

A Shot in the Arm: The Effect of COVID-19 Vaccine News on Financial and Commodity Markets

*Online Appendix**

Oleg Kucher [†] Alexander Kurov [‡] Marketa Halova Wolfe [§]

This Draft: May 25, 2022

Keywords: COVID-19 vaccine; stock market; interest rates; commodities; foreign exchange

JEL classification: F31; G12; G14; G15; I10; Q41

*We thank the editor, an anonymous referee, Peter von Allmen, Adrian Fernandez-Perez, Yueliang Lu, participants at the 2021 Liberal Arts Macro Conference, 2022 Financial Markets and Corporate Governance Conference, and participants in the seminars at the Auckland Centre for Financial Research, International Capital Market Association Centre at University of Reading, Skidmore College, and West Virginia University for their helpful comments. We also thank Zejun Jiang for assistance with collecting data about vaccine announcements from China and Shanxiang Yang for assistance with collecting data about COVID cases.

[†]Corresponding author. Department of Economics, Frostburg State University, 101 Braddock Rd, Frostburg, MD 21532, Phone: (304) 780-7395, Email: okucher@frostburg.edu

[‡]Department of Finance, John Chambers College of Business and Economics, West Virginia University, P.O. Box 6025, Morgantown, WV 26506, Phone: (304) 293-7892, Email: alkurov@mail.wvu.edu

[§]Department of Economics, Skidmore College, Saratoga Springs, NY 12866, Phone: (518) 580-8374, Email: mwolfe@skidmore.edu, Website: www.skidmore.edu/economics/faculty/wolfe.php

Contents

1	List of Vaccine Announcements	2
2	Stocks of Leading Vaccine Companies	12

1 List of Vaccine Announcements

This section shows the list of vaccine announcements released by the four leading vaccine developers (Johnson & Johnson, Moderna, Oxford-AstraZeneca, and Pfizer-BioNTech) analyzed in our paper. Table A1 presents the list. Section 3 in the paper provides details about the methodology used for collecting this data.

Table A1: List of Vaccine Announcements

No.	Vaccine	Date	Time	Announcement	Day	Selected
1	Moderna	01/23/20	09:15	Moderna Announces Funding Award from CEPI (Coalition for Epidemic Preparedness Innovations) to Accelerate Development of Messenger RNA (mRNA) Vaccine Against Novel Coronavirus	1	Yes (1)
2	J&J	01/29/20	08:48	Johnson & Johnson Launches Multi-Pronged Response to Coronavirus Global Public Health Threat	2	No
3	J&J	02/11/20	16:30	Johnson & Johnson Announces Collaboration with U.S. Department of Health & Human Services to Accelerate Development of a Potential Novel Coronavirus Vaccine	3	Yes (1)
4	Moderna	02/24/20	18:04	Moderna Ships mRNA Vaccine Against Novel Coronavirus (mRNA1273) for Phase 1 Study	4	Yes (2)
5	J&J	03/13/20	9:41	Johnson & Johnson Announces Collaboration with the Beth Israel Deaconess Medical Center to Accelerate COVID-19 Vaccine Development	5	No
6	Pfizer-BioNTech	03/13/20	15:25	Pfizer Outlines Five-Point Plan to Battle COVID-19	5	Yes(2)
7	Moderna	03/16/20	12:42	Moderna Announces First Participant Dosed in NIH-led (The National Institutes of Health) Phase 1 Study of mRNA Vaccine (mRNA-1273) Against Novel Coronavirus	6	No
8	Pfizer-BioNTech	03/17/20	02:00	Pfizer and BioNTech to Co-Develop Potential COVID-19 Vaccine	7	Yes (3)
9	Oxford-AstraZeneca	03/24/20	12:51	Oxford's COVID-19 Research Receives Government Funding	8	Yes (1)
10	Oxford-AstraZeneca	03/27/20	16:30	Oxford COVID-19 Vaccine Programme Opens for Clinical Trial Recruitment	9	Yes (2)
11	Moderna	03/29/20	20:48	Moderna Provides Update on the Impact of COVID-19 on Business Operations and Clinical Program Development	9	No
12	J&J	03/30/20	07:22	Johnson & Johnson Announces a Lead COVID-19 Vaccine Candidate; a Landmark New Partnership with U.S. Department of Health & Human Services; and Commitment to Supply One Billion Vaccines Worldwide for Emergency Pandemic Use	9	Yes (1)
13	Pfizer-BioNTech	04/06/20	08:00	Pfizer and The Pfizer Foundation Donate \$40 Million in Charitable Grants, Expand Product Access and Mobilize Colleagues to Combat COVID-19 Pandemic	10	No
14	Pfizer-BioNTech	04/09/20	07:50	Pfizer and BioNTech Announce Further Details on Collaboration to Accelerate Global COVID-19 Vaccine Development	11	No
15	Pfizer-BioNTech	04/09/20	07:50	Pfizer Advances Battle Against COVID-19 on Multiple Fronts	11	No
16	Moderna	04/14/20	07:00	Moderna Highlights Opportunity of mRNA Vaccines at its First Vaccines Day	12	No

17	Moderna	04/16/20	17:55	Moderna Announces Award from U.S. Government Agency BARDA (the Biomedical Advanced Research and Development Authority) for up to \$483 Million to Accelerate Development of mRNA Vaccine (mRNA-1273) Against Novel Coronavirus	13	Yes (1)
18	Oxford-AstraZeneca	04/17/20	13:07	Five Oxford COVID-19 Projects Receive UK Research and Innovation (UKRI) Funding	13	Yes (1)
19	Pfizer-BioNTech	04/22/20	00:00	BioNTech and Pfizer Announce Regulatory Approval from German Authority Paul-Ehrlich-Institut to Commence First Clinical Trial of COVID-19 Vaccine Candidates	14	Yes (2)
20	Oxford-AstraZeneca	04/23/20	07:36	Oxford COVID-19 Vaccine Begins Human Trial Stage	15	Yes (2)
21	J&J	04/23/20	18:51	Johnson & Johnson Announces Collaboration to Expand Manufacturing Capabilities For its COVID-19 Vaccine Candidate in Support of the Company's Goal to Supply More Than One Billion Vaccine Doses Globally	16	No
22	Moderna	04/27/20	16:30	Moderna Announces IND (Investigational New Drug) Submitted to U.S. FDA (Food and Drug Administration) for Phase 2 Study of mRNA Vaccine (mRNA-1273) Against Novel Coronavirus	17	Yes (2)
23	Pfizer-BioNTech	04/29/20	09:00	BioNTech and Pfizer Announce Completion of Dosing for First Cohort of Phase 1/2 Trial of COVID-19 Vaccine Candidates in Germany	18	Yes (2)
24	Oxford-AstraZeneca	04/30/20	11:00	AstraZeneca and Oxford University Announce Landmark Agreement for COVID-19 Vaccine	19	Yes (3)
25	Moderna	05/01/20	00:50	Moderna and Lonza Announce Worldwide Strategic Collaboration to Manufacture Moderna's Vaccine (mRNA-1273) Against Novel Coronavirus	20	No
26	Pfizer-BioNTech	05/05/20	06:45	Pfizer and BioNTech Dose First Participants in the U.S. as Part of Global COVID-19 mRNA Vaccine Development Program	21	Yes (2)
27	Moderna	05/12/20	08:00	Moderna Receives FDA Fast Track Designation for mRNA Vaccine (mRNA1273) Against Novel Coronavirus	22	No
28	Moderna	05/18/20	07:30	Moderna Announces Positive Interim Phase 1 Data for its mRNA Vaccine (mRNA-1273) Against Novel Coronavirus	23	Yes (2)
29	Oxford-AstraZeneca	05/18/20	10:32	Funding and Manufacturing Boost for UK Vaccine Programme	23	Yes (1)
30	Oxford-AstraZeneca	05/21/20	02:00	AstraZeneca Advances Response to Global COVID-19 Challenge as It Receives First Commitments for Oxford's Potential New Vaccine	24	No
31	Oxford-AstraZeneca	05/22/20	03:24	Oxford COVID-19 Vaccine to Begin Phase II/III Human Trials	25	Yes (2)
32	Moderna	05/29/20	16:52	Moderna Announces First Participants in Each Age Cohort Dosed in Phase 2 Study of mRNA Vaccine (mRNA-1273) Against Novel Coronavirus	26	Yes (2)

33	Oxford-AstraZeneca	06/04/20	11:00	AstraZeneca Takes Next Steps towards Broad and Equitable Access to Oxford University's COVID-19 Vaccine	27	No
34	J&J	06/10/20	09:25	Johnson & Johnson Announces Acceleration of its COVID-19 Vaccine Candidate; Phase 1/2a Clinical Trial to Begin in Second Half of July	28	Yes (2)
35	Moderna	06/11/20	07:57	Moderna Advances Late-Stage Development of its Vaccine (mRNA-1273) Against COVID-19	29	No
36	Oxford-AstraZeneca	06/13/20	09:00	AstraZeneca to Supply Europe with up to 400 million Doses of Oxford University's Vaccine at No Profit	30	Yes (4)
37	Moderna	06/25/20	07:30	Moderna and Catalent Announce Collaboration for Fill-Finish Manufacturing of Moderna's COVID-19 Vaccine Candidate	31	No
38	Oxford-AstraZeneca	06/28/20	07:41	Trial of Oxford COVID-19 Vaccine Starts in Brazil	32	Yes (2)
39	Pfizer-BioNTech	07/01/20	08:59	Pfizer and BioNTech Announce Early Positive Data from an Ongoing Phase 1/2 Study of mRNA-based Vaccine Candidate Against SARS-CoV-2	33	Yes (2)
40	Moderna	07/08/20	09:44	Moderna Completes Enrollment of Phase 2 Study of its mRNA Vaccine Against COVID-19 (mRNA-1273)	34	Yes (2)
41	Moderna	07/09/20	08:00	Moderna and ROVI (Laboratorios Farmacéuticos Rovi) Announce Collaboration for OUS Fill-Finish Manufacturing of Moderna's COVID-19 Vaccine Candidate	35	No
42	Pfizer-BioNTech	07/13/20	06:45	Pfizer and BioNTech Granted FDA Fast Track Designation for Two Investigational mRNA-based Vaccine Candidates Against SARS-CoV-2	36	No
43	Moderna	07/14/20	17:14	Moderna Announces Publication in The New England Journal of Medicine of Interim Results From Phase 1 Study of Its mRNA Vaccine Against COVID-19 (mRNA-1273)	37	Yes (2)
44	Pfizer-BioNTech	07/20/20	00:00	Pfizer and BioNTech Announce Agreement with the United Kingdom for 30 Million Doses of mRNA-based Vaccine Candidate against SARS-CoV-2	38	No
45	Pfizer-BioNTech	07/20/20	08:45	Pfizer and BioNTech Announce Early Positive Update from German Phase 1/2 COVID-19 Vaccine Study, Including First T Cell Response Data	38	Yes (2)
46	Oxford-AstraZeneca	07/20/20	09:40	COVID-19 Vaccine AZD1222 Showed Robust Immune Responses in all Participants in Phase I/II Trial	38	Yes (2)
47	Pfizer-BioNTech	07/22/20	07:10	Pfizer and BioNTech Announce an Agreement with U.S. Government for up to 600 Million Doses of mRNA-based Vaccine Candidate Against SARS-CoV-2	39	Yes (4)
48	Moderna	07/24/20	15:53	Statement from Moderna on Patent Trial and Appeal Board (PTAB) Ruling	40	No

49	Moderna	07/26/20	10:22	Moderna Announces Expansion of BARDA Agreement to Support Larger Phase 3 Program for Vaccine (mRNA-1273) Against COVID-19	41	Yes (1)
50	Moderna	07/27/20	06:52	Moderna Announces Phase 3 COVE (Coronavirus Efficacy) Study of mRNA Vaccine Against COVID-19 (mRNA-1273) Begins	41	Yes (2)
51	Pfizer-BioNTech	07/27/20	17:15	Pfizer and BioNTech Choose Lead mRNA Vaccine Candidate Against COVID-19 and Commence Pivotal Phase 2/3 Global Study	42	Yes (2)
52	Moderna	07/28/20	15:23	Moderna Announces Publication in The New England Journal of Medicine of Non-Human Primate Preclinical Viral Challenge Study of its mRNA Vaccine Against COVID-19 (mRNA-1273)	42	No
53	J&J	07/30/20	05:30	Single Dose of Johnson & Johnson COVID-19 Vaccine Candidate Demonstrates Robust Protection in Pre-clinical Studies	43	Yes (2)
54	Pfizer-BioNTech	07/31/20	05:15	Pfizer and BioNTech to Supply Japan with 120 Million Doses of their BNT162 mRNA-based Vaccine Candidate	44	No
55	Pfizer-BioNTech	08/05/20	08:00	Pfizer and BioNTech to Supply Canada with their BNT162 mRNA-Based Vaccine Candidate	45	No
56	J&J	08/05/20	08:30	Johnson & Johnson Announces Agreement with U.S. Government for 100 Million Doses of Investigational COVID-19 Vaccine	45	Yes (4)
57	Moderna	08/11/20	17:49	Moderna Announces Supply Agreement with U.S. Government for Initial 100 Million Doses of mRNA Vaccine Against COVID-19 (mRNA-1273)	46	Yes (4)
58	Oxford-AstraZeneca	08/14/20	07:13	AstraZeneca Concludes Agreement with the European Commission for the Supply of up to 400 Million Doses of AZD1222 COVID-19 Vaccine	47	No
59	J&J	08/14/20	09:58	Johnson & Johnson Announces Collaboration in Principle with the United Kingdom on Additional Phase 3 Study and Agreement to Supply its COVID-19 Vaccine Candidate	47	No
60	Pfizer-BioNTech	08/20/20	20:00	Pfizer and BioNTech Share Positive Early Data on Lead mRNA Vaccine Candidate BNT162b2 Against COVID-19	48	No
61	Moderna	08/24/20	09:18	Moderna Confirms Advanced Discussions with European Commission to Supply Europe with 80 Million Doses of mRNA Vaccine Against COVID-19 (mRNA-1273)	49	Yes (4)
62	Moderna	08/26/20	08:53	Moderna to Present New Interim Clinical Data About mRNA Vaccine Against COVID-19 (mRNA-1273) at Advisory Committee on Immunization Practices (ACIP) Meeting	50	No
63	Moderna	08/28/20	06:19	Moderna Confirms Discussions with the Ministry of Health, Labour and Welfare to Supply Japan with 40 Million Doses of mRNA Vaccine Against COVID-19 (mRNA-1273)	51	No

64	J&J	08/31/20	08:55	Johnson & Johnson Announces Agreement in Principle with Government of Canada to Supply its COVID-19 Vaccine Candidate	52	No
65	Oxford-AstraZeneca	08/31/20	16:30	Development of COVID-19 Vaccine AZD1222 Expands into US Phase III Clinical Trial Across All Adult Age Groups	53	Yes (2)
66	Oxford-AstraZeneca	08/31/20	16:30	AstraZeneca's Scientific and Social Commitment for COVID-19 Vaccine	53	No
67	J&J	09/08/20	06:30	Biopharma Leaders Unite to Stand with Science	54	No
68	Moderna	09/08/20	06:30	Biopharma Leaders Unite to Stand with Science	54	No
69	Oxford-AstraZeneca	09/08/20	10:00	Biopharma Leaders Unite to Stand with Science	54	No
70	Pfizer-BioNTech	09/08/20	10:00	Biopharma Leaders Unite to Stand with Science	54	No
71	Pfizer-BioNTech	09/09/20	06:15	Pfizer and BioNTech to Potentially Supply the EU with 200 Million Doses of mRNA-based Vaccine Candidate Against SARS-CoV-2	55	Yes (4)
72	Oxford-AstraZeneca	09/09/20	09:00	Statement on AstraZeneca Oxford SARS-CoV-2 Vaccine, AZD1222, COVID-19 Vaccine Trials Temporary Pause	55	No
73	Oxford-AstraZeneca	09/12/20	09:20	COVID-19 Vaccine AZD1222 Clinical Trials Resumed in the UK	56	Yes (2)
74	Pfizer-BioNTech	09/12/20	10:45	Pfizer and BioNTech Propose Expansion of Pivotal COVID-19 Vaccine Trial	56	Yes (2)
75	Pfizer-BioNTech	09/15/20	13:45	Pfizer Investor Day Features Significant Number of Pipeline Advances for COVID-19 Programs and Across Numerous Therapeutic Areas	57	No
76	Moderna	09/22/20	12:22	Canada Exercises Increased Option for 20 Million Doses of mRNA Vaccine Against COVID-19 (mRNA-1273)	58	No
77	J&J	09/23/20	06:45	Johnson & Johnson Announces Initiation of Pivotal Global Phase 3 Clinical Trial of Janssen's COVID-19 Vaccine Candidate	59	Yes (2)
78	J&J	09/25/20	15:09	Johnson & Johnson Posts Interim Results from Phase 1/2a Clinical Trial of its Janssen COVID-19 Vaccine Candidate (This statement was updated on October 4, 2020 to include additional information)	60	Yes (2)
79	J&J	09/28/20	17:45	Johnson & Johnson's One Dose COVID-19 Vaccine Trial with 60,000 Volunteers in Final Testing Phase	61	No
80	Moderna	09/29/20	18:17	Moderna Announces Publication in The New England Journal of Medicine of Interim Results From Older Adult Age Cohorts in Phase 1 Study of its mRNA Vaccine Against COVID-19 (mRNA-1273)	62	Yes (2)

81	Oxford-AstraZeneca	10/02/20	03:30	COVID-19 Vaccine AZD1222 Clinical Trial Resumed in Japan, Follows Restart of Trials in the UK, Brazil, South Africa and India	63	No
82	J&J	10/04/20	N/A	Update on Interim Results from Phase 1/2a Clinical Trial of its Janssen COVID-19 Vaccine Candidate	64	Yes (2)
83	Pfizer-BioNTech	10/06/20	07:00	BioNTech and Pfizer Initiate Rolling Submission to European Medicines Agency for SARS-CoV-2 Vaccine Candidate BNT162b2	65	No
84	Moderna	10/08/20	06:50	DARPA (The Defense Advanced Research Projects Agency) Awards Moderna up to \$56 Million to Enable Small-Scale, Rapid Mobile Manufacturing of Nucleic Acid Vaccines and Therapeutics	66	Yes (1)
85	J&J	10/08/20	07:50	Johnson & Johnson Announces European Commission Approval of Agreement to Supply 200 Million Doses of Janssen's COVID-19 Vaccine Candidate	66	Yes (4)
86	J&J	10/12/20	21:16	Johnson & Johnson Temporarily Pauses All Dosing in Our Janssen COVID-19 Vaccine Candidate Clinical Trials	67	No
87	Moderna	10/13/20	11:04	Moderna Announces Initiation of Rolling Submission to Health Canada for mRNA Vaccine Against COVID-19 (mRNA-1273)	67	No
88	Moderna	10/14/20	08:00	Moderna Receives Confirmation of Eligibility for Submission of Marketing Authorization Application to the European Medicines Agency for mRNA Vaccine Against COVID-19 (mRNA-1273)	68	No
89	Moderna	10/22/20	09:47	Moderna Completes Enrollment of Phase 3 COVE Study of mRNA Vaccine Against COVID-19 (mRNA-1273)	69	Yes (2)
90	J&J	10/23/20	15:21	Johnson & Johnson Prepares to Resume Phase 3 ENSEMBLE Trial of its Janssen COVID-19 Vaccine Candidate in the U.S.	70	Yes (2)
91	Oxford-AstraZeneca	10/23/20	15:30	FDA Authorises Restart of the COVID-19 AZD1222 Vaccine US Phase III Trial	70	Yes (2)
92	Moderna	10/26/20	07:00	Moderna Announces Supply Agreement with the Ministry of Public Health to Supply Qatar with mRNA Vaccine Against COVID-19 (mRNA-1273)	71	No
93	Moderna	10/27/20	09:00	UK Medicines and Healthcare products Regulatory Agency Begins Rolling Review of Moderna's mRNA Vaccine Against COVID-19 (mRNA-1273)	72	No
94	Moderna	10/29/20	02:00	Moderna Partners with Takeda and the Government of Japan to Supply 50 Million Doses of mRNA Vaccine Against COVID-19 (mRNA-1273) to Japan	73	No
95	Pfizer-BioNTech	11/09/20	06:45	Pfizer and BioNTech Announce Vaccine Candidate Against COVID-19 Achieved Success in First Interim Analysis from Phase 3 Study	74	Yes (2)

96	Pfizer-BioNTech	11/11/20	06:15	Pfizer and BioNTech Reach an Agreement to Supply the EU with 200 Million Doses of Their BNT162b2 mRNA-Based Vaccine Candidate Against SARS-CoV-2	75	Yes (4)
97	Moderna	11/11/20	16:01	Moderna Has Completed Case Accrual for First Planned Interim Analysis of its mRNA Vaccine Against COVID-19 (mRNA-1273)	76	No
98	Moderna	11/13/20	07:18	Swissmedic Begins Rolling Review of Moderna's mRNA Vaccine Against COVID-19 (mRNA-1273)	77	No
99	J&J	11/14/20	09:34	Johnson & Johnson and U.S. Department of Health & Human Services Expand Agreement to Support Next Phase of COVID-19 Vaccine Candidate Research and Development	78	Yes (1)
100	J&J	11/15/20	N/A	Johnson & Johnson Initiates Second Global Phase 3 Clinical Trial of its Janssen COVID-19 Vaccine Candidate	78	Yes (2)
101	Moderna	11/16/20	06:52	Moderna Announces Longer Shelf Life for its COVID-19 Vaccine Candidate at Refrigerated Temperatures	78	No
102	Moderna	11/16/20	06:56	Moderna's COVID-19 Vaccine Candidate Meets its Primary Efficacy Endpoint in the First Interim Analysis of the Phase 3 COVE Study	78	Yes (2)
103	Pfizer-BioNTech	11/16/20	08:00	Pfizer Update on Our U.S. COVID-19 Vaccine Candidate Distribution Preparedness	78	No
104	Moderna	11/17/20	09:11	Moderna Announces Supply Agreement with United Kingdom Government to Supply mRNA Vaccine Against COVID-19 (mRNA-1273) if Approved for Use	79	No
105	Moderna	11/17/20	09:18	European Medicines Agency Begins Rolling Review of Moderna's mRNA Vaccine Candidate Against COVID-19 (mRNA-1273)	79	No
106	Pfizer-BioNTech	11/18/20	06:59	Pfizer and BioNTech Conclude Phase 3 Study of COVID-19 Vaccine Candidate, Meeting All Primary Efficacy Endpoints	80	Yes (2)
107	Oxford-AstraZeneca	11/19/20	12:08	Oxford Coronavirus Vaccine Produces Strong Immune Response in Older Adults	81	Yes (2)
108	Pfizer-BioNTech	11/20/20	06:45	Pfizer and BioNTech to Submit Emergency Use Authorization Request Today to the U.S. FDA for COVID-19 Vaccine	82	No
109	Oxford-AstraZeneca	11/23/20	02:00	AZD1222 Vaccine Met Primary Efficacy Endpoint in Preventing COVID-19	83	Yes (2)
110	Moderna	11/25/20	06:49	Moderna Announces the European Commission's Approval of Advance Purchase Agreement for Initial 80 Million Doses of mRNA Vaccine Against COVID-19 (mRNA-1273)	84	Yes (4)
111	Moderna	11/29/20	08:37	Moderna Announces Amendment to Current Supply Agreement with United Kingdom Government for an Additional 2 Million Doses of mRNA Vaccine Against COVID-19 (mRNA-1273)	85	No

112	Moderna	11/30/20	06:59	Moderna Announces Primary Efficacy Analysis in Phase 3 COVE Study for Its COVID-19 Vaccine Candidate and Filing Today with U.S. FDA for Emergency Use Authorization	85	No
113	J&J	12/01/20	08:41	Johnson & Johnson Announces Initiation of Rolling Submission for its Single-dose COVID-19 Vaccine Candidate with the European Medicines Agency	86	No
114	Pfizer-BioNTech	12/02/20	02:05	Pfizer and BioNTech Achieve First Authorization in the World for a Vaccine to Combat COVID-19	87	Yes (5)
115	Moderna	12/03/20	05:07	Moderna Provides Updates on the Clinical Development and Production of Its COVID-19 Vaccine Candidate	88	No
116	Moderna	12/04/20	08:27	Moderna Announces Amendment to Supply Agreement with the Ministry of Health of Israel to Supply Additional Doses of mRNA Vaccine Against COVID-19 (mRNA-1273)	89	No
117	Moderna	12/07/20	09:27	Canada Exercises Increased Option for Total of 40 Million Doses of mRNA Vaccine Candidate Against COVID-19 (mRNA-1273)	90	No
118	Moderna	12/08/20	08:00	Switzerland Exercises Increased Option for 7.5 Million Doses of mRNA Vaccine Against COVID-19 (mRNA-1273)	91	No
119	Oxford-AstraZeneca	12/08/20	11:00	AZD1222 Oxford Phase III Trials Interim Analysis Results Published in The Lancet	91	Yes (2)
120	Moderna	12/10/20	07:00	Moderna Announces First Participants Dosed in Phase 2/3 Study of COVID-19 Vaccine Candidate in Adolescents	92	Yes (2)
121	Pfizer-BioNTech	12/10/20	11:43	Pfizer and BioNTech Announce Publication of Results from Landmark Phase 3 Trial of BNT162b2 COVID-19 Vaccine Candidate in The New England Journal of Medicine	92	No
122	Pfizer-BioNTech	12/10/20	18:50	Pfizer and BioNTech Receive FDA Advisory Committee Vote Supporting Potential First Emergency Use Authorization for Vaccine to Combat COVID-19 in the U.S.	93	No
123	Moderna	12/11/20	16:30	U.S. Government Exercises 1st Option for Additional 100 Million Doses of Moderna's COVID-19 Vaccine Candidate	94	Yes (4)
124	Pfizer-BioNTech	12/11/20	23:12	Pfizer and BioNTech Celebrate Historic First Authorization in the U.S. of Vaccine to Prevent COVID-19	94	Yes (5)
125	Pfizer-BioNTech	12/12/20	16:58	U.S. CDC Committee of Independent Health Experts Recommends Vaccination with Pfizer and BioNTech COVID-19 Vaccine for Persons Ages 16 Years and Older	94	No
126	Moderna	12/16/20	09:31	Moderna Confirms Supply Agreement with the Ministry of Health to Supply Singapore with mRNA Vaccine Against COVID-19 (mRNA-1273)	95	No
127	Oxford-AstraZeneca	12/17/20	11:20	Oxford Vaccine Stimulates Broad Antibody and T Cell Functions	96	Yes (2)

128	Moderna	12/17/20	17:27	Moderna Receives FDA Advisory Committee Vote Supporting Emergency Use for Moderna's Vaccine Against COVID-19 in the United States	97	No
129	Moderna	12/18/20	08:00	European Commission Exercises Option for Additional 80 Million Doses of Moderna's COVID-19 Vaccine Candidate	97	Yes (4)
130	Moderna	12/18/20	19:46	Moderna Announces FDA Authorization of Moderna COVID-19 Vaccine in U.S.	98	Yes (5)
131	Moderna	12/19/20	21:44	U.S. CDC (Centers for Disease Control and Prevention) Advisory Committee on Immunization Practices Recommends Vaccination with Moderna's COVID-19 Vaccine for Persons 18 Years and Older	98	No
132	Pfizer-BioNTech	12/21/20	09:21	Pfizer and BioNTech Receive CHMP (the Committee for Medicinal Products for Human Use) Positive Opinion for their COVID-19 Vaccine	98	No
133	Pfizer-BioNTech	12/21/20	14:09	Pfizer and BioNTech Receive Authorization in the European Union for COVID-19 Vaccine	98	Yes (5)
134	Pfizer-BioNTech	12/23/20	07:00	Pfizer and BioNTech to Supply the U.S. with 100 Million Additional Doses of COVID-19 Vaccine	99	Yes (4)
135	Moderna	12/23/20	11:20	Health Canada Authorizes Moderna COVID-19 Vaccine in Canada	99	No
136	Pfizer-BioNTech	12/29/20	13:11	Pfizer and BioNTech to Supply the European Union with 100 Million Additional Doses of COMIRNATY [®]	100	Yes (4)
137	Moderna	12/29/20	16:08	Moderna Confirms Discussions With the Government of South Korea to Supply South Korea With 40 Million Doses of COVID-19 Vaccine	101	No
138	Oxford-AstraZeneca	12/30/20	02:00	AstraZeneca's COVID-19 Vaccine Authorised for Emergency Supply in the UK	101	Yes (5)
139	Moderna	12/31/20	09:14	Moderna Confirms 40 Million COVID-19 Vaccine Dose Supply Agreement with the Government of the Republic of Korea	102	No
140	Moderna	12/31/20	09:22	Moderna Announces Publication of Results from the Pivotal Phase 3 Trial of the Moderna COVID-19 Vaccine in The New England Journal of Medicine.	102	No

This table lists the date, time, and title of the announcements about the Johnson & Johnson, Moderna, Oxford-AstraZeneca, and Pfizer-BioNTech vaccines from January 23, 2020 to December 31, 2020. There are 140 announcements. Time is Eastern Time. Day shows how multiple announcements combine into a single trading day when more than one announcement occurs on the same day (or on two consecutive days if the announcement(s) on the first day occurred after the stock market closed at 16:00 on the previous trading day). There are 102 trading days with announcements.

2 Stocks of Leading Vaccine Companies

This section analyzes the impact of the vaccine announcements listed in Table A1 on stock prices of the companies that developed the vaccines: AstraZeneca, BioNTech, Johnson & Johnson, Moderna, and Pfizer. We eliminate four announcements by University of Oxford that occur before the partnership between AstraZeneca and University of Oxford was formed on April 30, 2020 (announcements #9, #10, #18, and #20 in Table A1).

We begin by estimating the following equation using the ordinary least squares (OLS):

$$R_t = \alpha_0 + \sum_{l=1}^L \alpha_l R_{t-l} + \beta Ann_t + \epsilon_t, \quad (1)$$

where R_t is the return for a given vaccine company on day t ,¹ α_0 is a constant, and the return lags account for possible autocorrelation of returns. The optimal number of return lags, L , is determined with the Schwarz information criterion and results in zero lags for BioNTech and Moderna and one lag for the other three companies. Ann_t is an indicator variable that takes on the value of one if there is a vaccine announcement about this company on that day and zero otherwise. Since our sample includes only positive news about the vaccine development as described in Section 3 of the paper, a positive coefficient on the announcement indicator variable, β , means that the good news increases the return.

Table A2 reports the results. For conciseness, the coefficients on the return lags are not reported and are available upon request. The coefficient on the announcement indicator variable is significant for all four companies involved in development of the vaccines that have been approved in the U.S. (BioNTech, Johnson & Johnson, Moderna, and Pfizer). This means that the company stock returns are higher on days when these companies release the vaccine announcements. The Moderna and BioNTech stock prices on average move by 3.4% and 5.4%, respectively, on the vaccine announcement days. This impact is large probably because the COVID-19 vaccine is a substantial part of business in these corporations. The magnitude of the Johnson & Johnson and Pfizer stock price moves is lower (1.1% and 1.6%,

¹We use returns rather than abnormal returns in this estimation because it is conceivable that the vaccine announcements moved the entire stock market rather than only stocks of the companies developing the vaccines, which would have affected the expected market return and possibly also the factors (for example, the small-minus-big market capitalization factor and the high-minus-low book-to-market ratio factor) typically used in the abnormal return computation.

respectively), perhaps because they are larger corporations diversified into other products.

The coefficient is not significant for AstraZeneca. Although the AstraZeneca vaccine has been approved in the EU and other regions, the vaccine has been lagging behind the Johnson & Johnson, Moderna, and Pfizer-BioNTech vaccines in the U.S. approval process. Also, on June 4, 2020 AstraZeneca released announcement #33 in Table A1 in which Pascal Soriot, AstraZeneca Chief Executive Officer, announced: *“We are working tirelessly to honour our commitment to ensure broad and equitable access to Oxford’s vaccine across the globe and at no profit. Today marks an important step in helping us supply hundreds of millions of people around the world, including to those in countries with the lowest means...”* Perhaps investors considered this pricing decision and predicted the U.S. approval challenges and therefore did not react to the vaccine announcements as enthusiastically.

Table A2: Impact of Vaccine Announcements on Leading Vaccine Company Stocks

	AstraZeneca	BioNTech	J & J	Moderna	Pfizer	Random Effects
Announcement	0.272 (0.372)	5.367** (2.430)	1.117** (0.489)	3.376*** (1.153)	1.648*** (0.515)	2.681*** (0.438)
Constant	0.017 (0.156)	−0.055 (0.492)	−0.026 (0.130)	0.174 (0.440)	−0.209 (0.147)	−0.073 (0.249)
Other company ann.						0.064 (0.369)
Trading days	240	240	240	240	240	240
Trading days with ann.	19	32	19	50	32	99

This table shows the results of estimating equation (1) that regresses the daily return, R_t , on a constant and an indicator variable that takes on the value of one if there is a vaccine announcement about the given company on that day and zero otherwise. We include one lag in the AstraZeneca, Johnson & Johnson (J & J), and Pfizer equations; for conciseness, the coefficients on the return lags are not reported and are available upon request. The return is computed as $R_t = (P_t - P_{t-1})/P_{t-1} * 100$ where P_t is the closing stock price of the given company on day t . The sample period is from January 22, 2020 to December 31, 2020. Heteroskedasticity consistent standard errors are shown in parentheses. *, **, and *** indicate statistical significance at 10%, 5%, and 1% levels, respectively.

To gain a perspective on the economic significance of the Table A2 results, we compute cumulative stock returns by multiplying the coefficient estimate on the announcement indicator for each vaccine company by their announcement days. BioNTech, Moderna, Pfizer, and J & J earned approximately 172%, 169%, 53%, and 21% on their announcement days, respectively, and these returns accounted for a majority of total returns earned by these

companies even though most days did not have announcements.

Equation (1) includes only announcements of the given company. To allow for the possibility that the company returns are also affected by announcements made by the other four companies, we control for the other company announcements. We use the random effects panel estimator:

$$R_{it} = \alpha_0 + \sum_{l=1}^L \alpha_l R_{it-l} + \beta Ann_{it} + \gamma AnnOther_{jt} + \delta_t + \epsilon_{it}, \quad (2)$$

where Ann_{it} is an indicator variable that takes on the value of one if there is a vaccine announcement about company i on that day and zero otherwise, $AnnOther_{jt}$ is an indicator variable that takes on the value of one if there is an announcement about any of the other vaccines included in our analysis on that day and zero otherwise, and δ_t stands for the random time effects.² The model does not include cross-section random effects because Lagrange multiplier tests for random effects indicate that cross-section effects are redundant.

The last column of Table A2 shows the results. The coefficient on the announcement indicator variable is 2.68 and significant at the 1% level, confirming the results from estimating equation (1). The coefficient on the announcements about the other vaccines is not significant. In another robustness check, we add the other company announcements to equation (1) estimated with OLS for each company separately. For example, the AstraZeneca equation then includes an additional indicator variable that takes on the value of one if there is an announcement by BioNTech, J & J, Moderna, and/or Pfizer on that day and zero otherwise. The coefficient estimates on the announcement indicator variable are very similar to those reported in Table 2. The coefficients on the announcements about the other vaccines are not significant. These estimates are available upon request.

²In this estimation we include the four University of Oxford vaccine announcements that were made before the AstraZeneca and University of Oxford partnership was formed on April 30, 2020. For all five vaccine companies, these four announcements are classified as announcement about the other vaccines.