Consequences of Conflict Mineral Disclosures for Supply Chains

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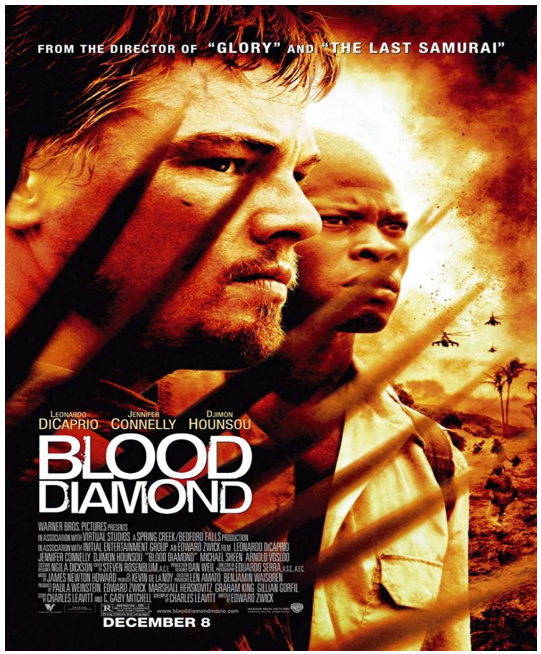
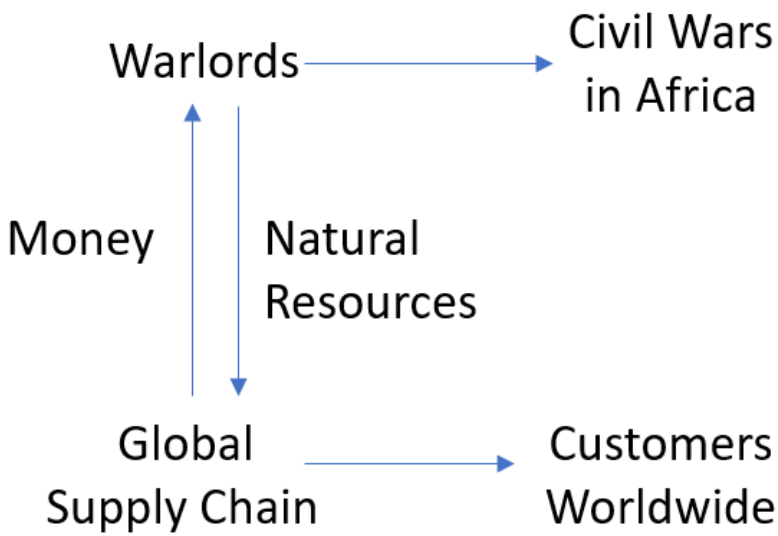
Motivation - Conflict mining in Africa



Mining funded civil wars in Sierra Leone



Conflict mineral Mining in the Democratic Republic of Congo

U.S. Congress initiated Conflict Mineral Disclosure (CMD) regulation to restrain the financing of civil wars and promote human rights in Africa,.

Publicly-listed firms are required to report and monitor the supply chains for conflict minerals used in their production process, including tin, tungsten, tantalum and gold (3TG).

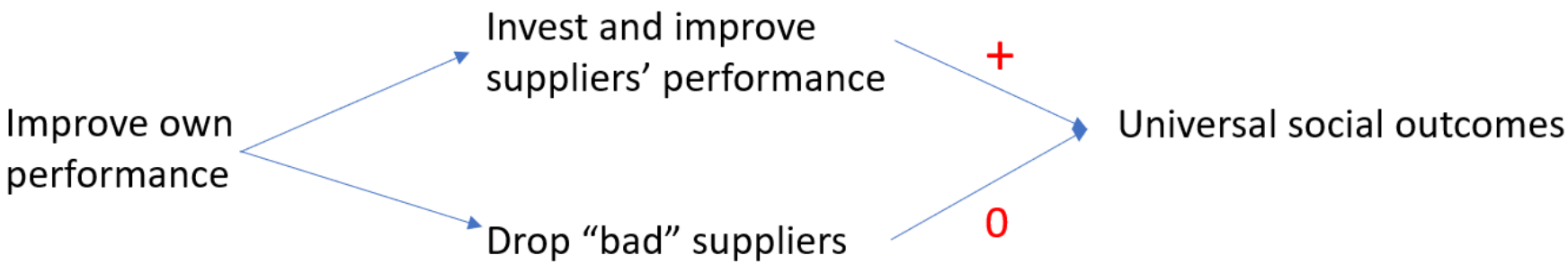
Supply Chain Example

Motivation - Why regulations may affect supply chains

- Disclosure regulations may have real effects.
  - Expected reputation costs, as a sufficiently credible threat, may decrease firm value (Grewal et al., 2019; Andreicovici et al., 2022).
  - To avoid reputation costs, firms have incentives to change their own decisions, establish or facilitate compliance, and/or to improve performance (Christensen et al., 2017; Bonetti et al., 2020; Rauter, 2020).
- Open question whether and how the CMD regulation may affect firms' decisions about other stakeholders, for example, suppliers.

Motivation - Why regulations may affect supply chains

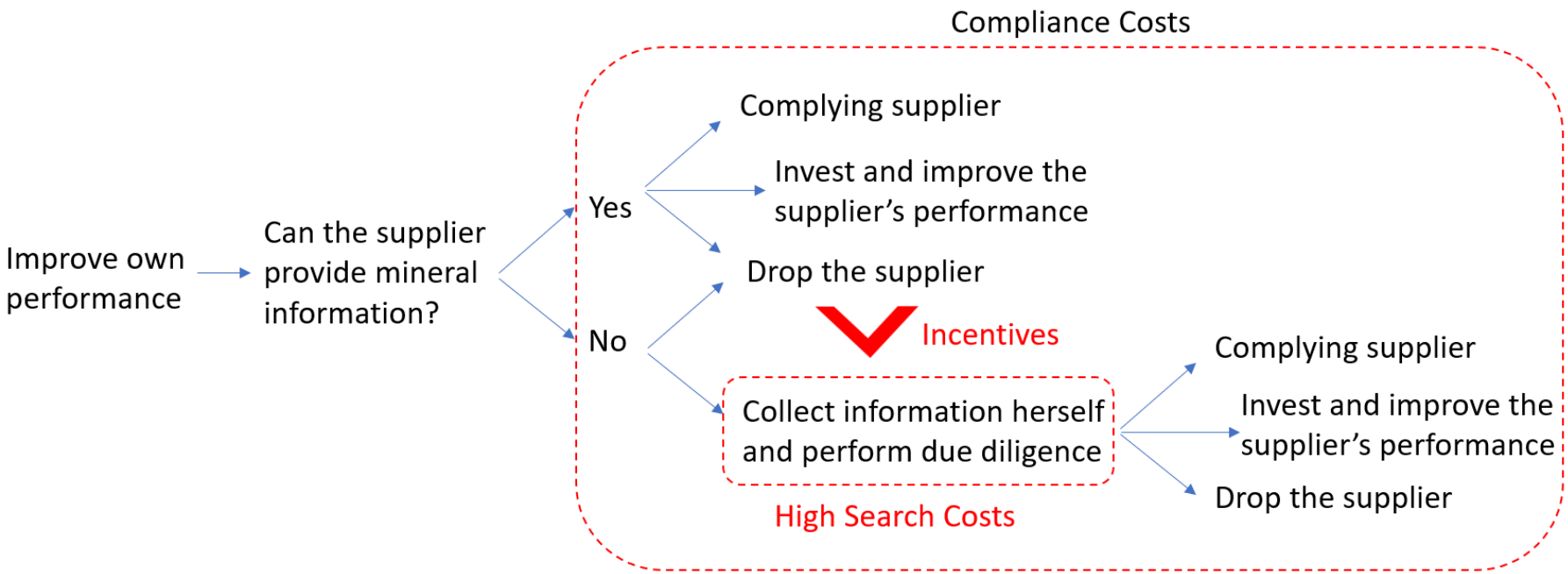
- Global supply chain presents challenges for regulations within a single jurisdiction.
  - U.S. was the first country to enact such disclosure regulation in 2014; the European Union passed a similar regulation in 2021.
  - Regulated customer firms' ability to monitor and influence their suppliers is undermined when suppliers have outside options (unregulated customers in other countries).
- More than one way to comply with the regulation



Motivation - Costs of the CMD regulation

- Evaluating the costs is necessary to understand the overall economic effects of the regulation (Coates and Srinivasan, 2014; Leuz and Wysocki, 2016).
  - High costs might distort firms' incentives and induce avoidance strategies (Gao et al., 2009).

- Among the compliance costs, direct search costs of the CMD are particularly high, but not emphasized enough.



Motivation - Compliance costs of the CMD regulation

The compliance process can be divided into three steps.
If a public firm meets certain conditions, it will face more stringent requirements, increasing compliance costs.

Step 1 Usage of 3TG minerals in own products

↓ Yes

Step 2 Request mineral origins from suppliers: all minerals are conflict-free

Yes ↙ ↘ No or not sure

Step 3

File a Form SD explaining the inquiry process

1. Perform due diligence on suppliers following OECD framework
2. File a Form SD, including disclosure of the origins and refiners of the minerals in a dedicated conflict mineral report

⏩ Form SD ⏩ CM report ⏩ Effort ⏩ Supplier Type

Example - Compliance costs of the CMD regulation

The search costs for customer firms when faced with non-subject suppliers can be prohibitively high.

From: John Phipps

May 18, 2017

I work for a privately held company. But ALL of our customers are publicly traded and therefore I must answer 100's of individual inquiries for the same information each year.

Tantalum is added to a very few alloys of stainless steel. Steel is melted and remelted. If the chemistry at the steel mill says they have enough tantalum (less than .8% by weight Tantalum and Columbium combined, so who knows) then they pour the melt. If they are low, they add an alloy high in columbium and tantalum, or they add a compound containing tantalum. (or columbium, or both) When the melt meets specification requirements, they pour.

Then they sell the steel to a mill. Then that mill sells it to a tube mill. Then the tube mill sells the tubes to a distributor. Then I buy tubes from the distributor. I do not know where that 1/8 of an ounce per pound of 347 alloy stainless steel comes from. I do not even know if I sell a customer 347 alloy stainless in any given year.

Research Questions

1. How does the conflict mineral disclosure regulation affect firms' supply chains?
2. How can we quantify the (expected) compliance costs associated with the supply chain disclosure regulation?

Hypotheses Development - How regulations may affect supply chains

Firms need to balance compliance costs and reputation costs for every current and potential supplier.

- Suppliers differ in compliance costs. ⏩ Definitions of Suppliers
- Firms are incentivized to stay away from non-subject suppliers
  - to avoid having to compensate suppliers for collecting mineral information;
  - to decrease the potential reputation costs if suppliers give no/false information or do use conflict minerals (Kalkanci and Plambeck, 2020).

H1(a): Regulated firms are more likely to terminate contracts with non-subject suppliers.

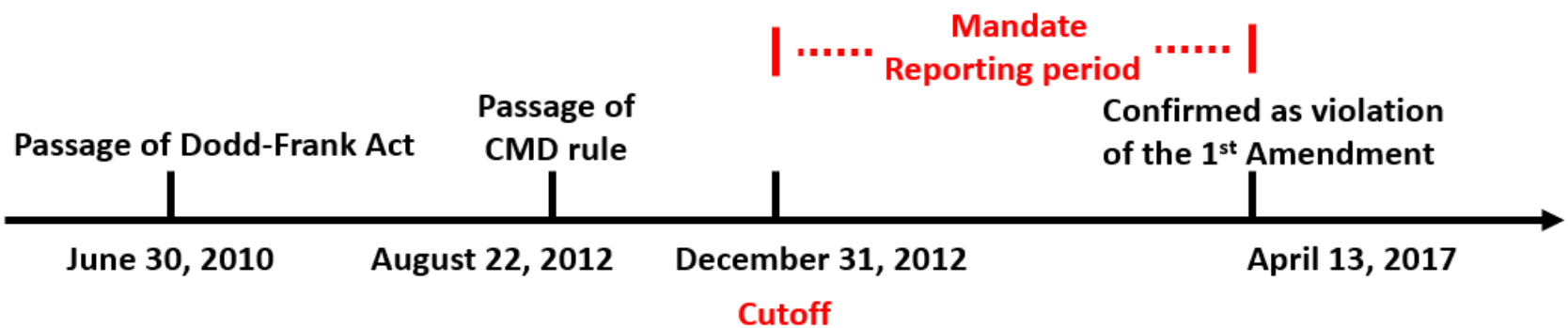
H1(b): Regulated firms are less likely to contract with new non-subject suppliers.

Hypotheses Development - Compliance costs and supply chain compositions

- Reducing cooperation with non-subject suppliers may come with substantial costs.
  - Non-subject suppliers are costly to keep, but do not necessarily use conflict minerals (= reputation cost).
  - Ending relationships with non-subject suppliers may not improve firm's true performance when suppliers do not use conflict minerals.
  - Changes in supply chains cause the firm to deviate from otherwise optimal operating model (= adaptation cost).
- H2: Regulated firms will experience decreases in firms value if
  - having more non-subject suppliers before the regulation or
  - removing more non-subject suppliers after the regulation.

Setting - CMD regulation

- All firms using the 3TG minerals and fall under Section 13(a) or 15(d) of the Exchange Act.
- Regulated firms must file their first Form SD by May 31, 2014, for the calendar year 2013, and annually thereafter.
  - Firms that fail to claim that the 3TG minerals do not originate from a conflict regions need to file the conflict mineral report, disclosing information of the smelters and minerals origins.
- Timeline of the U.S. CMD regulation



Lawsuits against CMD

Data

- Sample Universe
  - Intersection of non-financial firms between Bloomberg Supply Chain Database and Compustat
  - Calendar year 2011 to 2016
- Supplier Data
  - Essential to cover both subject and non-subject suppliers
  - Bloomberg Supply Chain Function, which uses sources from news, analyst reports, and worldwide public filings
  - Data is not directly downloadable. I developed an algorithm to retrieve and parse data from screenshots on the Bloomberg terminal. Bloomberg
  - In total, 219,796 unique supplier-customer relationships for 2,369 firms are identified.
- Supply Chain Policy Data
  - Refinitiv: Forced Labor Policy, ILO (International Labour Organization) Declaration, and Supplier Training.

Empirical Design - Identification

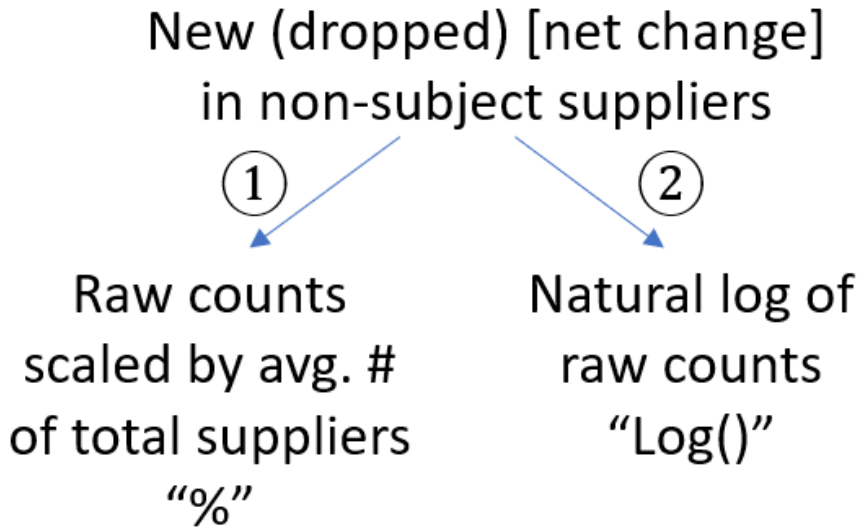
- Identification of treatment firms
  - Firms' usage of 3TG minerals are not observable.
  - I use firms' filings as an (ex-post) indicator for treatment and control firms:
  - A firm is defined as treatment if the firm issued Form SDs every year after 2014.
  - A firm is defined as control if the firm issued other periodic reports but never issued Form SD after 2014.
- Identification of subject and non-subject suppliers
  - Suppliers' usage of the 3TG minerals is even more difficult to access as many of them are private.
  - Private or non-US public firms are not subject to the regulation.
  - A subject supplier is a supplier that issued at least one Form SD after 2014.
  - A non-subject supplier is a supplier that did not issue periodic report after 2014.

Descriptive Results - Industry distribution of treatment and control firms

FF-48 Industry Names	Control	Treatment
Agriculture	8	2
Food Products	44	2
Candy & Soda	11	0
Beer & Liquor	8	1
Tobacco Products	0	2
Recreation	4	13
Entertainment	33	6
Printing and Publishing	13	3
Consumer Goods	6	29
Apparel	8	26
Healthcare	39	5
Medical Equipment	21	66
Pharmaceutical Products	205	28
Chemicals	28	29
Rubber and Plastic Products	6	8
Textiles	4	3
Construction Materials	15	25
Construction	27	8
Steel Works Etc	8	20
Fabricated Products	1	4
Machinery	10	77
Electrical Equipment	14	32
Automobiles and Trucks	7	47
Aircraft	1	16
Shipbuilding, Railroad Equipment	0	7
Defense	0	6
Precious Metals	7	1
Non-Metallic and Industrial Metal Mining	13	1
Coal	4	4
Petroleum and Natural Gas	99	13
Utilities	18	1
Communication	80	5
Personal Services	23	3
Business Services	302	39
Computers	39	59
Electronic Equipment	24	152
Measuring and Control Equipment	2	55
Business Supplies	13	15
Shipping Containers	2	6
Transportation	57	5
Wholesale	73	29
Retail	100	54
Restaurants, Hotels, Motels	49	2
Others	25	9
Total # of firms	**1451**	**918**

Empirical Design - Variable definitions

- Two sets of measures for the changes ion non-subject suppliers
  - New Non-subject Suppliers = non-subject suppliers that the firm newly contracts with
  - Dropped Non-subject Suppliers = non-subject suppliers that the firm terminates contracts with
  - Changes in Non-subject Suppliers = Δ number of non-subject suppliers



Descriptive Results - Summary statistics (Table 1)

	N	Mean	Median	SD	1%	99%
Treat	11,693	0.4331	0	0.4955	0	1
Dedicated Report	11,693	0.3782	0	0.4850	0	1
Non-dedicated Report	11,693	0.0548	0	0.2277	0	1
Post	11,693	0.6756	1	0.4682	0	1
Changes in Non-subject Suppliers%	11,693	0.0145	0	0.2397	-1	1
New Non-subject Suppliers%	11,693	0.0937	0	0.1741	0	1
Dropped Non-subject Suppliers%	11,693	0.0795	0	0.1635	0	1
Log(Changes in Non-subject Suppliers)	11,693	0.0915	0	0.8804	-2.3026	2.8904
Log(New Non-subject Suppliers)	11,693	0.5546	0	0.8001	0	3.4965
Log(Dropped Non-subject Suppliers)	11,693	0.4841	0	0.7170	0	3.0910
Log(Total Suppliers)	11,693	2.1192	1.9459	1.1718	0	5.6937
Log(Subject Suppliers)	11,693	1.6022	1.3863	1.1428	0	5.0039
GeoSegments	11,693	0.6765	0.5098	0.5477	0	2.0445
BusSegments	11,693	0.8101	0.6931	0.7453	0	2.6391
Policy Labor Policy	3,862	0.236	0	0.4246	0	1
ILO Declaration	3,862	0.1279	0	0.3340	0	1
Supplier Training	3,862	0.1535	0	0.3606	0	1

Empirical Design - Difference-in-difference design

- H1(a): Regulated firms are more likely to terminate contracts with current non-subject suppliers.
- H1(b): Regulated firms are less likely to contract with new non-subject suppliers.

$$Y_{i,t} = \beta_1 Treat_i + \beta_2 Post_t + \beta_3 Treat_i \times Post_t + \beta_4 Controls_{i,t} + \theta_{firm} + \gamma_{year} + \epsilon_{i,t}$$

$Y_{i,t}$ = dependent variables of supplier composition changes

$Treat_i = 1$, if firm i is in the treatment group

$Post_t = 1$, if the observation is from 2013 or later

Results - Effects of Conflict Mineral Regulation on Supplier Choices (Table 2)

	(1)	(2)	(3)	(4)	(5)	(6)
	New Non-subject Suppliers%	Dropped Non-subject Suppliers%	Changes in Non-subject Suppliers%	Log(New) Non-subject Suppliers	Log(Dropped) Non-subject Suppliers	Log(Changes in) Non-subject Suppliers
Treat x Post	-0.0263***	0.0161**	-0.0423***	-0.0577***	0.0921***	-0.2179***
	(0.0073)	(0.0065)	(0.0101)	(0.0212)	(0.0191)	(0.0402)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Clustering	Firm	Firm	Firm	Firm	Firm	Firm
N	11,693	11,693	11,693	11,693	11,693	11,693
R^2	0.25	0.21	0.21	0.73	0.70	0.23

- Regulated firms' new contracts with non-subject suppliers are 28% (-0.0263/0.0937) lower compared to unregulated firms.
- Regulated firms' terminations with non-subject suppliers are 20% (0.0161/0.795) higher compared to unregulated firms.

Results - Additionals Evidences on the Effects on Other Types of Suppliers (Table 3)

	(1) Log(Total Suppliers)	(2) Log(Subject Suppliers)	(3) GeoSegment	(4) BusSegment
Treat × Post	0.0532***	0.0583***	0.0343**	0.0056
	(0.0199)	(0.0193)	(0.0167)	(0.0195)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Clustering	Firm	Firm	Yes	Yes
N	11,693	11,693	11,693	11,693
R^2	0.94	0.94	0.94	0.90

- Increase in the number of subject suppliers
- The regulation only negatively affects non-subject suppliers
- No decrease in firms' geographic or business segments

Empirical Design - Does the CMD regulation affect supply chain compositions?

Firms with dedicated conflict mineral reports (in Step 3) have to collect more detailed information and bear even higher compliance, especially search costs.

Cross-sectional test: the effects of non-subject suppliers are stronger for firms that need to file dedicated conflict mineral reports.

$$\begin{aligned} Y_{i,t} =& \beta_1 DedicatedReport_i + \beta_2 Non\text{-}dedicatedReport_i + \beta_3 Post_t \\ &+ \beta_4 DedicatedReport_i \times Post_t + \beta_5 Non\text{-}dedicatedReport_i \\ &\times Post_t + \beta_6 Controls_{i,t} + \theta_{firm} + \gamma_{year} + \epsilon_{i,t} \end{aligned}$$

$DedicatedReport_i$ =1, if firm i is in the treatment group and has issued a dedicated conflict mineral report.

$Non\text{-}dedicatedReport_i$ = 1, if firm i is in the treatment group, but never issued a dedicated conflict mineral report.

Results - Effects of Conflict Mineral Report on Supplier Choices (Table 4)

	(1)	(2)	(3)	(4)	(5)	(6)
	New Non-subject Suppliers%	Dropped Non-subject Suppliers%	Changes in Non-subject Suppliers%	Log(New) Non-subject Suppliers	Log(Dropped) Non-subject Suppliers	Log(Changes in) Non-subject Suppliers
Dedicated Report × Post	-0.0268***	0.0176***	-0.0444***	-0.0599***	0.1049***	-0.2442***
	(0.0076)	(0.0068)	(0.0105)	(0.0222)	(0.0200)	(0.0423)
Non-dedicated Report × Post	-0.0224	0.0055	-0.0278	-0.0416	0.0022	-0.0338
	(0.0146)	(0.0113)	(0.0198)	(0.0413)	(0.0390)	(0.0768)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Clustering	Firm	Firm	Firm	Firm	Firm	Firm
N	11,693	11,693	11,693	11,693	11,693	11,693
R^2	0.25	0.21	0.21	0.73	0.70	0.23

- Firms that are required to file the dedicated conflict mineral report changes non-subject suppliers after the mandate.
- Supportive evidence for compliance costs as the potential mechanism.

Results - Market Reactions to the CMD Events

H2: Regulated firms will experience decreases in firms value if

- having more non-subject suppliers before the regulation – passage of the regulation
- removing non-subject suppliers after the regulation – first issuance of Form SD

	(1)	(2)	(3)	(4)
	Event - Regulation Passage Day		**Event - 1st Disclosure Day**	
	Abn Return [0,+4]	Abn Return [0,+6]	Abn Return [0,+4]	Abn Return [0,+6]
Dropped Non-subject Suppliers			-0.0050***	-0.0072***
			(0.0016)	(0.0019)
Treat	0.0042	0.0030		
	(0.0042)	(0.0049)		
Non-subject Supplier%	0.0044	0.0085*		
	(0.0041)	(0.0051)		
Treat × Non-subject Supplier%	-0.0124*	-0.0149**		
	(0.0064)	(0.0074)		
Industry FE	Yes	Yes	Yes	Yes
Clustering	Firm	Firm	Yes	Yes
N	2,101	2,101	891	891
R^2	0.11	0.13	0.10	0.09

- On the regulation passage day, the negative market reaction decreases in the proportion of non-subject suppliers
- On the first disclosure day, the negative market reaction decreases in the numbers of dropped non-subject suppliers.

Results - Effects of Conflict Mineral Report on Supply Chain Policies (Table 5)

	(1) Forced Labor Policy	(2) ILO Declaration	(3) Supplier Training
Treat × Post	0.1069***	0.0364**	0.0384*
	(0.0223)	(0.0153)	(0.0216)
Controls	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Clustering	Firm	Firm	Firm
N	3,862	3,862	3,862
R^2	0.74	0.85	0.75

Firms also commit to increasing direct investments in human rights performances along the supply chain

Summary

- Conflict mineral disclosure (CMD) regulation has real effects on firms' supply chain composition.
- Specifically, high compliance costs of the CMD regulation push firms to terminate current relationships with suppliers that are not subject to the regulation and deter them from contracting with new non-subject suppliers.
- Such changes in supply chain are costly as indicated by negative stock market reactions around the regulation passage and the firm's first disclosure.

Contribution

- Extending the literature on how disclosure regulations can have effects on firms' supplier choices (Dyreng et al., 2016; Christensen et al., 2017; Rauter, 2020; She, 2021).
- Providing evidence on how compliance costs of disclosure regulation distort firms; behaviors (Gao et al., 2009; Illiev, 2010; Breuer, 2021; Breuer et al., 2022).
- Testing a theoretical model of how supply chain disclosure mandates can deter firms' learning of suppliers' behavior (Kalkanci and Plambeck, 2020)

Example - Conflict Mineral Disclosure

Intel's strategy

In our effort to achieve a conflict-free supply chain, we have taken the following actions:

- Completed on-site reviews of over 40 smelters in many countries, representing all four conflict minerals.
- Conducted an on-the-ground review of the extractives and minerals trade in the DRC.
- Participating in the "Solutions for Hope" pilot with AVX to source "conflict free" tantalum from DRC.
- Partnering with the US Department of State and US Agency for International Development to establish the Public-Private Alliance for Responsible Minerals Trade
- Developed tantalum, tin tungsten and gold smelter audit protocols as co-chair of the EICC working group.
- Intel in partnership with the EICC & GeSI has identified six smelters that are compliant to the Conflict-Free Smelter assessment program protocol. More smelters are being added to the compliance list - see latest information at: www.conflictfreesmelter.org

Example - Conflict Mineral Disclosure

Example of Apple's dedicated conflict mineral report

ANNEX I : Smelter and Refiner List

Smelters and refiners of 3TG reported in Apple's supply chain as of December 31, 2020.

Conflict Mineral	Name of Smelter or Refiner	Location of Smelter or Refiner
Tin	Alpha*	United States Of America
Tin	Chenzhou Yunxiang Mining and Metallurgy Co., Ltd.*	China
Tin	Chifeng Dajingzi Tin Industry Co., Ltd.*	China
Tin	China Tin Group Co., Ltd.	China
Tin	Dowa*	Japan
Tin	EM Vinto	Bolivia (Plurinational State Of)
Tin	Fenix Metals	Poland
Tin	Gejiu Fengming Metallurgy Chemical Plant	China
Tin	Gejiu Kai Meng Industry and Trade, LLC	China
Tin	Gejiu Non-Ferrous Metal Processing Co., Ltd.	China
Tin	Gejiu Yunxin Nonferrous Electrolysis Co., Ltd.*	China

Example - Conflict Mineral Disclosure

Example of a Form SD without conflict mineral report

During 2014, we evaluated 100% of the parts and materials necessary to the functionality or production of products manufactured by us or contracted to be manufactured for us and determined that the Company manufactures or contracts to manufacture some products that contain 3TG. We conducted a reasonable country of origin inquiry ("RCOI") to determine if the 3TG in any of our products originated in the DRC or an adjoining country. In connection with that evaluation, we developed and distributed a Conflict Minerals Compliance Certification form to each of our suppliers providing these raw materials or products that contain 3TG.

Source: https://www.sec.gov/Archives/edgar/data/1000229/000100022915000084/a2014formsd.htm

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Example - Legal Proceedings against the Conflict Mineral Disclosure

- The National Manufacturer Association sued the SEC in 2012 after the CMD regulation was passed.
- In 2014, the District of Columbia Court of Appeals ruled that part of the CMD regulation violates the First Amendment of the Constitution.
  - The then regulation required firms to hire third-part audits on the due diligence and disclose whether the products are "conflict-free" or "conflict-undeterminable".
  - That part of the regulation never came into effect and is not considered as a mandate in this paper.
- In 2017, the court reaffirmed the decision and presented new issues regarding the CMD regulation. The SEC announced that no further enforcement would be conducted in case of missing conflict disclosure reports.
  - Most firms continued disclosing the report voluntarily.

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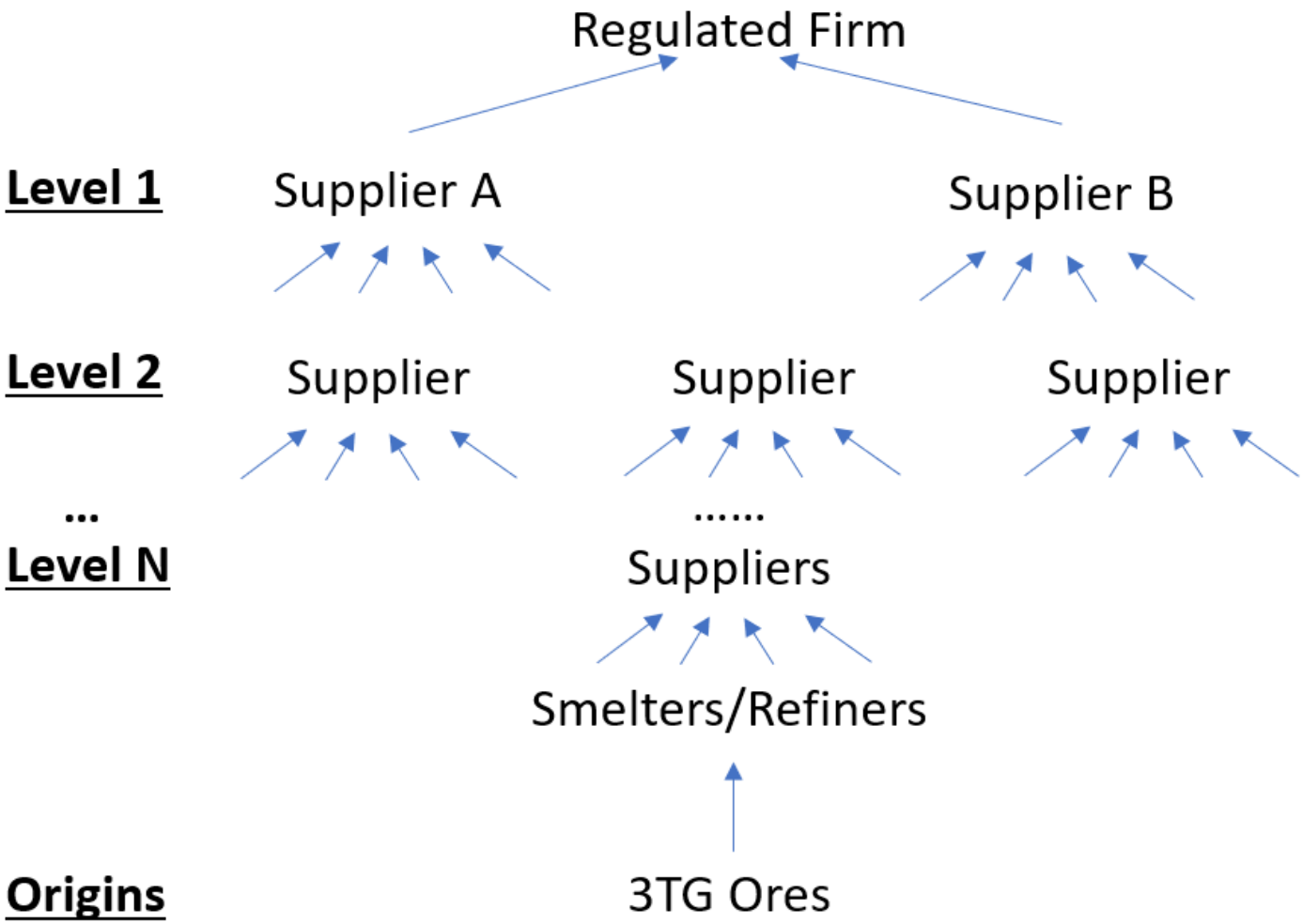
Example - How minerals are transferred along supply chains



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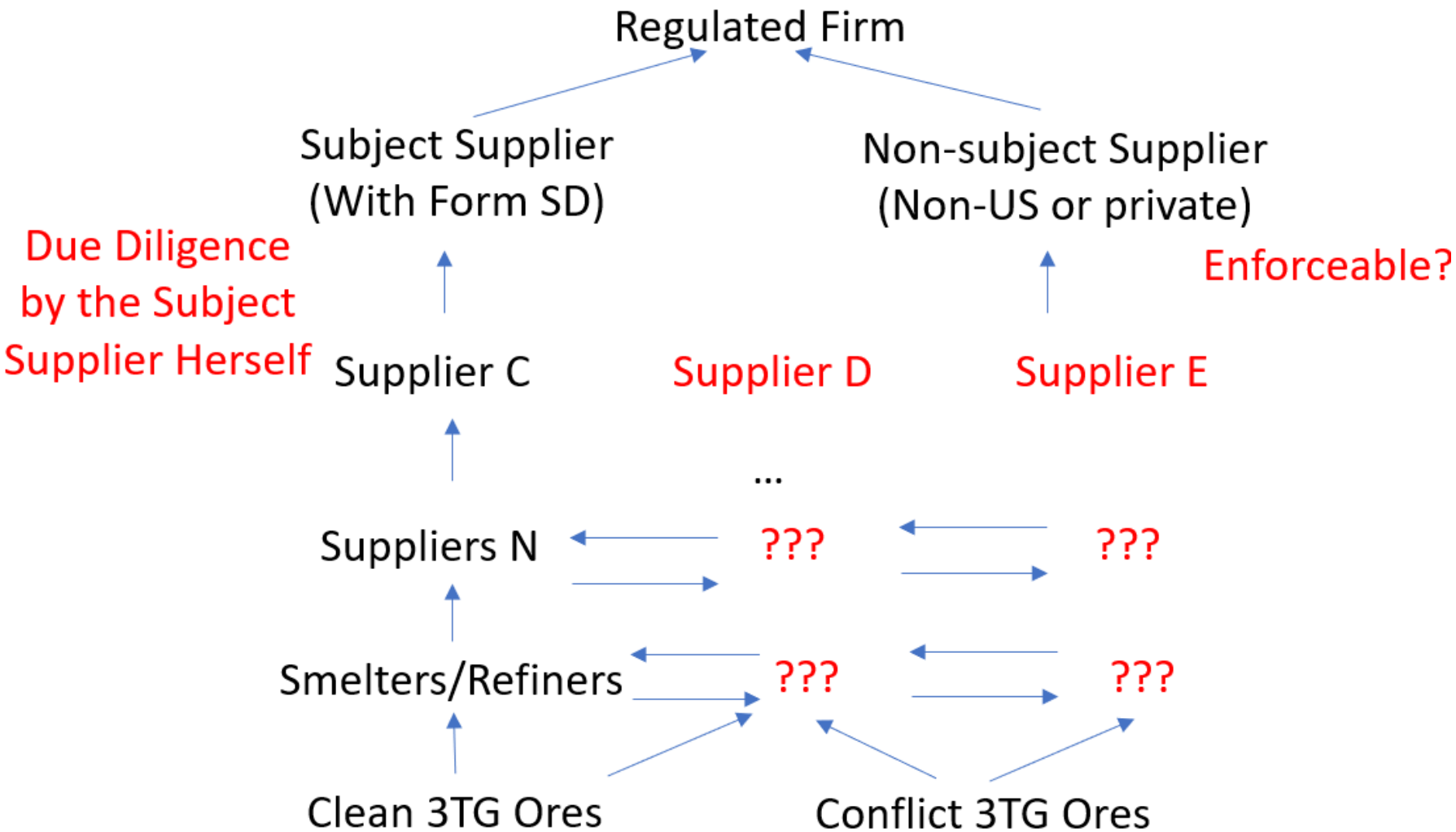
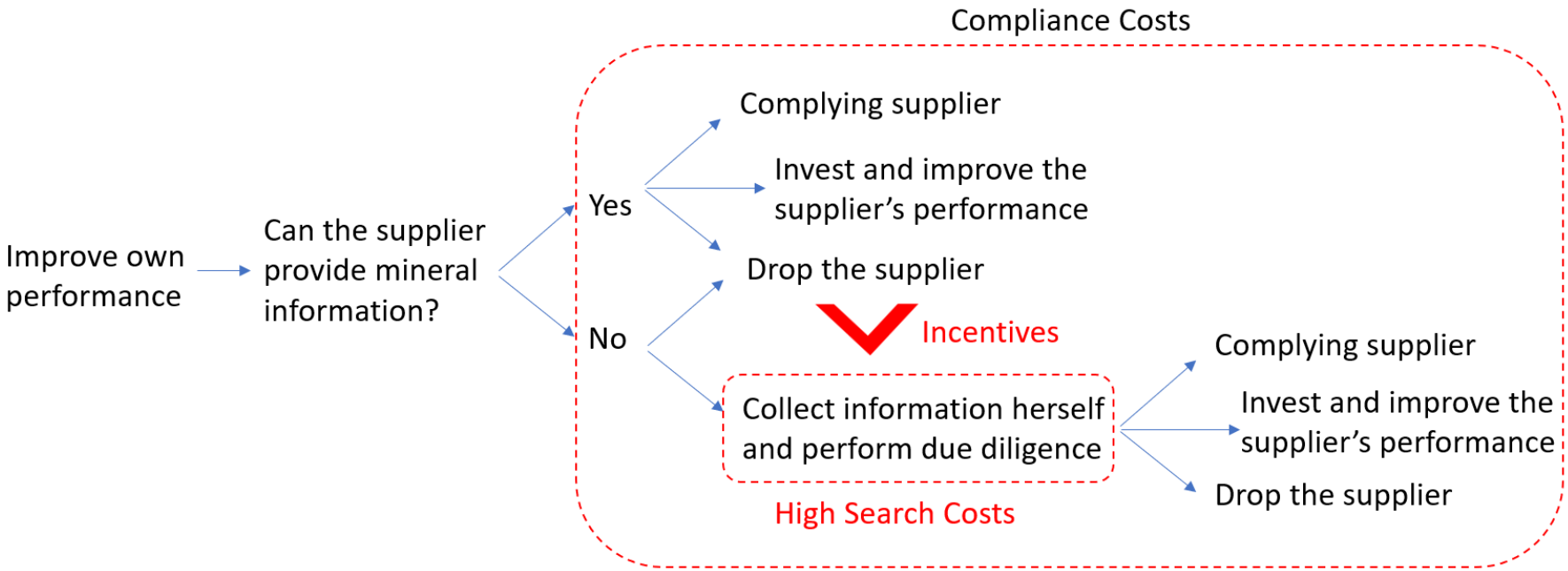
Example - Definitions of subject and Non-subject Suppliers



Results - compliance costs of the CMD regulation



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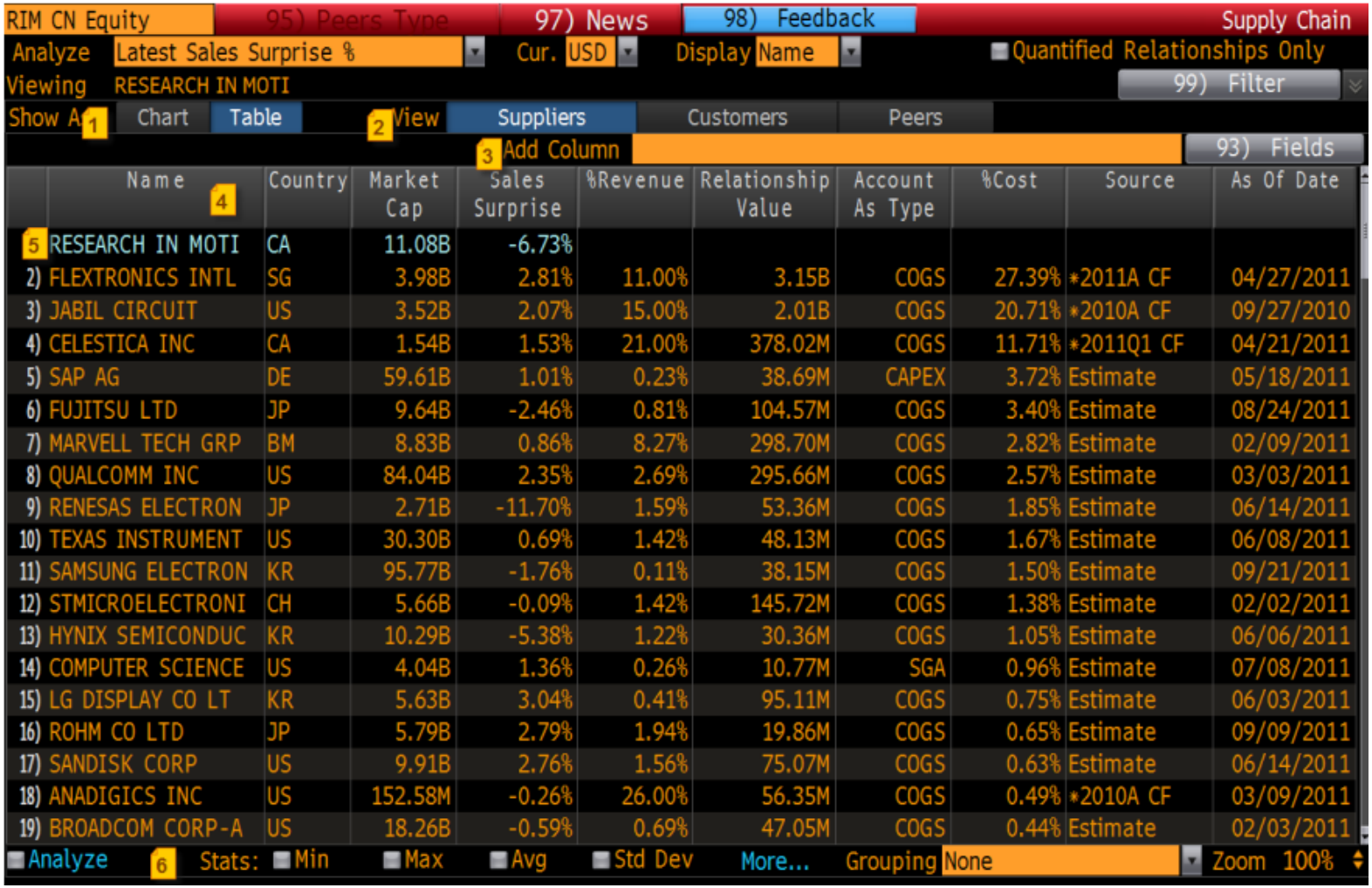
Example - Bloomberg SPLC Data



RIM CN Equity | 95) Peers Type | 97) News | 98) Feedback | Supply Chain

Analyze | Latest Sales Surprise % | Cur. USD | Display Name | Quantified Relationships Only

Viewing RESEARCH IN MOTI | 99) Filter

Show A 1 | Chart | Table | 2 View | Suppliers | Customers | Peers

3 Add Column | 93) Fields

	Name 4	Country	Market Cap	Sales Surprise	%Revenue	Relationship Value	Account As Type	%Cost	Source	As Of Date
5	RESEARCH IN MOTI	CA	11.08B	-6.73%						
2)	FLEXTRONICS INTL	SG	3.98B	2.81%	11.00%	3.15B	COGS	27.39%	*2011A CF	04/27/2011
3)	JABIL CIRCUIT	US	3.52B	2.07%	15.00%	2.01B	COGS	20.71%	*2010A CF	09/27/2010
4)	CELESTICA INC	CA	1.54B	1.53%	21.00%	378.02M	COGS	11.71%	*2011Q1 CF	04/21/2011
5)	SAP AG	DE	59.61B	1.01%	0.23%	38.69M	CAPEX	3.72%	Estimate	05/18/2011
6)	FUJITSU LTD	JP	9.64B	-2.46%	0.81%	104.57M	COGS	3.40%	Estimate	08/24/2011
7)	MARVELL TECH GRP	BM	8.83B	0.86%	8.27%	298.70M	COGS	2.82%	Estimate	02/09/2011
8)	QUALCOMM INC	US	84.04B	2.35%	2.69%	295.66M	COGS	2.57%	Estimate	03/03/2011
9)	RENESAS ELECTRON	JP	2.71B	-11.70%	1.59%	53.36M	COGS	1.85%	Estimate	06/14/2011
10)	TEXAS INSTRUMENT	US	30.30B	0.69%	1.42%	48.13M	COGS	1.67%	Estimate	06/08/2011
11)	SAMSUNG ELECTRON	KR	95.77B	-1.76%	0.11%	38.15M	COGS	1.50%	Estimate	09/21/2011
12)	STMICROELECTRONI	CH	5.66B	-0.09%	1.42%	145.72M	COGS	1.38%	Estimate	02/02/2011
13)	HYNIX SEMICONDUC	KR	10.29B	-5.38%	1.22%	30.36M	COGS	1.05%	Estimate	06/06/2011
14)	COMPUTER SCIENCE	US	4.04B	1.36%	0.26%	10.77M	SGA	0.96%	Estimate	07/08/2011
15)	LG DISPLAY CO LT	KR	5.63B	3.04%	0.41%	95.11M	COGS	0.75%	Estimate	06/03/2011
16)	ROHM CO LTD	JP	5.79B	2.79%	1.94%	19.86M	COGS	0.65%	Estimate	09/09/2011
17)	SANDISK CORP	US	9.91B	2.76%	1.56%	75.07M	COGS	0.63%	Estimate	06/14/2011
18)	ANADIGICS INC	US	152.58M	-0.26%	26.00%	56.35M	COGS	0.49%	*2010A CF	03/09/2011
19)	BROADCOM CORP-A	US	18.26B	-0.59%	0.69%	47.05M	COGS	0.44%	Estimate	02/03/2011

Analyze | 6 Stats: Min | Max | Avg | Std Dev | More... | Grouping None | Zoom 100%

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