value of firms. On the surface this seems like a difficult task, but a measure can be constructed easily using an event study. Using financial market data, an event study measures the impact of a specific event on the value of a firm. The usefulness of such a study comes from the fact that, given rationality in the marketplace, the effects of an event will be reflected immediately in security prices. Thus a measure of the event's economic impact can be constructed using security prices observed over a relatively short time period. In contrast, direct productivity related measures may require many months or even years of observation.

The event study has many applications. In accounting and finance research, event studies have been applied to a variety of firm specific and economy wide events. Some examples include mergers and acquisitions, earnings announcements, issues of new debt or equity, and announcements of macroeconomic variables such as the trade deficit.[1] However, applications in other fields are also abundant. For example, event studies are used in the field of law and economics to measure the impact on the value of a firm of a change in the regulatory environment (see G. William Schwert 1981) and in legal liability cases event studies are used to assess damages (see Mark Mitchell and Jeffry Netter 1994). In the majority of applications, the focus is the effect of an event on the price of a particular class of securities of the firm, most often common equity. In this paper the methodology is discussed in terms of applications that use common equity. However, event studies can be applied using debt securities with little modification.

Event studies have a long history. Perhaps the first published study is James Dolley (1933). In this work, he examines the price effects of stock splits, studying nominal price changes at the time of the split. Using a sample of 95 splits from 1921 to 1931, he finds that the price in-

[1] The first three examples will be discussed later in the paper. Grant McQueen and Vance Roley (1993) provide an illustration of the fourth using macroeconomic news announcements.

creased in 57 of the cases and the price declined in only 26 instances. Over the decades from the early 1930s until the late 1960s the level of sophistication of event studies increased. John H. Myers and Archie Bakay (1948), C. Austin Barker (1956, 1957, 1958), and John Ashley (1962) are examples of studies during this time period. The improvements included removing general stock market price movements and separating out confounding events. In the late 1960s seminal studies by Ray Ball and Philip Brown (1968) and Eugene Fama et al. (1969) introduced the methodology that is essentially the same as that which is in use today. Ball and Brown considered the information content of earnings, and Fama et al. studied the effects of stock splits after removing the effects of simultaneous dividend increases.

In the years since these pioneering studies, a number of modifications have been developed. These modifications relate to complications arising from violations of the statistical assumptions used in the early work and relate to adjustments in the design to accommodate more specific hypotheses. Useful papers which deal with the practical importance of many of the complications and adjustments are the work by Stephen Brown and Jerold Warner published in 1980 and 1985. The 1980 paper considers implementation issues for data sampled at a monthly interval and the 1985 paper deals with issues for daily data.

In this paper, event study methods are reviewed and summarized. The paper begins with discussion of one possible procedure for conducting an event study in Section 2. Section 3 sets up a sample event study which will be used to illustrate the methodology. Central to an event study is the measurement of an abnormal stock return. Section 4 details the first step—measuring the normal performance—and Section 5 follows with the necessary tools for calculating an abnormal return, making statistical inferences about these returns, and aggregating over many event observations. The null hypothesis that the event has no impact on the distribution of returns is maintained in Sections 4 and 5. Section 6 discusses modifying this null hypothesis to focus only on the mean of the return distribution. Section 7 presents analysis of the power of an event study. Section 8 presents nonparametric approaches to event studies which eliminate the need for parametric structure. In some cases theory provides hypotheses concerning the relation between the magnitude of the event abnormal return and firm characteristics. Section 9 presents a cross-sectional regression approach that is useful to investigate such hypotheses. Section 10 considers some further issues relating event study design and the paper closes with the concluding discussion in Section 11.

2. *Procedure for an Event Study*

At the outset it is useful to briefly discuss the structure of an event study. This will provide a basis for the discussion of details later. While there is no unique structure, there is a general flow of analysis. This flow is discussed in this section.

The initial task of conducting an event study is to define the event of interest and identify the period over which the security prices of the firms involved in this event will be examined—the event window. For example, if one is looking at the information content of an earnings with daily data, the event will be the earnings announcement and the event window will include the one day of the announcement. It is customary to define the event window to be larger than the specific period of interest. This permits examination of periods surrounding the

event. In practice, the period of interest is often expanded to multiple days, including at least the day of the announcement and the day after the announcement. This captures the price effects of announcements which occur after the stock market closes on the announcement day. The periods prior to and after the event may also be of interest. For example, in the earnings announcement case, the market may acquire information about the earnings prior to the actual announcement and one can investigate this possibility by examining pre-event returns.

After identifying the event, it is necessary to determine the selection criteria for the inclusion of a given firm in the study. The criteria may involve restrictions imposed by data availability such as listing on the New York Stock Exchange or the American Stock Exchange or may involve restrictions such as membership in a specific industry. At this stage it is useful to summarize some sample characteristics (e.g., firm market capitalization, industry representation, distribution of events through time) and note any potential biases which may have been introduced through the sample selection.

Appraisal of the event's impact requires a measure of the abnormal return. The abnormal return is the actual ex post return of the security over the event window minus the normal return of the firm over the event window. The normal return is defined as the expected return without conditioning on the event taking place. For firm i and event date τ the abnormal return is

$$AR_{i\tau} = R_{i\tau} - E(R_{i\tau}|X_\tau) \qquad (1)$$

where $AR_{i\tau}$, $R_{i\tau}$, and $E(R_{i\tau}|X_\tau)$ are the abnormal, actual, and normal returns respectively for time period τ. X_τ is the conditioning information for the normal return model. There are two common choices for modeling the normal return—the *constant mean return model* where X_τ is a constant, and the *market model* where X_τ is the market return. The constant mean return model, as the name implies, assumes that the mean return of a given security is constant through time. The market model assumes a stable linear relation between the market return and the security return.

Given the selection of a normal performance model, the estimation window needs to be defined. The most common choice, when feasible, is using the period prior to the event window for the estimation window. For example, in an event study using daily data and the market model, the market model parameters could be estimated over the 120 days prior to the event. Generally the event period itself is not included in the estimation period to prevent the event from influencing the normal performance model parameter estimates.

With the parameter estimates for the normal performance model, the abnormal returns can be calculated. Next comes the design of the testing framework for the abnormal returns. Important considerations are defining the null hypothesis and determining the techniques for aggregating the individual firm abnormal returns.

The presentation of the empirical results follows the formulation of the econometric design. In addition to presenting the basic empirical results, the presentation of diagnostics can be fruitful. Occasionally, especially in studies with a limited number of event observations, the empirical results can be heavily influenced by one or two firms. Knowledge of this is important for gauging the importance of the results.

Ideally the empirical results will lead to insights relating to understanding the sources and causes of the effects (or lack

of effects) of the event under study. Additional analysis may be included to distinguish between competing explanations. Concluding comments complete the study.

3. *An Example of an Event Study*

The Financial Accounting Standards Board (FASB) and the Securities Exchange Commission strive to set reporting regulations so that financial statements and related information releases are informative about the value of the firm. In setting standards, the information content of the financial disclosures is of interest. Event studies provide an ideal tool for examining the information content of the disclosures.

In this section the description of an example selected to illustrate event study methodology is presented. One particular type of disclosure—quarterly earnings announcements—is considered. The objective is to investigate the information content of these announcements. In other words, the goal is to see if the release of accounting information provides information to the marketplace. If so there should be a correlation between the observed change of the market value of the company and the information.

The example will focus on the quarterly earnings announcements for the 30 firms in the Dow Jones Industrial Index over the five-year period from January 1989 to December 1993. These announcements correspond to the quarterly earnings for the last quarter of 1988 through the third quarter of 1993. The five years of data for 30 firms provide a total sample of 600 announcements. For each firm and quarter, three pieces of information are compiled: the date of the announcement, the actual earnings, and a measure of the expected earnings. The source of the date of the announcement is Datastream, and the source of the actual earnings is Compustat.

If earnings announcements convey information to investors, one would expect the announcement impact on the market's valuation of the firm's equity to depend on the magnitude of the unexpected component of the announcement. Thus a measure of the deviation of the actual announced earnings from the market's prior expectation is required. For constructing such a measure, the mean quarterly earnings forecast reported by the Institutional Brokers Estimate System (I/B/E/S) is used to proxy for the market's expectation of earnings. I/B/E/S compiles forecasts from analysts for a large number of companies and reports summary statistics each month. The mean forecast is taken from the last month of the quarter. For example, the mean third quarter forecast from September 1990 is used as the measure of expected earnings for the third quarter of 1990.

To facilitate the examination of the impact of the earnings announcement on the value of the firm's equity, it is essential to posit the relation between the information release and the change in value of the equity. In this example the task is straightforward. If the earnings disclosures have information content, higher than expected earnings should be associated with increases in value of the equity and lower than expected earnings with decreases. To capture this association, each announcement is assigned to one of three categories: good news, no news, or bad news. Each announcement is categorized using the deviation of the actual earnings from the expected earnings. If the actual exceeds expected by more than 2.5 percent the announcement is designated as good news, and if the actual is more than 2.5 percent less than expected the announcement is designated as bad news. Those announce-

ments where the actual earnings is in the 5 percent range centered about the expected earnings are designated as no news. Of the 600 announcements, 189 are good news, 173 are no news, and the remaining 238 are bad news.

With the announcements categorized, the next step is to specify the parameters of the empirical design to analyze the equity return, i.e., the percent change in value of the equity. It is necessary to specify a length of observation interval, an event window, and an estimation window. For this example the interval is set to one day, thus daily stock returns are used. A 41-day event window is employed, comprised of 20 pre-event days, the event day, and 20 post-event days. For each announcement the 250 trading day period prior to the event window is used as the estimation window. After presenting the methodology of an event study, this example will be drawn upon to illustrate the execution of a study.

4. *Models for Measuring Normal Performance*

A number of approaches are available to calculate the normal return of a given security. The approaches can be loosely grouped into two categories—statistical and economic. Models in the first category follow from statistical assumptions concerning the behavior of asset returns and do not depend on any economic arguments. In contrast, models in the second category rely on assumptions concerning investors' behavior and are not based solely on statistical assumptions. It should, however, be noted that to use economic models in practice it is necessary to add statistical assumptions. Thus the potential advantage of economic models is not the absence of statistical assumptions, but the opportunity to calculate more precise measures of the normal return using economic restrictions.

For the statistical models, the assumption that asset returns are jointly multivariate normal and independently and identically distributed through time is imposed. This distributional assumption is sufficient for the constant mean return model and the market model to be correctly specified. While this assumption is strong, in practice it generally does not lead to problems because the assumption is empirically reasonable and inferences using the normal return models tend to be robust to deviations from the assumption. Also one can easily modify the statistical framework so that the analysis of the abnormal returns is autocorrelation and heteroskedasticity consistent by using a generalized method-of-moments approach.

A. *Constant Mean Return Model*

Let μ_i be the mean return for asset i. Then the constant mean return model is

$$R_{it} = \mu_i + \zeta_{it} \qquad (2)$$

$$E(\zeta_{it}) = 0 \qquad \text{var}(\zeta_{it}) = \sigma^2_{\zeta_i}.$$

where R_{it} is the period-t return on security i and ζ_{it} is the time period t disturbance term for security i with an expectation of zero and variance $\sigma^2_{\zeta_i}$.

Although the constant mean return model is perhaps the simplest model, Brown and Warner (1980, 1985) find it often yields results similar to those of more sophisticated models. This lack of sensitivity to the model can be attributed to the fact that the variance of the abnormal return is frequently not reduced much by choosing a more sophisticated model. When using daily data the model is typically applied to nominal returns. With monthly data the model can be applied to real returns or excess returns (the return in excess of the nominal risk free return generally measured using the U.S. Treasury Bill with one month to maturity) as well as nominal returns.

B. *Market Model*

The market model is a statistical model which relates the return of any given security to the return of the market portfolio. The model's linear specification follows from the assumed joint normality of asset returns. For any security i the market model is

$$R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it} \qquad (3)$$

$$E(\varepsilon_{it} = 0) \qquad \text{var}(\varepsilon_{it}) = \sigma^2_{\varepsilon_i}$$

where R_{it} and R_{mt} are the period-t returns on security i and the market portfolio, respectively, and ε_{it} is the zero mean disturbance term. α_i, β_i, and $\sigma^2_{\varepsilon_i}$ are the parameters of the market model. In applications a broad based stock index is used for the market portfolio, with the S&P 500 Index, the CRSP Value Weighted Index, and the CRSP Equal Weighted Index being popular choices.

The market model represents a potential improvement over the constant mean return model. By removing the portion of the return that is related to variation in the market's return, the variance of the abnormal return is reduced. This in turn can lead to increased ability to detect event effects. The benefit from using the market model will depend upon the R^2 of the market model regression. The higher the R^2 the greater is the variance reduction of the abnormal return, and the larger is the gain.

C. *Other Statistical Models*

A number of other statistical models have been proposed for modeling the normal return. A general type of statistical model is the *factor model*. Factor models are motivated by the benefits of reducing the variance of the abnormal return by explaining more of the variation in the normal return. Typically the factors are portfolios of traded securities. The market model is an example of a one factor model. Other multifactor models include industry indexes in addition to the market. William Sharpe (1970) and Sharpe, Gordon Alexander, and Jeffery Bailey (1995, p. 303) provide discussion of index models with factors based on industry classification. Another variant of a factor model is a procedure which calculates the abnormal return by taking the difference between the actual return and a portfolio of firms of similar size, where size is measured by market value of equity. In this approach typically ten size groups are considered and the loading on the size portfolios is restricted to unity. This procedure implicitly assumes that expected return is directly related to market value of equity.

Generally, the gains from employing multifactor models for event studies are limited. The reason for the limited gains is the empirical fact that the marginal explanatory power of additional factors the market factor is small, and hence, there is little reduction in the variance of the abnormal return. The variance reduction will typically be greatest in cases where the sample firms have a common characteristic, for example they are all members of one industry or they are all firms concentrated in one market capitalization group. In these cases the use of a multifactor model warrants consideration.

The use of other models is dictated by data availability. An example of a normal performance return model implemented in situations with limited data is the market-adjusted return model. For some events it is not feasible to have a pre-event estimation period for the normal model parameters, and a market-adjusted abnormal return is used. The market-adjusted return model can be viewed as a restricted market model with α_i constrained to be zero and β_i constrained to be one. Because the model coefficients

are prespecified, an estimation period is not required to obtain parameter estimates. An example of when such a model is used is in studies of the under pricing of initial public offerings. Jay Ritter (1991) presents such an example. A general recommendation is to only use such restricted models if necessary, and if necessary, consider the possibility of biases arising from the imposition of the restrictions.

D. *Economic Models*

Economic models can be cast as restrictions on the statistical models to provide more constrained normal return models. Two common economic models which provide restrictions are the Capital Asset Pricing Model (CAPM) and the Arbitrage Pricing Theory (APT). The CAPM due to Sharpe (1964) and John Lintner (1965) is an equilibrium theory where the expected return of a given asset is determined by its covariance with the market portfolio. The APT due to Stephen Ross (1976) is an asset pricing theory where the expected return of a given asset is a linear combination of multiple risk factors.

The use of the Capital Asset Pricing Model is common in event studies of the 1970s. However, deviations from the CAPM have been discovered, implying that the validity of the restrictions imposed by the CAPM on the market model is questionable.[2] This has introduced the possibility that the results of the studies may be sensitive to the specific CAPM restrictions. Because this potential for sensitivity can be avoided at little cost by using the market model, the use of the CAPM has almost ceased.

Similarly, other studies have employed multifactor normal performance models motivated by the Arbitrage Pricing Theory. A general finding is that with the APT the most important factor behaves like a market factor and additional factors add relatively little explanatory power. Thus the gains from using an APT motivated model versus the market model are small. See Stephen Brown and Mark Weinstein (1985) for further discussion. The main potential gain from using a model based on the arbitrage pricing theory is to eliminate the biases introduced by using the CAPM. However, because the statistically motivated models also eliminate these biases, for event studies such models dominate.

[2] Eugene Fama and Kenneth French (1996) provide discussion of these anomalies.

5. *Measuring and Analyzing Abnormal Returns*

In this section the problem of measuring and analyzing abnormal returns is considered. The framework is developed using the market model as the normal performance return model. The analysis is virtually identical for the constant mean return model.

Some notation is first defined to facilitate the measurement and analysis of abnormal returns. Returns will be indexed in event time using τ. Defining $\tau = 0$ as the event date, $\tau = T_1 + 1$ to $\tau = T_2$ represents the event window, and $\tau = T_0 + 1$ to $\tau = T_1$ constitutes the estimation window. Let $L_1 = T_1 - T_0$ and $L_2 = T_2 - T_1$ be the length of the estimation window and the event window respectively. Even if the event being considered is an announcement on given date it is typical to set the event window length to be larger than one. This facilitates the use of abnormal returns around the event day in the analysis. When applicable, the post-event window will be from $\tau = T_2 + 1$ to $\tau = T_3$ and of length $L_3 = T_3 - T_2$. The timing sequence is illustrated with a time line in Figure 1.

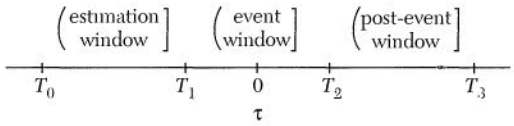


Figure 1. Time line for an event study.

It is typical for the estimation window and the event window not to overlap. This design provides estimators for the parameters of the normal return model which are not influenced by the returns around the event. Including the event window in the estimation of the normal model parameters could lead to the event returns having a large influence on the normal return measure. In this situation both the normal returns and the abnormal returns would capture the event impact. This would be problematic because the methodology is built around the assumption that the event impact is captured by the abnormal returns. On occasion, the post event window data is included with the estimation window data to estimate the normal return model. The goal of this approach is to increase the robustness of the normal market return measure to gradual changes in its parameters. In Section 6 expanding the null hypothesis to accommodate changes in the risk of a firm around the event is considered. In this case an estimation framework which uses the event window returns will be required.

A. *Estimation of the Market Model*

Under general conditions ordinary least squares (OLS) is a consistent estimation procedure for the market model parameters. Further, given the assumptions of Section 4, OLS is efficient. For the i^{th} firm in event time, the OLS estimators of the market model parameters for an estimation window of observations are

$$\hat{\beta}_i = \frac{\sum_{\tau=T_0+1}^{T_1} (R_{i\tau} - \hat{\mu}_i)(R_{m\tau} - \hat{\mu}_m)}{\sum_{\tau=T_0+1}^{T_1} (R_{m\tau} - \hat{\mu}_m)^2} \tag{4}$$

$$\hat{\alpha}_i = \hat{\mu}_i - \hat{\beta}_i \hat{\mu}_m \tag{5}$$

$$\hat{\sigma}^2_{\varepsilon_i} = \frac{1}{L_1 - 2} \sum_{\tau=T_0+1}^{T_1} (R_{i\tau} - \hat{\alpha}_i - \hat{\beta}_i R_{m\tau})^2 \tag{6}$$

where

$$\hat{\mu}_i = \frac{1}{L_1} \sum_{\tau=T_0+1}^{T_1} R_{i\tau}$$

and

$$\hat{\mu}_m = \frac{1}{L_1} \sum_{\tau=T_0+1}^{T_1} R_{m\tau}.$$

$R_{i\tau}$ and $R_{m\tau}$ are the return in event period τ for security i and the market respectively. The use of the OLS estimators to measure abnormal returns and to develop their statistical properties is addressed next. First, the properties of a given security are presented followed by consideration of the properties of abnormal returns aggregated across securities.

B. *Statistical Properties of Abnormal Returns*

Given the market model parameter estimates, one can measure and analyze the abnormal returns. Let $AR_{i\tau}$, $\tau = T_1 + 1, \ldots, T_2$, be the sample of L_2 abnormal returns for firm i in the event window. Using the market model to measure the normal return, the sample abnormal return is

$$AR_{i\tau} = R_{i\tau} - \hat{\alpha}_i - \hat{\beta}_i R_{m\tau}. \tag{7}$$

The abnormal return is the disturbance term of the market model calculated on an out of sample basis. Under the null hypothesis, conditional on the event win-

dow market returns, the abnormal returns will be jointly normally distributed with a zero conditional mean and conditional variance $\sigma^2(AR_{i\tau})$ where

$$\sigma^2(AR_{i\tau}) = \sigma^2_{\varepsilon_i} + \frac{1}{L_1}\left[1 + \frac{(R_{m\tau} - \hat{\mu}_m)^2}{\hat{\sigma}^2_m}\right]. \quad (8)$$

From (8), the conditional variance has two components. One component is the disturbance variance $\sigma^2_{\varepsilon_i}$ from (3) and a second component is additional variance due to the sampling error in α_i and β_i. This sampling error, which is common for all the event window observations, also leads to serial correlation of the abnormal returns despite the fact that the true disturbances are independent through time. As the length of the estimation window L_1 becomes large, the second term approaches zero as the sampling error of the parameters vanishes. The variance of the abnormal return will be $\sigma^2_{\varepsilon_i}$ and the abnormal return observations will become independent through time. In practice, the estimation window can usually be chosen to be large enough to make it reasonable to assume that the contribution of the second component to the variance of the abnormal return is zero.

Under the null hypothesis, H_0, that the event has no impact on the behavior of returns (mean or variance) the distributional properties of the abnormal returns can be used to draw inferences over any period within the event window. Under H_0 the distribution of the sample abnormal return of a given observation in the event window is

$$AR_{i\tau} \sim N(0, \sigma^2(AR_{i\tau})). \quad (9)$$

Next (9) is built upon to consider the aggregation of the abnormal returns.

C. *Aggregation of Abnormal Returns*

The abnormal return observations must be aggregated in order to draw overall inferences for the event of interest. The aggregation is along two dimensions—through time and across securities. We will first consider aggregation through time for an individual security and then will consider aggregation both across securities and through time. The concept of a cumulative abnormal return is necessary to accommodate a multiple period event window. Define $CAR_i(\tau_1,\tau_2)$ as the sample cumulative abnormal return (CAR) from τ_1 to τ_2 where $T_1 < \tau_1 \le \tau_2 \le T_2$. The CAR from τ_1 to τ_2 is the sum of the included abnormal returns,

$$CAR_i(\tau_1,\tau_2) = \sum_{\tau=\tau_1}^{\tau_2} AR_{i\tau}. \quad (10)$$

Asymptotically (as L_1 increases) the variance of CAR_i is

$$\sigma^2_i(\tau_1,\tau_2) = (\tau_2 - \tau_1 + 1)\,\sigma^2_{\varepsilon_i}. \quad (11)$$

This large sample estimator of the variance can be used for reasonable values of L_1. However, for small values of L_1 the variance of the cumulative abnormal return should be adjusted for the effects of the estimation error in the normal model parameters. This adjustment involves the second term of (8) and a further related adjustment for the serial covariance of the abnormal return.

The distribution of the cumulative abnormal return under H_0 is

$$CAR_i(\tau_1,\tau_2) \sim N(0, \sigma^2_i(\tau_1,\tau_2)). \quad (12)$$

Given the null distributions of the abnormal return and the cumulative abnormal return, tests of the null hypothesis can be conducted.

However, tests with one event observation are not likely to be useful so it is necessary to aggregate. The abnormal return observations must be aggregated for the event window and across observations of the event. For this aggregation,

TABLE 1

Event Day	Market Model					
	Good News		No News		Bad News	
	AR	CAR	AR	CAR	AR	CAR
−20	.093	.093	.080	.080	−.107	−.107
−19	−.177	−.084	.018	.098	−.180	−.286
−18	.088	.004	.012	.110	.029	−.258
−17	.024	.029	−.151	−.041	−.079	−.337
−16	−.018	.011	−.019	−.060	−.010	−.346
−15	−.040	−.029	.013	−.047	−.054	−.401
−14	.038	.008	.040	−.007	−.021	−.421
−13	.056	.064	−.057	−.065	.007	−.414
−12	.065	.129	.146	.081	−.090	−.504
−11	.069	.199	−.020	.061	−.088	−.592
−10	.028	.227	.025	.087	−.092	−.683
−9	.155	.382	.115	.202	−.040	−.724
−8	.057	.438	.070	.272	.072	−.652
−7	−.010	.428	−.106	.166	−.026	−.677
−6	.104	.532	.026	.192	−.013	−.690
−5	.085	.616	−.085	.107	.164	−.527
−4	.099	.715	.040	.147	−.139	−.666
−3	.117	.832	.036	.183	.098	−.568
−2	.006	.838	.226	.409	−.112	−.680
−1	.164	1.001	−.168	.241	−.180	−.860
0	.965	1.966	−.091	.150	−.679	−1.539
1	.251	2.217	−.008	.142	−.204	−1.743
2	−.014	2.203	.007	.148	.072	−1.672
3	−.164	2.039	.042	.190	.083	−1.589
4	−.014	2.024	.000	.190	.106	−1.483
5	.135	2.160	−.038	.152	.194	−1.289
6	−.052	2.107	−.302	−.150	.076	−1.213
7	.060	2.167	−.199	−.349	.120	−1.093
8	.155	2.323	−.108	−.457	−.041	−1.134
9	−.008	2.315	−.146	−.603	−.069	−1.203
10	.164	2.479	.082	−.521	.130	−1.073
11	−.081	2.398	.040	−.481	−.009	−1.082
12	−.058	2.341	.246	−.235	−.038	−1.119
13	−.165	2.176	.014	−.222	.071	−1.048
14	−.081	2.095	−.091	−.312	.019	−1.029
15	−.007	2.088	−.001	−.314	−.043	−1.072
16	.065	2.153	−.020	−.334	−.086	−1.159
17	.081	2.234	.017	−.317	−.050	−1.208
18	.172	2.406	.054	−.263	.066	−1.142
19	−.043	2.363	.119	−.144	−.088	−1.230
20	.013	2.377	.094	−.050	−.028	−1.258

TABLE 1 (*Cont.*)

Constant Mean Return Model					
Good News		No News		Bad News	
AR	CAR	AR	CAR	AR	CAR
.105	.105	.019	.019	−.077	−.077
−.235	−.129	−.048	−.029	−.142	−.219
.069	−.060	−.086	−.115	−.043	−.262
−.026	−.086	−.140	−.255	−.057	−.319
−.086	−.172	.039	−.216	−.075	−.394
−.183	−.355	.099	−.117	−.037	−.431
−.020	−.375	−.150	−.266	−.101	−.532
−.025	−.399	−.191	−.458	−.069	−.601
.101	−.298	.133	−.325	−.106	−.707
.126	−.172	.006	−.319	−.169	−.876
.134	−.038	.103	−.216	−.009	−.885
.210	.172	.022	−.194	.011	−.874
.106	.278	.163	.−031	.135	-.738
−.002	.277	.009	−.022	−.027	−.765
.011	.288	−.029	−.051	.030	−.735
.061	.349	−.068	−.120	.320	−.415
.031	.379	.089	−.031	−.205	−.620
.067	.447	.013	−.018	.085	−.536
.010	.456	.311	.294	−.256	−.791
.198	.654	−.170	.124	−.227	−1.018
1.034	1.688	−.164	−.040	−.643	−1.661
.357	2.045	−.170	−.210	−.212	−1.873
−.013	2.033	.054	−.156	.078	−1.795
.088	1.944	−.121	−.277	.146	−1.648
.041	1.985	.023	−.253	.149	-1.499
.248	2.233	−.003	−.256	.286	−1.214
−.035	2.198	−.319	−.575	.070	−1.143
.017	2.215	−.112	−.687	.102	−1.041
.112	2.326	−.187	−.874	.056	−.986
−.052	2.274	−.057	−.931	−.071	−1.056
.147	2.421	.203	−.728	.267	−.789
−.013	2.407	.045	−.683	.006	−.783
−.054	2.354	.299	−.384	.017	−.766
−.246	2.107	−.067	−.451	.114	−.652
−.011	2.096	−.024	−.475	.089	−.564
−.027	2.068	−.059	−.534	−.022	−.585
.103	2.171	−.046	−.580	−.084	−.670
.066	2.237	−.098	−.677	−.054	−.724
.110	2.347	.021	−.656	−.071	−.795
−.055	2.292	.088	−.568	.026	−.769
.019	2.311	.013	−.554	−.115	−.884

Abnormal returns for an event study of the information content of earnings announcements. The sample consists of a total of 600 quarterly announcements for the 30 companies in the Dow Jones Industrial Index for the five year period January 1989 to December 1993. Two models are considered for the normal returns, the market model using the CRSP value-weighted index and the constant return model. The announcements are categorized into three groups, good news, no news, and bad news. AR is the sample average abnormal return for the specified day in event time and CAR is the sample average cumulative abnormal return for day −20 to the specified day. Event time is days relative to the announcement date.

it is assumed that there is not any clustering. That is, there is not any overlap in the event windows of the included securities. The absence of any overlap and the maintained distributional assumptions imply that the abnormal returns and the cumulative abnormal returns will be independent across securities. Later inferences with clustering will be discussed.

The individual securities' abnormal returns can be aggregated using $AR_{i\tau}$ from (7) for each event period, $\tau = T_1 + 1, \ldots, T_2$. Given N events, the sample aggregated abnormal returns for period τ is

$$\overline{AR}_\tau = \frac{1}{N}\sum_{i=1}^{N} AR_{i\tau} \tag{13}$$

and for large L_1, its variance is

$$\text{var}(\overline{AR}_\tau) = \frac{1}{N^2}\sum_{i=1}^{N} \sigma^2_{\varepsilon_i}. \tag{14}$$

Using these estimates, the abnormal returns for any event period can be analyzed.

The average abnormal returns can then be aggregated over the event window using the same approach as that used to calculate the cumulative abnormal return for each security i. For any interval in the event window

$$\overline{CAR}(\tau_1,\tau_2) = \sum_{\tau=\tau_1}^{\tau_2} \overline{AR}_\tau, \tag{15}$$

$$\text{var}(\overline{CAR}(\tau_1,\tau_2)) = \sum_{\tau=\tau_1}^{\tau_2} \text{var}\,(\overline{AR}_\tau). \tag{16}$$

Observe that equivalently one can form the CAR's security by security and then aggregate through time,

$$\overline{CAR}(\tau_1,\tau_2) = \frac{1}{N}\sum_{i=1}^{N} CAR_i\,(\tau_1,\tau_2) \tag{17}$$

$$\text{var}(\overline{CAR}(\tau_1,\tau_2)) = \frac{1}{N^2}\sum_{i=1}^{N} \sigma^2_i(\tau_1,\tau_2). \tag{18}$$

For the variance estimators the assumption that the event windows of the N securities do not overlap is used to set the covariance terms to zero. Inferences about the cumulative abnormal returns can be drawn using

$$\overline{CAR}(\tau_1,\tau_2) \sim N[0, \text{var}(\overline{CAR}\,(\tau_1, \tau_2))] \tag{19}$$

to test the null hypothesis that the abnormal returns are zero. In practice, because $\sigma^2_{\varepsilon_i}$ is unknown, an estimator must be used to calculate the variance of the abnormal returns as in (14). The usual sample variance measure of $\sigma^2_{\varepsilon_i}$ from the market model regression in the estimation window is an appropriate choice. Using this to calculate $\text{var}(\overline{AR}_\tau)$ in (14), H_0 can be tested using

$$\theta_1 = \frac{\overline{CAR}(\tau_1,\tau_2)}{\text{var}(\overline{CAR}\,(\tau_1,\tau_2))^{1/2}} \sim N(0,1). \tag{20}$$

This distributional result is asymptotic with respect to the number of securities N and the length of estimation window L_1.

Modifications to the basic approach presented above are possible. One common modification is to standardize each abnormal return using an estimator of its standard deviation. For certain alternatives, such standardization can lead to more powerful tests. James Patell (1976) presents tests based on standardization and Brown and Warner (1980, 1985) provide comparisons with the basic approach.

D. *CAR's for the Earnings Announcement Example*

The information content of earnings example previously described illustrates the use of sample abnormal residuals and sample cumulative abnormal returns. Table 1 presents the abnormal returns av-

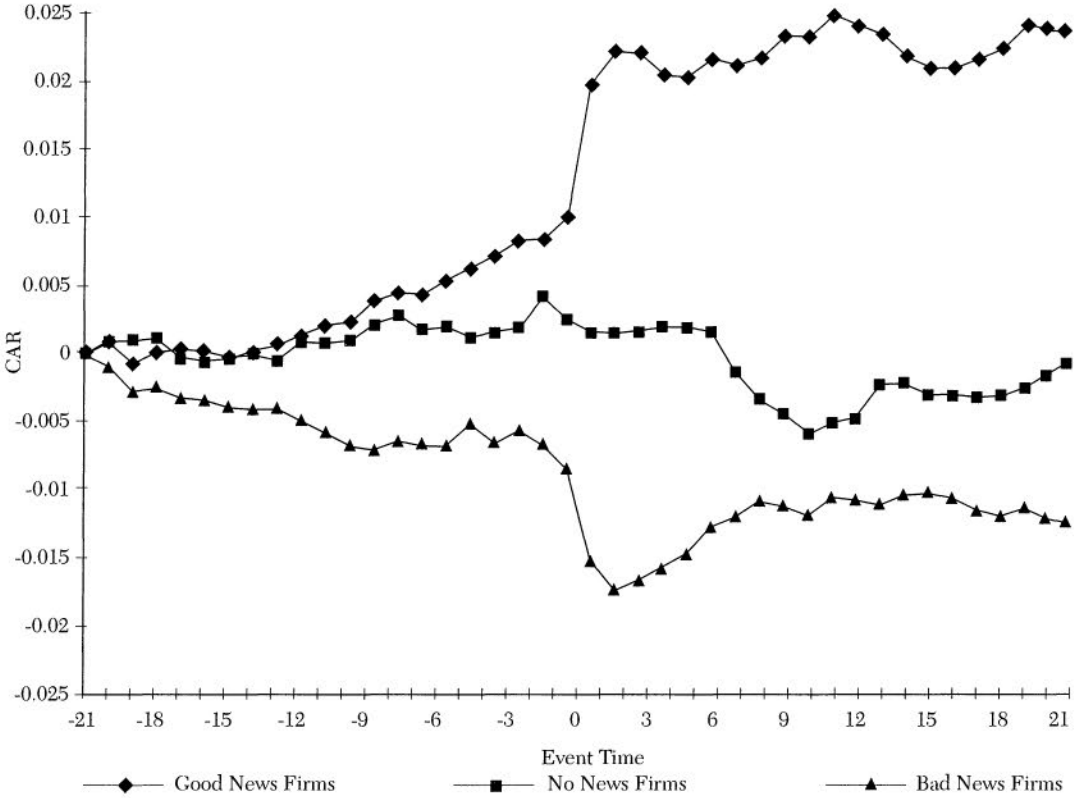


Figure 2a. Plot of cumulative abnormal return for earning announcements from event day -20 to event day 20. The abnormal return is calculated using the market model as the normal return measure.

eraged across the 600 event observations (30 firms, 20 announcements per firm) as well as the aggregated cumulative abnormal return for each of the three earnings news categories. Two normal return models are considered; the market model and for comparison, the constant mean return model. Plots of the cumulative abnormal returns are also included, with the CAR's from the market model in Figure 2a and the CAR's from the constant mean return model in Figure 2b.

The results of this example are largely consistent with the existing literature on the information content of earnings. The evidence strongly supports the hypothesis that earnings announcements do indeed convey information useful for the valuation of firms. Focusing on the announcement day (day 0) the sample average abnormal return for the good news firm using the market model is 0.965 percent. Given the standard error of the one day good news average abnormal return is 0.104 percent, the value of θ_1 is 9.28 and the null hypothesis that the event has no impact is strongly rejected. The story is the same for the bad news firms. The event day sample abnormal return is −0.679 percent, with a standard error of 0.098 percent, leading to θ_1 equal to −6.93 and again strong evidence against the null hypothesis. As would be expected, the abnormal return of the no news firms is small at −0.091 percent and

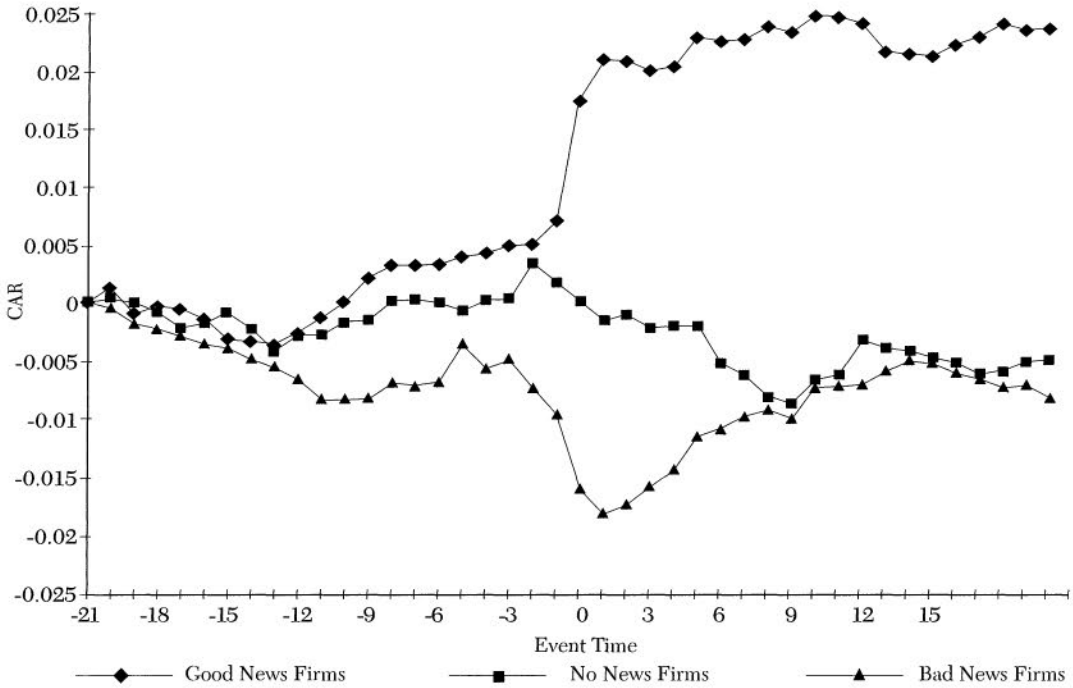


Figure 2b. Plot of cumulative abnormal return for earning announcements from event day -20 to event day 20. The abnormal return is calculated using the constant mean return model as the normal return

with a standard error of 0.098 percent is less than one standard error from zero. There is some evidence of the announcement effect on day one. The average abnormal return is 0.251 percent and −0.204 percent for the good news and the bad news firms respectively. Both these values are more than two standard errors from zero. The source of these day one effects is likely to be that some of the earnings announcements are made on event day zero after the close of the stock market. In these cases, the effects will be captured in the return on day one.

The conclusions using the abnormal returns from the constant return model are consistent with those from the market model. However, there is some loss of precision using the constant return model, as the variance of the average abnormal return increases for all three categories. When measuring abnormal returns with the constant mean return model the standard errors increase from 0.104 percent to 0.130 percent for good news firms, from 0.098 percent to 0.124 percent for no news firms, and from 0.098 percent to 0.131 percent for bad news firms. These increases are to be expected when considering a sample of large firms such as those in the Dow Index because these stocks tend to have an important market component whose variability is eliminated using the market model.

The CAR plots show that to some extent the market gradually learns about the forthcoming announcement. The average CAR of the good news firms gradually drifts up in days −20 to −1 and the average CAR of the bad news firms gradually drifts down over this period. In the days after the an-

nouncement the CAR is relatively stable as would be expected, although there does tend to be a slight (but statistically insignificant) increase with the bad news firms in days two through eight.

E. *Inferences with Clustering*

The analysis aggregating abnormal returns has assumed that the event windows of the included securities do not overlap in calendar time. This assumption allows us to calculate the variance of the aggregated sample cumulative abnormal returns without concern about the covariances across securities because they are zero. However, when the event windows do overlap and the covariances between the abnormal returns will not be zero, the distributional results presented for the aggregated abnormal returns are no longer applicable. Victor Bernard (1987) discusses some of the problems related to clustering.

Clustering can be accommodated in two ways. The abnormal returns can be aggregated into a portfolio dated using event time and the security level analysis of Section 5 can applied to the portfolio. This approach will allow for cross correlation of the abnormal returns.

A second method to handle clustering is to analyze the abnormal returns without aggregation. One can consider testing the null hypothesis of the event having no impact using unaggregated security by security data. This approach is applied most commonly when there is total clustering, that is, there is an event on the same day for a number of firms. The basic approach is an application of a multivariate regression model with dummy variables for the event date. This approach is developed in the papers of Katherine Schipper and Rex Thompson (1983, 1985) and Daniel Collins and Warren Dent (1984). The advantage of the approach is that, unlike the portfolio approach, an alternative hypothesis where some of the firms have positive abnormal returns and some of the firms have negative abnormal returns can be accommodated. However, in general the approach has two drawbacks—frequently the test statistic will have poor finite sample properties except in special cases and often the test will have little power against economically reasonable alternatives. The multivariate framework and its analysis is similar to the analysis of multivariate tests of asset pricing models. MacKinlay (1987) provides analysis in that context.

6. *Modifying the Null Hypothesis*

Thus far the focus has been on a single null hypothesis—that the given event has no impact on the behavior of the returns. With this null hypothesis either a mean effect or a variance effect will represent a violation. However, in some applications one may be interested in testing for a mean effect. In these cases, it is necessary to expand the null hypothesis to allow for changing (usually increasing) variances. To allow for changing variance as part of the null hypothesis, it is necessary to eliminate the reliance on the past returns to estimate the variance of the aggregated cumulative abnormal returns. This is accomplished by using the cross section of cumulative abnormal returns to form an estimator of the variance for testing the null hypothesis. Ekkehart Boehmer, Jim Musumeci, and Annette Poulsen (1991) discuss methodology to accommodate changing variance.

The cross sectional approach to estimating the variance can be applied to the average cumulative abnormal return ($\overline{CAR}(\tau_1,\tau_2)$). Using the cross-section to form an estimator of the variance gives

$$\text{var}(\overline{CAR}(\tau_1,\tau_2)) = \frac{1}{N^2}\sum_{i=1}^{N}(CAR_i(\tau_1,\tau_2) - \overline{CAR}(\tau_1,\tau_2))^2. \quad (21)$$

For this estimator of the variance to be consistent, the abnormal returns need to be uncorrelated in the cross-section. An absence of clustering is sufficient for this requirement. Note that cross-sectional homoskedasticity is not required. Given this variance estimator, the null hypothesis that the cumulative abnormal returns are zero can then be tested using the usual theory.

One may also be interested in the question of the impact of an event on the risk of a firm. The relevant measure of risk must be defined before this question can be addressed. One choice as a risk measure is the market model beta which is consistent with the Capital Asset Pricing Model being appropriate. Given this choice, the market model can be formulated to allow the beta to change over the event window and the stability of the risk can be examined. Edward Kane and Haluk Unal (1988) present an application of this idea.

7. *Analysis of Power*

An important consideration when setting up an event study is the ability to detect the presence of a non-zero abnormal return. The inability to distinguish between the null hypothesis and economically interesting alternatives would suggest the need for modification of the design. In this section the question of the likelihood of rejecting the null hypothesis for a specified level of abnormal return associated with an event is addressed. Formally, the power of the test is evaluated.

Consider a two-sided test of the null hypothesis using the cumulative abnormal return based statistic θ_1 from (20). It is assumed that the abnormal returns are uncorrelated across securities; thus the variance of $\overline{CAR}$ is $1/N^2\sum_{i=1}^{N}\sigma_i^2(\tau_1,\tau_2)$ and N is the sample size. Because the null distribution of θ_1 is standard normal, for a two sided test of size α, the null hypothesis will be rejected if θ_1 is in the critical region, that is,

$$\theta_1 < c\left(\frac{\alpha}{2}\right) \text{ or } \theta_1 > c\left(1-\frac{\alpha}{2}\right)$$

where $c(x) = \phi^{-1}(x)$. $\phi(\cdot)$ is the standard normal cumulative distribution function (CDF).

Given the specification of the alternative hypothesis H_A and the distribution of θ_1 for this alternative, the power of a test of size α can be tabulated using the power function,

$$P(\alpha,H_A) = pr\left(\theta_1 < c\left(\frac{\alpha}{2}\right) \mid H_A\right) + pr\left(\theta_1 > c\left(1-\frac{\alpha}{2}\right) \mid H_A\right). \quad (22)$$

The distribution of θ_1 under the alternative hypothesis considered below will be normal. The mean will be equal to the true cumulative abnormal return divided by the standard deviation of $\overline{CAR}$ and the variance will be equal to one.

To tabulate the power one must posit economically plausible scenarios. The alternative hypotheses considered are four levels of abnormal returns, 0.5 percent, 1.0 percent, 1.5 percent, and 2.0 percent and two levels of the average variance for the cumulative abnormal return of a given security over the event period, 0.0004 and 0.0016. The

TABLE 2

Sample Size	Abnormal Return .005	.010	.015	.020	Abnormal Return .005	.010	.015	.020
	$\sigma = 0.02$				$\sigma = 0.04$			
1	0.06	0.08	0.12	0.17	0.05	0.06	0.07	0.08
2	0.06	0.11	0.19	0.29	0.05	0.06	0.08	0.11
3	0.07	0.14	0.25	0.41	0.06	0.07	0.10	0.14
4	0.08	0.17	0.32	0.52	0.06	0.08	0.12	0.17
5	0.09	0.20	0.39	0.61	0.06	0.09	0.13	0.20
6	0.09	0.23	0.45	0.69	0.06	0.09	0.15	0.23
7	0.10	0.26	0.51	0.75	0.06	0.10	0.17	0.26
8	0.11	0.29	0.56	0.81	0.06	0.11	0.19	0.29
9	0.12	0.32	0.61	0.85	0.07	0.12	0.20	0.32
10	0.12	0.35	0.66	0.89	0.07	0.12	0.22	0.35
11	0.13	0.38	0.70	0.91	0.07	0.13	0.24	0.38
12	0.14	0.41	0.74	0.93	0.07	0.14	0.25	0.41
13	0.15	0.44	0.77	0.95	0.07	0.15	0.27	0.44
14	0.15	0.46	0.80	0.96	0.08	0.15	0.29	0.46
15	0.16	0.49	0.83	0.97	0.08	0.16	0.31	0.49
16	0.17	0.52	0.85	0.98	0.08	0.17	0.32	0.52
17	0.18	0.54	0.87	0.98	0.08	0.18	0.34	0.54
18	0.19	0.56	0.89	0.99	0.08	0.19	0.36	0.56
19	0.19	0.59	0.90	0.99	0.08	0.19	0.37	0.59
20	0.20	0.61	0.92	0.99	0.09	0.20	0.39	0.61
25	0.24	0.71	0.96	1.00	0.10	0.24	0.47	0.71
30	0.28	0.78	0.98	1.00	0.11	0.28	0.54	0.78
35	0.32	0.84	0.99	1.00	0.11	0.32	0.60	0.84
40	0.35	0.89	1.00	1.00	0.12	0.35	0.66	0.89
45	0.39	0.92	1.00	1.00	0.13	0.39	0.71	0.92
50	0.42	0.94	1.00	1.00	0.14	0.42	0.76	0.94
60	0.49	0.97	1.00	1.00	0.16	0.49	0.83	0.97
70	0.55	0.99	1.00	1.00	0.18	0.55	0.88	0.99
80	0.61	0.99	1.00	1.00	0.20	0.61	0.92	0.99
90	0.66	1.00	1.00	1.00	0.22	0.66	0.94	1.00
100	0.71	1.00	1.00	1.00	0.24	0.71	0.96	1.00
120	0.78	1.00	1.00	1.00	0.28	0.78	0.98	1.00
140	0.84	1.00	1.00	1.00	0.32	0.84	0.99	1.00
160	0.89	1.00	1.00	1.00	0.35	0.89	1.00	1.00
180	0.92	1.00	1.00	1.00	0.39	0.92	1.00	1.00
200	0.94	1.00	1.00	1.00	0.42	0.94	1.00	1.00

Power of event study methodology for test of the null hypothesis that the abnormal return is zero. The power is reported for a two-sided test using θ_1 with a size of 5 percent. The sample size is the number of event observations included the study and σ is the square root of the average variance of the abnormal return across firms.

sample size, that is the number of securities for which the event occurs, is varied from one to 200. The power for a test with a size of 5 percent is documented. With $\alpha = 0.05$, the critical values calculated using $c(\alpha/2)$ and $c(1 - \alpha/2)$ are -1.96 and 1.96 respectively. Of course, in applications, the power of the test should be considered when selecting the size.

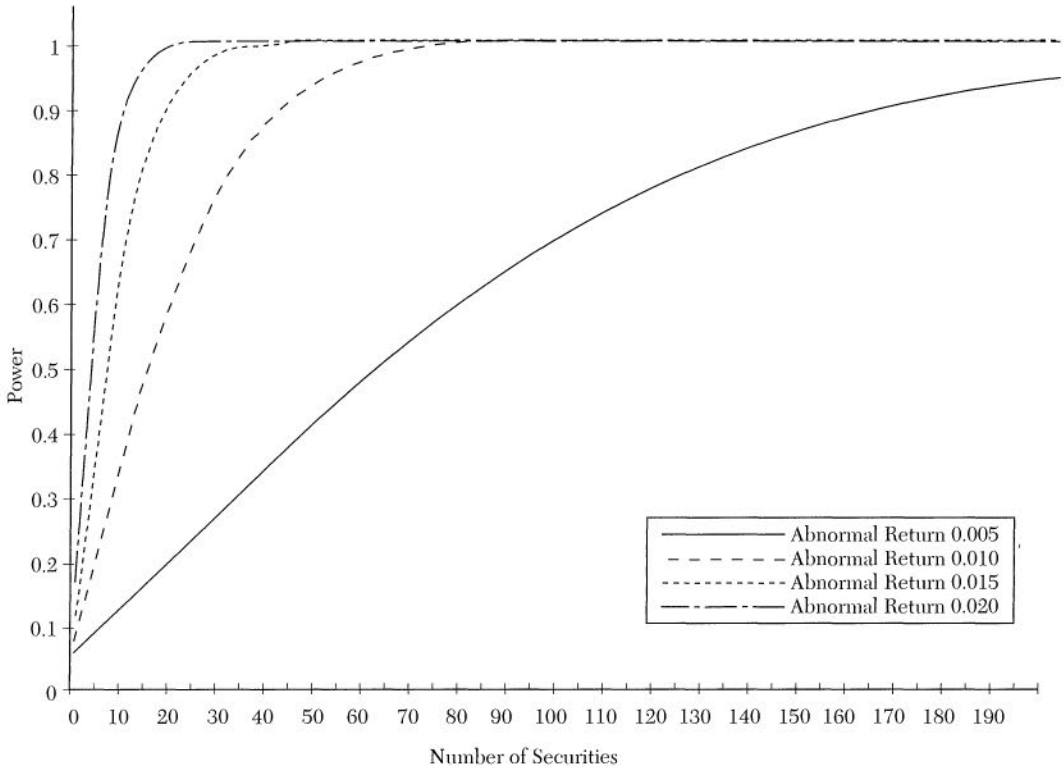


Figure 3a. Power of event study test statistic θ_1 to reject the null hypothesis that the abnormal return is zero, when the square root of the average variance of the abnormal return across firms is 2 percent.

The power results are presented in Table 2, and are plotted in Figures 3a and 3b. The results in the left panel of Table 2 and Figure 3a are for the case where the average variance is 0.0004. This corresponds to a cumulative abnormal return standard deviation of 2 percent and is an appropriate value for an event which does not lead to increased variance and can be examined using a one-day event window. In terms of having high power this is the best case scenario. The results illustrate that when the abnormal return is only 0.5 percent the power can be low. For example with a sample size of 20 the power of a 5 percent test is only 0.20. One needs a sample of over 60 firms before the power reaches 0.50. However, for a given sample size, increases in power are substantial when the abnormal return is larger. For example, when the abnormal return is 2.0 percent the power of a 5 percent test with 20 firms is almost 1.00 with a value of 0.99. The general results for a variance of 0.0004 is that when the abnormal return is larger than 1 percent the power is quite high even for small sample sizes. When the abnormal return is small a larger sample size is necessary to achieve high power.

In the right panel of Table 2 and in Figure 3b the power results are presented for the case where the average variance of the cumulative abnormal return is 0.0016. This case corresponds roughly to either a multi-day event window or to a one-day event window with the event leading to increased variance

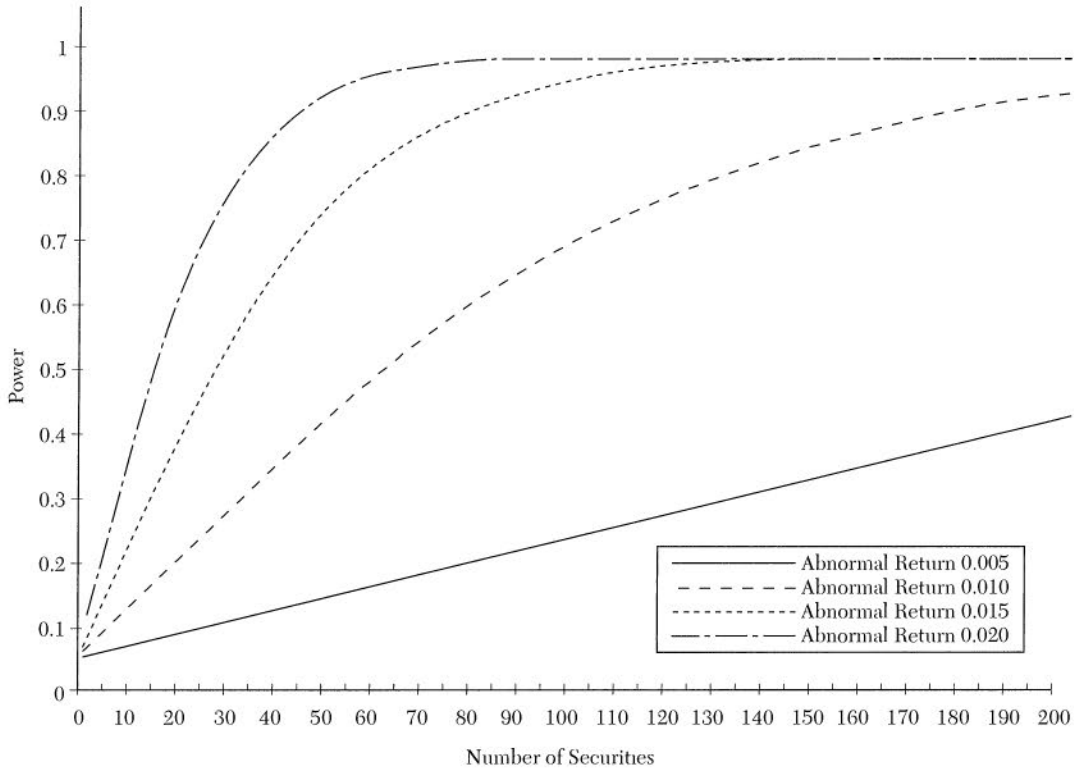


Figure 3b. Power of event study test statistic θ_1 to reject the null hypothesis that the abnormal return is zero, when the square root of the average variance of the abnormal return across firms is 4 percent.

which is accommodated as part of the null hypothesis. When the average variance of the CAR is increased from 0.0004 to 0.0016 there is a dramatic power decline for a 5 percent test. When the CAR is 0.5 percent the power is only 0.09 with 20 firms and is only 0.42 with a sample of 200 firms. This magnitude of abnormal return is difficult to detect with the larger variance. In contrast, when the CAR is as large as 1.5 percent or 2.0 percent the 5 percent test is still has reasonable power. For example, when the abnormal return is 1.5 percent and there is a sample size of 30 the power is 0.54. Generally if the abnormal return is large one will have little difficulty rejecting the null hypothesis of no abnormal return.

In the preceding analysis the power is considered analytically for the given distributional assumptions. If the distributional assumptions are inappropriate then the results may differ. However, Brown and Warner (1985) consider this possible difference and find that the analytical computations and the empirical power are very close.

It is difficult to make general conclusions concerning the adequacy of the ability of event study methodology to detect non-zero abnormal returns. When conducting an event study it is best to evaluate the power given the parameters and objectives of the study. If the power seems sufficient then one can proceed, otherwise one should search for ways of increasing the power. This can be done by increasing the sample size, shortening the event window, or by

developing more specific predictions to test.

8. *Nonparametric Tests*

The methods discussed to this point are parametric in nature, in that specific assumptions have been made about the distribution of abnormal returns. Alternative approaches are available which are nonparametric in nature. These approaches are free of specific assump- tions concerning the distribution of returns. Common nonparametric tests for event studies are the sign test and the rank test. These tests are discussed next.

The sign test, which is based on the sign of the abnormal return, requires that the abnormal returns (or more generally cumulative abnormal returns) are independent across securities and that the expected proportion of positive abnormal returns under the null hypothesis is 0.5. The basis of the test is that, under the null hypothesis, it is equally probable that the CAR will be positive or negative. If, for example, the null hypothesis is that there is a positive abnormal return associated with a given event, the null hypothesis is H_0:$p \leq 0.5$ and the alternative is H_A:$p > 0.5$ where $p = pr[CAR_i \geq 0.0]$. To calculate the test statistic we need the number of cases where the abnormal return is positive, N^+, and the total number of cases, N. Letting θ_2 be the test statistic,

$$\theta_2 = \left[\frac{N^+}{N} - 0.5\right]\frac{\sqrt{N}}{0.5} \sim N(0,1). \qquad (23)$$

This distributional result is asymptotic. For a test of size $(1 - \alpha)$, H_0 is rejected if $\theta_2 > \Phi^{-1}(\alpha)$.

A weakness of the sign test is that it may not be well specified if the distribution of abnormal returns is skewed as can be the case with daily data. In response to this possible shortcoming, Charles Corrado (1989) proposes a nonparametric rank test for abnormal performance in event studies. A brief description of his test of no abnormal return for event day zero follows. The framework can be easily altered for more general tests.

Drawing on notation previously introduced, consider a sample of L_2 abnormal returns for each of N securities. To implement the rank test, for each security it is necessary to rank the abnormal returns from one to L_2. Define $K_{i\tau}$ as the rank of the abnormal return of security i for event time period τ. Recall, τ ranges from $T_1 + 1$ to T_2 and $\tau = 0$ is the event day. The rank test uses the fact that the expected rank of the event day is $(L_2 + 1)/2$ under the null hypothesis. The test statistic for the null hypothesis of no abnormal return on event day zero is

$$\theta_3 = \frac{1}{N}\sum_{i=1}^{N}\left(K_{i0} - \frac{L_2 + 1}{2}\right)\Big/ s(K) \qquad (24)$$

where

$$s(K) = \sqrt{\frac{1}{L_2}\sum_{\tau = T_1 + 1}^{T_2}\left(\frac{1}{N}\sum_{i=1}^{N}\left(K_{i\tau} - \frac{L_2 + 1}{2}\right)\right)^2}. \qquad (25)$$

Tests of the null hypothesis can be implemented using the result that the asymptotic null distribution of θ_3 is standard normal. Corrado (1989) includes further discussion of details of this test.

Typically, these nonparametric tests are not used in isolation but in conjunction with the parametric counterparts. Inclusion of the nonparametric tests provides a check of the robustness of conclusions based on parametric tests. Such a check can be worthwhile as illustrated by the work of Cynthia Campbell and Charles Wasley (1993). They find that for NASDAQ stocks daily returns the nonparametric rank test provides more reliable inferences than do the standard parametric tests.

9. *Cross-Sectional Models*

Theoretical insights can result from examining the association between the magnitude of the abnormal return and characteristics specific to the event observation. Often such an exercise can be helpful when multiple hypotheses exist for the source of the abnormal return. A cross-sectional regression model is an appropriate tool to investigate this association. The basic approach is to run a cross-sectional regression of the abnormal returns on the characteristics of interest.

Given a sample of N abnormal return observations and M characteristics, the regression model is:

$$AR_j = \delta_0 + \delta_1 x_{1j} + \cdots + + \delta_M x_{Mj} + \eta_j \quad (26)$$

$$E(\eta_j) = 0 \quad (27)$$

where AR_j is the j^{th} abnormal return observation, $x_{mj}, m = 1, \ldots, M$, are M characteristics for the j^{th} observation and η_j is the zero mean disturbance term that is uncorrelated with the x's. δ_m, $m = 0, \ldots, M$ are the regression coefficients. The regression model can be estimated using OLS. Assuming the η_j's are cross-sectionally uncorrelated and homoskedastic, inferences can be conducted using the usual OLS standard errors. Alternatively, without assuming homoskedasticity, heteroskedasticity-consistent t-statistics using standard errors can be derived using the approach of Halbert White (1980). The use of heteroskedasticity-consistent standard errors is advisable because there is no reason to expect the residuals of (26) to be homoskedastic.

Paul Asquith and David Mullins (1986) provide an example of this cross-sectional approach. The two day cumulative abnormal return for the announcement of an equity offering is regressed on the size of the offering as a percentage of the value of the total equity of the firm and on the cumulative abnormal return in the eleven months prior to the announcement month. They find that the magnitude of the (negative) abnormal return associated with the announcement of equity offerings is related to both these variables. Larger pre-event cumulative abnormal returns are associated with less negative abnormal returns and larger offerings are associated with more negative abnormal returns. These findings are consistent with theoretical predictions which they discuss.

Issues concerning the interpretation of the results can arise with the cross-sectional regression approach. In many situations, the event window abnormal return will be related to firm characteristics not only through the valuation effects of the event but also through a relation between the firm characteristics and the extent to which the event is anticipated. This can happen when investors rationally use the firm characteristics to forecast the likelihood of the event occurring. In these cases, a linear relation between the valuation effect of the event and the firm characteristic can be hidden. Paul Malatesta and Thompson (1985) and William Lanen and Thompson (1988) provide examples of this situation.

Technically, with the relation between the firm characteristics and the degree of anticipation of the event introduces a selection bias. The assumption that the regression residual is uncorrelated with the regressors breaks down and the OLS estimators are inconsistent. Consistent estimators can be derived by explicitly incorporating the selection bias. Sankarshan Acharya (1988) and B. Espen Eckbo, Vojislav Maksimovic, and Joseph Williams (1990) provide examples of this approach. N. R. Prabhala (1995) provides a good discussion of this problem and the possible solutions. He argues that, despite an incorrect specification, under weak conditions, the OLS ap-

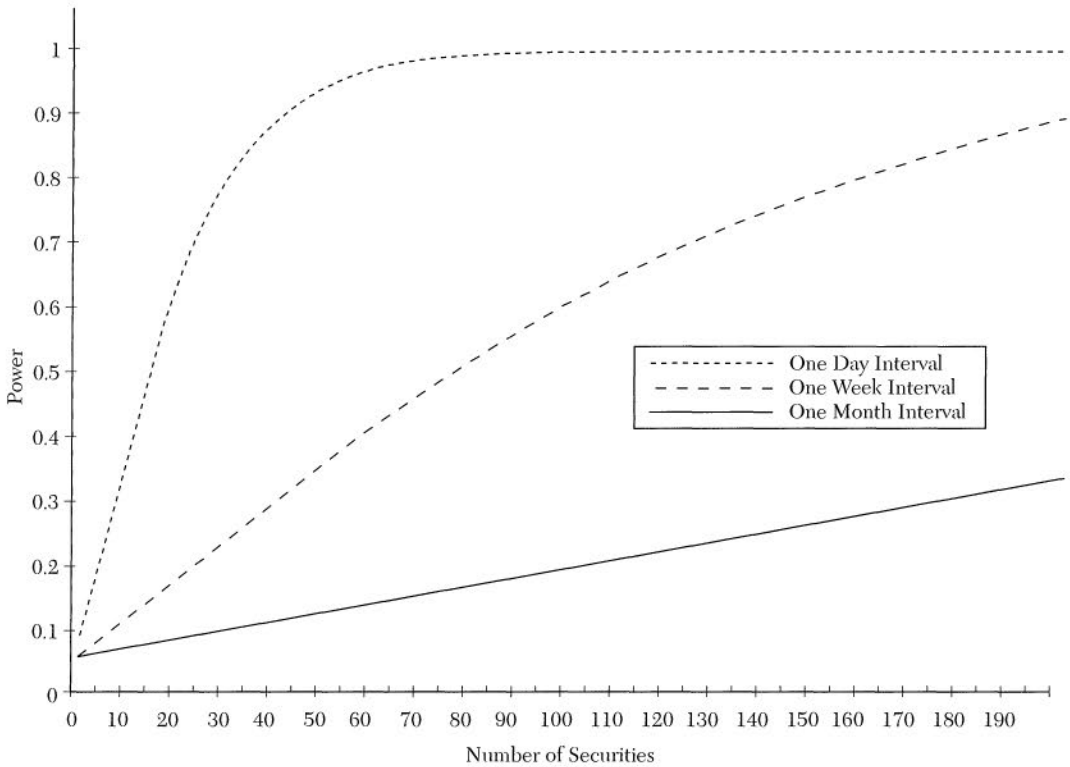


Figure 4. Power of event study test statistic θ_1 to reject the null hypothesis that the abnormal return is zero, for different sampling intervals, when the square root of the average variance of the abnormal return across firms is 4 percent for the daily interval. Size of test is 5 percent.

proach can be used for inferences and that the *t*-statistics can be interpreted as lower bounds on the true significance level of the estimates.

10. *Other Issues*

A number of further issues often arise when conducting an event study. These issues include the role of the sampling interval, event date uncertainty, robustness, and some additional biases.

A. *Role of Sampling Interval*

Stock return data is available at different sampling intervals, with daily and monthly intervals being the most common. Given the availability of various intervals, the question of the gains of using more frequent sampling arises. To address this question one needs to consider the power gains from shorter intervals. A comparison of daily versus monthly data is provided in Figure 4. The power of the test of no event effect is plotted against the alternative of an abnormal return of one percent for 1 to 200 securities. As one would expect given the analysis of Section 7, the decrease in power going from a daily interval to a monthly interval is severe. For example, with 50 securities the power for a 5 percent test using daily data is 0.94, whereas the power using weekly and monthly data is only 0.35 and 0.12 respectively. The clear message is that there is a substantial payoff in terms of increased power from reducing the sampling inter-

val. Dale Morse (1984) presents detailed analysis of the choice of daily versus monthly data and draws the same conclusion.

A sampling interval of one day is not the shortest interval possible. With the increased availability of transaction data, recent studies have used observation intervals of duration shorter than one day. However, the net benefit of intervals less than one day is unclear as some complications are introduced. Discussion of using transaction data for event studies is included in the work of Michael Barclay and Robert Litzenberger (1988).

B. *Inferences with Event-Date Uncertainty*

Thus far it is assumed that the event date can be identified with certainty. However, in some studies it may be difficult to identify the exact date. A common example is when collecting event dates from financial publications such as the *Wall Street Journal*. When the event announcement appears in the paper one can not be certain if the market was informed prior to the close of the market the prior trading day. If this is the case then the prior day is the event day, if not then the current day is the event day. The usual method of handling this problem is to expand the event window to two days—day 0 and day +1. While there is a cost to expanding the event window, the results in Section 6 indicated that the power properties of two day event windows are still good suggesting that the costs are worth bearing rather than to take the risk of missing the event.

Clifford Ball and Walter Torous (1988) have investigated the issue. They develop a maximum likelihood estimation procedure which accommodates event date uncertainty and examine results of their explicit procedure versus the informal procedure of expanding the event window. The results indicates that the informal procedure works well and there is little to gain from the more elaborate estimation framework.

C. *Robustness*

The statistical analysis of Sections 4, 5, and 6 is based on assumption that returns are jointly normal and temporally independently and identically distributed. In this section, discussion of the robustness of the results to departures from this assumption is presented. The normality assumption is important for the exact finite sample results to hold. Without assuming normality, all results would be asymptotic. However, this is generally not a problem for event studies because for the test statistics, convergence to the asymptotic distributions is rather quick. Brown and Warner (1985) provide discussion of this issue.

D. *Other Possible Biases*

A number of possible biases can arise in the context of conducting an event study. Nonsynchronous trading can introduce a bias. The nontrading or nonsynchronous trading effect arises when prices, are taken to be recorded at time intervals of one length when in fact they are recorded at time intervals of other possibly irregular lengths. For example, the daily prices of securities usually employed in event studies are generally "closing" prices, prices at which the last transaction in each of those securities occurred during the trading day. These closing prices generally do not occur at the same time each day, but by calling them "daily" prices, one is implicitly and incorrectly assuming that they are equally spaced at 24-hour intervals. This nontrading effect induces biases in the moments and co-moments of returns.

The influence of the nontrading effect on the variances and covariances of individual stocks and portfolios naturally feeds into a bias for the market model

beta. Myron Scholes and Williams (1977) present a consistent estimator of beta in the presence of nontrading based on the assumption that the true return process is uncorrelated through time. They also present some empirical evidence which shows the nontrading-adjusted beta estimates of thinly traded securities to be approximately 10 to 20 percent larger than the unadjusted estimates. However, for actively traded securities, the adjustments are generally small and unimportant.

Prem Jain (1986) considers the influence of thin trading on the distribution of the abnormal returns from the market model with the beta estimated using the Scholes-Williams approach. When comparing the distribution of these abnormal returns to the distribution of the abnormal returns using the usual OLS betas finds that the differences are minimal. This suggests that in general the adjustments for thin trading are not important.

The methodology used to compute the cumulative abnormal returns can induce an upward bias. The bias arises from the observation by observation rebalancing to equal weights implicit in the calculation of the aggregate cumulative abnormal return combined with the use of transaction prices which can represent both the bid and the offer side of the market. Marshall Blume and Robert Stambaugh (1983) analyze this bias and show that it can be important for studies using low market capitalization firms which have, in percentage terms, wide bid offer spreads. In these cases the bias can be eliminated by considering cumulative abnormal returns which represent buy and hold strategies.

11. *Concluding Discussion*

In closing, examples of event study successes and limitations are presented. Perhaps the most successful applications have been in the area of corporate finance. Event studies dominate the empirical research in this area. Important examples include the wealth effects of mergers and acquisitions and the price effects of financing decisions by firms. Studies of these events typically focus on the abnormal return around the date of first announcement.

In the 1960s there was a paucity of empirical evidence on the wealth effects of mergers and acquisitions. For example, Henry Manne (1965) discusses the various arguments for and against mergers. At that time the debate centered on the extent to which mergers should be regulated in order to foster competition in the product markets. Manne argued that mergers represent a natural outcome in an efficiently operating market for corporate control and consequently provide protection for shareholders. He downplayed the importance of the argument that mergers reduce competition. At the conclusion of his article Manne suggested that the two competing hypotheses for mergers could be separated by studying the price effects of the involved corporations. He hypothesized that, if mergers created market power, one would observe price increases for both the target and acquirer. In contrast, if the merger represented the acquiring corporation paying for control of the target, one would observe a price increase for the target only and not for the acquirer. However, Manne concludes, in reference to the price effects of mergers, that "no data are presently available on this subject."

Since that time an enormous body of empirical evidence on mergers and acquisitions has developed which is dominated by the use of event studies. The general result is that, given a successful takeover, the abnormal returns of the targets are large and positive and the abnormal returns of the acquirer are close

to zero. Gregg Jarrell and Poulsen (1989) document that the average abnormal return for target shareholders exceeds 20 percent for a sample of 663 successful takeovers from 1960 to 1985. In contrast the abnormal returns for acquirers is close to zero. For the same sample, Jarrell and Poulsen find an average abnormal return of 1.14 percent for acquirers. In the 1980s they find the average abnormal return is negative at -1.10 percent. Eckbo (1983) explicitly addresses the role of increased market power in explaining merger related abnormal returns. He separates mergers of competing firms from other mergers and finds no evidence that the wealth effects for competing firms are different. Further, he finds no evidence that rivals of firms merging horizontally experience negative abnormal returns. From this he concludes that reduced competition in the product market is not an important explanation for merger gains. This leaves competition for corporate control a more likely explanation. Much additional empirical work in the area of mergers and acquisitions has been conducted. Michael Jensen and Richard Ruback (1983) and Jarrell, James Brickley, and Netter (1988) provide detailed surveys of this work.

A number of robust results have been developed from event studies of financing decisions by corporations. When a corporation announces that it will raise capital in external markets there is, on average, a negative abnormal return. The magnitude of the abnormal return depends on the source of external financing. Asquith and Mullins (1986) find for a sample of 266 firms announcing an equity issue in the period 1963 to 1981 the two day average abnormal return is −2.7 percent and on a sample of 80 firms for the period 1972 to 1982 Wayne Mikkelson and Megan Partch (1986) find the two day average abnormal return is −3.56 percent. In contrast, when firms decide to use straight debt financing, the average abnormal return is closer to zero. Mikkelson and Partch (1986) find the average abnormal return for debt issues to be −0.23 percent for a sample of 171 issues. Findings such as these provide the fuel for the development of new theories. For example, in this case, the findings motivate the pecking order theory of capital structure developed by Stewart Myers and Nicholas Majluf (1984).

A major success related to those in the corporate finance area is the implicit acceptance of event study methodology by the U.S. Supreme Court for determining materiality in insider trading cases and for determining appropriate disgorgement amounts in cases of fraud. This implicit acceptance in the 1988 Basic, Incorporated v. Levinson case and its importance for securities law is discussed in Mitchell and Netter (1994).

There have also been less successful applications. An important characteristic of a successful event study is the ability to identify precisely the date of the event. In cases where the event date is difficult to identify or the event date is partially anticipated, studies have been less useful. For example, the wealth effects of regulatory changes for affected entities can be difficult to detect using event study methodology. The problem is that regulatory changes are often debated in the political arena over time and any accompanying wealth effects generally will gradually be incorporated into the value of a corporation as the probability of the change being adopted increases.

Larry Dann and Christopher James (1982) discuss this issue in the context of the impact of deposit interest rate ceilings for thrift institutions. In their study of changes in rate ceilings, they decide not to consider a change in 1973 because it was due to legislative action. Schipper

and Thompson (1983, 1985) also encounter this problem in a study of merger related regulations. They attempt to circumvent the problem of regulatory changes being anticipated by identifying dates when the probability of a regulatory change being passed changes. However, they find largely insignificant results leaving open the possibility the of absence of distinct event dates as the explanation of the lack of wealth effects.

Much has been learned from the body of research based on the use of event study methodology. In a general context, event studies have shown that, as would be expected in a rational marketplace, prices do respond to new information. As one moves forward, it is expected that event studies will continue to be a valuable and widely used tool in economics and finance.

References

ACHARYA, SANKARSHAN. "A Generalized Econometric Model and Tests of a Signalling Hypothesis with Two Discrete Signals," *J. Finance*, June 1988, *43*(2), pp. 413–29.

ASHLEY, JOHN W. "Stock Prices and Changes in Earnings and Dividends: Some Empirical Results," *J. Polit. Econ.*, Feb. 1962, *70*(1), pp. 82–85.

ASQUITH, PAUL AND MULLINS, DAVID. "Equity Issues and Offering Dilution," *J. Finan. Econ.*, Jan./Feb. 1986, *15*(1/2), pp. 61–89.

BALL, CLIFFORD A. AND TOROUS, WALTER N. "Investigating Security-Price Performance in the Presence of Event-Date Uncertainty," *J. Finan. Econ.*, Oct. 1988, *22*(1), pp. 123–53.

BALL, RAY AND BROWN, PHILIP. "An Empirical Evaluation of Accounting Income Numbers," *J. Acc. Res.* , Autumn 1968, *6*(2), pp. 159–78.

BARCLAY, MICHAEL J. AND LITZENBERGER, ROBERT H. "Announcement Effects of New Equity Issues and the Use of Intraday Price Data," *J. Finan. Econ.*, May 1988, *21*(1), pp. 71–99.

BARKER, C. AUSTIN. "Effective Stock Splits," *Harvard Bus. Rev.*, Jan./Feb. 1956, *34*(1), pp. 101–06.

———. "Stock Splits in a Bull Market," *Harvard Bus. Rev.*, May/June 1957, *35*(3), pp. 72–79.

———. "Evaluation of Stock Dividends," *Harvard Bus. Rev.*, July/Aug. 1958, *36*(4), pp. 99–114.

BERNARD, VICTOR L. "Cross-Sectional Dependence and Problems in Inference in Market-Based Accounting Research," *J. Acc. Res.*, 1987, *25*(1), pp. 1–48.

BLUME, MARSHALL E. AND STAMBAUGH, ROBERT F. "Biases in Computed Returns: An Application to the Size Effect," *J. Finan. Econ.* , Nov. 1983, *12*(3), pp. 387–404.

BOEHMER, EKKEHART; MUSUMECI, JIM AND POULSEN, ANNETTE B. "Event-Study Methodology under Conditions of Event-Induced Variance," *J. Finan. Econ.*, Dec. 1991, *30*(2), pp. 253–72.

BROWN, STEPHEN J. AND WARNER, JEROLD B. "Measuring Security Price Performance," *J. Finan. Econ.*, Sept. 1980, *8*(3), 205–58.

———. "Using Daily Stock Returns: The Case of Event Studies," *J. Finan. Econ.*, Mar. 1985, *14*(1), pp. 3–31.

BROWN, STEPHEN AND WEINSTEIN, MARK I. "Derived Factors in Event Studies," *J. Finan. Econ.*, Sept. 1985, *14*(3), pp. 491–95.

CAMPBELL, CYNTHIA J. AND WASLEY, CHARLES E. "Measuring Security Price Performance Using Daily NASDAQ Returns," *J. Finan. Econ.*, Feb. 1993, *33*(1), pp. 73–92.

COLLINS, DANIEL W. AND DENT, WARREN T. "A Comparison of Alternative Testing Methodologies Used In Capital Market Research," *J. Acc. Res.*, Spring 1984, *22*(1), pp. 48–84.

CORRADO, CHARLES. "A Nonparametric Test for Abnormal Security-Price Performance in Event Studies," *J. Finan. Econ.*, Aug. 1989, *23*(2), pp. 385–95.

DANN, LARRY Y. AND JAMES, CHRISTOPHER M. "An Analysis of the Impact of Deposit Rate Ceilings on the Market Values of Thrift Institutions," *J. Finance*, Dec. 1982, *37*(5), pp. 1259–75.

DOLLEY, JAMES CLAY. "Characteristics and Procedure of Common Stock Split-Ups," *Harvard Bus. Rev.*, Apr. 1933, *11*, pp. 316–26.

ECKBO, B. ESPEN. "Horizontal Mergers, Collusion, and Stockholder Wealth," *J. Finan. Econ.*, Apr. 1983, *11*(1–4), pp. 241–73.

ECKBO, B. ESPEN; MAKSIMOVIC, VOJISLAV AND WILLIAMS, JOSEPH. "Consistent Estimation of Cross-Sectional Models in Event Studies," *Rev. Financial Stud.*, 1990, *3*(3), pp. 343–65.

FAMA, EUGENE F. ET AL. "The Adjustment of Stock Prices to New Information," *Int. Econ. Rev.*, Feb. 1969, *10*(1), pp. 1–21.

FAMA, EUGENE F. AND FRENCH, KENNETH R. "Multifactor Explanations of Asset Pricing Anomalies," *J. Finance*, Mar. 1996, *51*(1), pp. 55–84.

JAIN, PREM. "Analyses of the Distribution of Security Market Model Prediction Errors for Daily Returns Data," *J. Acc. Res.*, Spring 1986, *24*(1), pp. 76–96.

JARRELL, GREGG A.; BRICKLEY, JAMES A. AND NETTER, JEFFRY M. "The Market for Corporate Control: The Empirical Evidence Since 1980," *J. Econ. Perspectives*, Winter 1988, *2*(1), pp. 49–68.

JARRELL, GREGG AND POULSEN, ANNETTE. "The Returns to Acquiring Firms in Tender Offers:

Evidence from Three Decades," *Financial Management*, Autumn 1989, *18*(3), pp. 12–19.

JENSEN, MICHAEL C. AND RUBACK, RICHARD S. "The Market for Corporate Control: The Scientific Evidence," *J. Finan. Econ.*, Apr. 1983, *11*(1–4), pp. 5–50.

KANE, EDWARD J. AND UNAL, HALUK. "Change in Market Assessments of Deposit-Institution Riskiness," *J. Finan. Services Res.*, June 1988, *1*(3), pp. 207–29.

LANEN, WILLIAM N. AND THOMPSON, REX. "Stock Price Reactions as Surrogates for the Net Cash-Flow Effects of Corporate Policy Decisions," *J. Acc. Econ.*, Dec. 1988, *10*(4), pp. 311–34.

LINTNER, JOHN. "The Valuation of Risky Assets and the Selection of Risky Investments in Stock Portfolios and Capital Budgets," *Rev. Econ. Stat.*, Feb. 1965, *47*(1), pp. 13–37.

MACKINLAY, A. CRAIG. "On Multivariate Tests of the CAPM," *J. Finan. Econ.*, June 1987, *18*(2), pp. 341–71.

MALATESTA, PAUL H. AND THOMPSON, REX. "Partially Anticipated Events: A Model of Stock Price Reactions with an Application to Corporate Acquisitions," *J. Finan. Econ.*, June 1985, *14*(2), pp. 237–50.

MANNE, HENRY G. "Mergers and the Market for Corporate Control," *J. Polit. Econ.*, Apr. 1965, *73*(2), pp. 110–20.

MCQUEEN, GRANT AND ROLEY, VANCE. "Stock Prices, News, and Business Conditions," *Rev. Finan. Stud.*, 1993, *6*(3), pp. 683–707.

MIKKELSON, WAYNE H. AND PARTCH, MEGAN. "Valuation Effects of Security Offerings and the Issuance Process," *J. Finan. Econ.*, Jan./Feb. 1986, *15*(1/2), pp. 31–60.

MITCHELL, MARK L. AND NETTER, JEFFRY M. "The Role of Financial Economics in Securities Fraud Cases: Applications at the Securities and Exchange Commission," *Business Lawyer*, Feb. 1994, *49*(2), pp. 545–90.

MORSE, DALE. "An Econometric Analysis of the Choice of Daily Versus Monthly Returns In Tests of Information Content," *J. Acc. Res.*, Autumn 1984, *22*(2), pp. 605–23.

MYERS, JOHN H. AND BAKAY, ARCHIE J. "Influence of Stock Split-Ups on Market Price," *Harvard Bus. Rev.*, Mar. 1948, *26*, pp. 251–55.

MYERS, STEWART C. AND MAJLUF, NICHOLAS S. "Corporate Financing and Investment Decisions When Firms Have Information That Investors Do Not Have," *J. Finan. Econ.*, June 1984, *13*(2), pp. 187–221.

PATELL, JAMES M. "Corporate Forecasts of Earnings Per Share and Stock Price Behavior: Empirical Tests," *J. Acc. Res.*, Autumn 1976, *14*(2), pp. 246–76.

PRABHALA, N. R. "Conditional Methods in Event Studies and an Equilibrium Justification for Using Standard Event Study Procedures." Working Paper. Yale U., Sept. 1995.

RITTER, JAY R. "Long-Run Performance of Initial Public Offerings," *J. Finance*, Mar. 1991, *46*(1), pp. 3–27.

ROSS, STEPHEN A. "The Arbitrage Theory of Capital Asset Pricing," *J. Econ. Theory*, Dec. 1976, *13*(3), pp. 341–60.

SCHIPPER, KATHERINE AND THOMPSON, REX. "The Impact of Merger-Related Regulations on the Shareholders of Acquiring Firms," *J. Acc. Res.*, Spring 1983, *21*(1), pp. 184–221.

———. "The Impact of Merger-Related Regulations Using Exact Distributions of Test Statistics," *J. Acc. Res.*, Spring 1985, *23*(1), pp. 408–15.

SCHOLES, MYRON AND WILLIAMS, JOSEPH T. "Estimating Betas from Nonsynchronous Data," *J. Finan. Econ.*, Dec. 1977, *5*(3), pp. 309–27.

SCHWERT, G. WILLIAM. "Using Financial Data to Measure Effects of Regulation," *J. Law Econ.*, Apr. 1981, *24*(1), pp. 121–58.

SHARPE, WILLIAM F. "Capital Asset Prices: A Theory of Market Equilibrium Under Conditions of Risk," *J. Finance*, Sept. 1964, *19*(3), pp. 425–42.

———. *Portfolio theory and capital markets*. New York: McGraw-Hill, 1970.

SHARPE, WILLIAM F.; ALEXANDER, GORDON J. AND BAILEY, JEFFERY V. *Investments*. Fifth Ed. Englewood Cliffs, NJ: Prentice-Hall, 1995.

WHITE, HALBERT. "A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity," *Econometrica*, May 980, *48*(4), pp. 817–38.