Firm Responses to Shocks: Reallocation of Capital Contingent Upon Property Rights

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1 Introduction and Motivation

In August 2019, Donald Trump tweeted that he's ordering American companies to shift production from China.[1] Notwithstanding the murky legal basis of his power to do so, Trump was behind the times: companies had already been shifting production from China for multiple reasons. The trade war had increased the costs of doing business with China, labor costs were rising,[2] and companies selling Chinese-manufactured goods outside of China had grown uncomfortable with concentrating their supply chains in one place.[3] Alternatives such as India, Bangladesh, and Vietnam proved fruitful,[4] but countries like Cambodia sometimes lack necessary specialized supply chains and labor and infrastructure capacity. The retail and manufacturing sectors appear hardest hit,[5] but Hewlett Packard Enterprise reported mitigation of the cost impact of tariffs through a diversified supply chain.

Why do firm-level responses to a policy shock to supply chains vary within an industry? I will argue that firms end up being political actors in a different way than lobbying and vote wrangling: they reveal preferences about the property rights in supplier countries by making supply chain decisions based on likelihood of government expropriation. Firms with high research and development costs will more highly value secure property protections and companies with less research and development spending will make decisions based more on costs of moving.

The results of this theoretical model have the potential to illuminate possible effects of trade policy. Firms will react differently to such shocks and diversify more broadly, but in a predictable pattern. Tariff policy can force capacity-strained emerging market economies (EMEs) to accommodate pressure from multi-national corporations to scale up infrastructure.[6] This paper argues that the types of firms moving into EMEs will self-sort according to governance attributes of the country.

2 Background

Two bodies of literature are pertinent to this study: literature examining the political behavior of firms and literature examining firm supply chain decisions.

2.1 Political Behavior of Firms

The first body of literature, encompassing political science, economics, and operations research work, clearly establishes that firms can be political actors in several ways. Firstly, firms can be important actors in the economy, possessing capabilities and qualities of government.[7] In some cases, foreign firms' visibility is sufficiently large that it can affect public opinion of their origin countries.[8] Secondly, the policy-making process is well within reach of firms: firms can try to overtly affect policymaker decisions through lobbying[9] or political contributions to politicians friendly to their policy positions.[10] Thirdly, firms can af-

[1] Telford (2019).
[2] Chen and Xia (2019).
[3] Lardy (2019).
[4] Rapoza (2020).
[5] Reed (2019).
[6] Akamatsu (1962).
[7] Zingales (2017).
[8] Chilton, Milner and Tingley (2017).
[9] Kim (2017).
[10] Cunha (2019).

fect the other side of politics, the political behavior of constituents, by mobilizing votes.[11] More indirectly, firms determine the socio-economic conditions of their workers via corporate social responsibility policies, negotiations with unions, and other channels.[12]

This paper will argue that firms are political in another way: by allocating resources in reaction to the political climate of a country. This argument has appeared in certain places before, but never with such a combination of a formal theoretical framework and novel empirical test. A large literature shows that firms generally prefer to invest in countries with strong property rights protections.[13] To make the decision to move into a country with a risk of expropriation, firms can price the risk of expropriation by the host government of a supplier country by various methods.[14] Firms with intimate knowledge of the political climate in a country can extract advantages.[15] In the extreme case where firms can depend on their own government for intervention, firms can extract benefits from the host government via bargaining.[16]

Although this literature is deep, its analyses usually lack formal analysis, leading to conflicting hypotheses and results. Henisz and Macher (2004) consider a topic closest to my proposed model, arguing that firms with advanced technology are averse to expropriation hazards, while firms with less advanced technology are more willing to accept a trade-off.[17] However, their analysis lacks a formal theoretical model. Johns and Wellhausen (2016) offer the only formal game theoretic model in my literature review, which differs from my proposed model because it is a one-period game between the government and the firm. In short, there is room for a formal theoretic contribution to this literature.

2.2 Operations Research

The second relevant body of literature considers organizational management. This literature studies a broad variety of puzzles, including inventory management, contracting approaches, and manufacturer balancing of multiple retailers; to match the scope of this paper I will restrict this discussion to importing retailer/wholesaler management of supply chain manufacturers. A shock such as the tariff imposition we're considering amounts to an increase in uncertainty in the relationship between the importer and the supplier, requiring adaptation.[18] Studies in the Transaction Cost Economics (TCE) literature use a starting point such as this that leads to renegotiation of existing contracts.[19] A robust recent example of such a model is Monarch (2014), which derives a general equilibrium model depicting the cost-benefit structure of firms switching suppliers within and across cities.[20]

Alternative approaches to TCE exist in production and operations management literature. Incomplete Contracts/Property Rights Theory argues that the ownership structure of the firm affects its functionality, and the Resource-, Knowledge-, and Capability-based approaches focus on the importance of their namesakes. Particularly relevant to us is the knowledge-based approach, which argues that a determinant of firm success is "the transmission and use of tacit knowledge, and the relative ease with which this knowledge can be

[11] Frye, Reuter and Szakonyi (2014).
[12] Rodgers et al. (2019).
[13] Oneal (1994); Jensen (2003); Li and Resnick (2003); Li (2006); Jensen (2008*a*,*b*); Li (2009); Staats and Biglaiser (2012); Jensen (2013); Johns and Wellhausen (2016). As cited in Pandya (2016).
[14] Mahajan (1990); Clark (2003); Akhtaruzzaman, Berg and Hajzler (2017).
[15] Boddewyn (2015).
[16] Li et al. (2013).
[17] Henisz and Macher (2004).
[18] Williamson (1971).
[19] Tsay et al. (2018).
[20] Monarch (2014).

developed and shared within and between firms."[21] One extension of these theories is Real Options Theory (ROT), which treats investment decisions as options contracts to be exercised.[22] There are two possible applications of ROT to our research scenario: the firm exercising an option to relocate its supply or the government of the supplier country exercising an option to expropriate form the firm.[23]

Firm literature breaks up the drivers of firm supply chain decisions into specialization of input, contract availability, correlation of default among suppliers (and its relationship with price), and supply chain resilience. These traits then lend supply networks the characteristics of efficiency and redundancy to shocks. Kharrazi, Rovenskaya and Fath (2017) find that network efficiency, while positively correlated with growth, appears to coincide with lower resilience: losing more and growing less following an economic shock. Increased redundancy, on the other hand, minimizes losses and increases post-shock growth without affecting growth before the shock.[24] When suppliers are capacity constrained, retailers will order more than optimal to ensure a favorable allocation from the supplier.[25]

Operations research and industrial organization literature considers supplier diversification, finding that retailers prefer suppliers with highly correlated likelihoods of default (failure to supply the good) despite the associated increase in default risk because it drives down inter-supplier competition and decreases prices.[26] Cadot, Carrère and Strauss-Kahn (2014) find that OECD buyers increase supplier diversification over time as the set of suppliers repeatedly contracts and expands, but this trend of diversification over time has decreased recently alongside China's increasing manufacturing share.[27] However, mitigating concerns my impinge upon the best practice of supplier diversification such as bulk discounts that direct business towards the most efficient supplier.[28]

Literature on this topic studies the effects of shocks on trade networks, the effects of protectionism on trade, and the causes and results of supplier diversification. The big focus of the literature examining trade network response to shocks has been the disaster at the Fukushima nuclear plant in 2011. MacKenzie, Santos and Barker (2012) find that in the wake of the Fukushima disaster, "Japanese demand was satisfied by other countries."[29] The authors show in a later paper that this then had downstream effects on the market share of automotive companies in other countries who relied on Japanese-manufactured unfinished goods.[30] Further literature considers how the effects of nominal demand shocks differ across countries.[31] Some analyses conclude that the global food trade network will exhibit low resilience to shocks like extreme weather events, but the diffusion of these shocks depends on per capita income of importing countries.[32]

My argument will contribute to the literature a theory of firm-level strategic decision-making based on competition, firm characteristics, and quality of government in the new supplier country. I will advance the

[21] (Tsay et al., 2018, p. 1182). Important contributions to this theory include Polanyi (2015); Williamson (1975); Nelson and Winter (1982); Teece et al. (1986); Kogut and Zander (1992); Nonaka (1994); Monteverde (1995); Grant (1996*a*,*b*); Foss (1996); Mahoney (2001); Ziedonis (2004).

[22] Clark (2003).

[23] Sanchez and Mahoney (1996); Leiblein (2003).

[24] Kharrazi, Rovenskaya and Fath (2017).

[25] Cachon and Lariviere (1999).

[26] Babich, Burnetas and Ritchken (2007).

[27] Cadot, Carrère and Strauss-Kahn (2014).

[28] Swaminathan and Shanthikumar (1999).

[29] (MacKenzie, Santos and Barker, 2012, p. 293).

[30] MacKenzie, Barker and Santos (2014).

[31] Kireyev and Leonidov (2018).

[32] He and Deem (2010); Fair, Bauch and Anand (2017); Distefano et al. (2018).

literature by disaggregating FDI into multinational firms' specific production activities. My novel micro-founded empirical approach will add considerable depth to empirical support for my claim.

3 The Theoretical Model

3.1 Set-Up

In the face of shocks to their supply chain, such as the US-China trade war, two firms compete in an industry and sell their products to markets outside their supplier countries. Firm A and Firm B are headquartered their mutual home country, country C_0, and both produce all products in country C_1 and import them to C_0 for sale. The two firms compete in product x but not in products a and b.

The government of country C_0 imposes a tariff $\tau \in (0,1]$ of produced value on goods imported from C_1. Both firms face the simultaneous decision to keep production in C_1 (that is, to Stay S) or to move (M) production to an alternative supplier country C_2, which is located close to C_1. C_2 is an emerging market economy and is smaller than C_1, with a capacity constraint on how much capital it can successfully accommodate. This capacity constraint comes in the form of limited specialized labor. Its capacity κ_2 is given by $q_x^\Lambda + q_x^\Sigma + q_a^\Lambda + q_b^\Sigma < \kappa_2 < 2q_x^\Lambda + q_a^\Lambda + q_b^\Lambda$; that is, C_2 has capacity to support the production of one large firm or a large and small firm, but not two large firms.

Moving production to C_2 is associated with a fixed start-up cost proportional to the amount of production being moved there (e.g. for Firm A: $c(q_x^A + q_a^A)$). Maintaining production in C_1 is subject to the cost of the tariff (e.g. for Firm A: $\tau(q_x^A + q_a^A)$). There is some risk ρ that the government of C_2 will expropriate a firm moving its production there. The government of C_2 is either expropriative (type ε, $\rho = 1$) or not expropriative (type $\sim \varepsilon$, $\rho = 0$), which is known to all players.

3.2 Factors Affecting Firm Preferences

The size and Research and Development (R&D) type of both firms affect decisions to move or stay. This is a game of incomplete information: Nature generates asymmetric information between the players about their R&D types (high h or low ℓ), which they each privately observe before making their simultaneous move. Each firm forms beliefs about the other's R&D type over all of its lines of business based on its competition with the firm in Product x as well as public information and company reporting about Products a and b. Firms with high R&D costs would not move to low-property-rights countries out of fear of expropriation; firms with low R&D costs do not have this fear.

Firms also consider what fraction of new country capacity will be taken up by the moves of both firms. Notwithstanding its R&D type, a large firm (Λ) still seeks to gain a competitive edge in the market by diversifying its supply chain. A large firm prefers (in order) that it alone moves, that both firms stay, and that its opponent moves and it stays. A small firm (Σ) prefers (in order) that it alone moves, nobody moves, and its opponent alone moves. Firms may gain competitive utility from denying its opponent the ability to move; firm size is known to all players.

Upon receiving news of the tariffs, both firms simultaneously decide to move or stay in a one-period game. This decision is based upon its and its competitor's size and R&D costs as well as the new supplier country's government's expropriation type. Because of the new supplier country's resource constraints, each firm's decision depends on its belief about its competitor's likelihood to move.

There are three moving parts in this game: the R&D type of each firm (h,ℓ), the size of each firm (Λ,Σ), and the expropriative type of the government of the new supplier country $(\varepsilon,\sim\varepsilon)$. However, in any given situation, firm size and type of government are perfectly known by all players. Thus, the only unknown is the R&D type of each firm. Solving this game will involve examining each of the eight different possible situations (four combinations of firm size and two possible government types) separately, and finding Nash equilibrium in each according to each firm's belief about its opponent's type.

3.3 Preferences

There are four possible outcomes:

- O_{MM}: Firm A moves, Firm B moves.
- O_{MS}: Firm A moves, Firm B stays.
- O_{SM}: Firm A stays, Firm B moves.
- O_{SS}: Firm A stays, Firm B stays.

Firms have high or low (h,ℓ) type in research and development costs with probability $(p,1-p)$ for Firm A and $(q,1-q)$ for Firm B, respectively. Each firm has the same possible set of strategies over the above outcomes: $\mathbb{S}=\left\{M^hM^\ell,M^hS^\ell,S^hM^\ell,S^hS^\ell\right\}$. Tables 1 and 2 depict the ranked preferences, formatted as $firm^{rank}_{A_{type}B_{type}}$, for firms under each of the eight combinations of government type, own firm R&D type, opponent R&D type, own firm size, and opponent firm size.

Table 1: Ranked Preferences Under a Government ε

(Firm A Size, Firm B Size)	Outcome	(Firm A Type, Firm B Type) (h,h)	(h,ℓ)	(ℓ,h)	(ℓ,ℓ)
(Λ,Λ)	O_{MM}	(a^4_{hh},b^4_{hh})	$(a^4_{h\ell},b^4_{h\ell})$	$(a^4_{\ell h},b^4_{\ell h})$	$(a^4_{\ell\ell},b^4_{\ell\ell})$
	O_{MS}	(a^3_{hh},b^1_{hh})	$(a^3_{h\ell},b^3_{h\ell})$	$(a^1_{\ell h},b^1_{\ell h})$	$(a^1_{\ell\ell},b^3_{\ell\ell})$
	O_{SM}	(a^1_{hh},b^3_{hh})	$(a^1_{h\ell},b^1_{h\ell})$	$(a^3_{\ell h},b^3_{\ell h})$	$(a^3_{\ell\ell},b^1_{\ell\ell})$
	O_{SS}	(a^2_{hh},b^2_{hh})	$(a^2_{h\ell},b^2_{h\ell})$	$(a^2_{\ell h},b^2_{\ell h})$	$(a^2_{\ell\ell},b^2_{\ell\ell})$
(Λ,Σ)	O_{MM}	(a^3_{hh},b^3_{hh})	$(a^4_{h\ell},b^2_{h\ell})$	$(a^2_{\ell h},b^3_{\ell h})$	$(a^3_{\ell\ell},b^3_{\ell\ell})$
	O_{MS}	(a^4_{hh},b^1_{hh})	$(a^3_{h\ell},b^1_{h\ell})$	$(a^3_{\ell h},b^1_{\ell h})$	$(a^1_{\ell\ell},b^4_{\ell\ell})$
	O_{SM}	(a^1_{hh},b^4_{hh})	$(a^1_{h\ell},b^3_{h\ell})$	$(a^1_{\ell h},b^4_{\ell h})$	$(a^4_{\ell\ell},b^1_{\ell\ell})$
	O_{SS}	(a^2_{hh},b^2_{hh})	$(a^2_{h\ell},b^4_{h\ell})$	$(a^4_{\ell h},b^2_{\ell h})$	$(a^2_{\ell\ell},b^2_{\ell\ell})$
(Σ,Λ)	O_{MM}	(a^3_{hh},b^3_{hh})	$(a^3_{h\ell},b^2_{h\ell})$	$(a^2_{\ell h},b^4_{\ell h})$	$(a^3_{\ell\ell},b^3_{\ell\ell})$
	O_{MS}	(a^4_{hh},b^1_{hh})	$(a^4_{h\ell},b^3_{h\ell})$	$(a^3_{\ell h},b^1_{\ell h})$	$(a^4_{\ell\ell},b^1_{\ell\ell})$
	O_{SM}	(a^1_{hh},b^4_{hh})	$(a^1_{h\ell},b^1_{h\ell})$	$(a^1_{\ell h},b^3_{\ell h})$	$(a^1_{\ell\ell},b^4_{\ell\ell})$
	O_{SS}	(a^2_{hh},b^2_{hh})	$(a^2_{h\ell},b^4_{h\ell})$	$(a^4_{\ell h},b^2_{\ell h})$	$(a^2_{\ell\ell},b^2_{\ell\ell})$
(Σ,Σ)	O_{MM}	(a^3_{hh},b^3_{hh})	$(a^3_{h\ell},b^2_{h\ell})$	$(a^2_{\ell h},b^3_{\ell h})$	$(a^2_{\ell\ell},b^2_{\ell\ell})$
	O_{MS}	(a^4_{hh},b^1_{hh})	$(a^4_{h\ell},b^1_{h\ell})$	$(a^4_{\ell h},b^1_{\ell h})$	$(a^4_{\ell\ell},b^1_{\ell\ell})$
	O_{SM}	(a^1_{hh},b^4_{hh})	$(a^1_{h\ell},b^4_{h\ell})$	$(a^1_{\ell h},b^4_{\ell h})$	$(a^1_{\ell\ell},b^4_{\ell\ell})$
	O_{SS}	(a^2_{hh},b^2_{hh})	$(a^2_{h\ell},b^3_{h\ell})$	$(a^3_{\ell h},b^2_{\ell h})$	$(a^3_{\ell\ell},b^3_{\ell\ell})$

The ranked preferences for the two firms under government type $\sim \varepsilon$ are:

Table 2: Ranked Preferences Under a Government $\sim \varepsilon$

(Firm A Size, Firm B Size)	Outcome	(Firm A Type, Firm B Type) (h,h)	(h,ℓ)	(ℓ,h)	(ℓ,ℓ)
(Λ,Λ)	O_{MM}	(a^4_{hh},b^4_{hh})	$(a^4_{h\ell},b^4_{h\ell})$	$(a^4_{\ell h},b^4_{\ell h})$	$(a^4_{\ell\ell},b^4_{\ell\ell})$
	O_{MS}	(a^1_{hh},b^3_{hh})	$(a^1_{h\ell},b^3_{h\ell})$	$(a^1_{\ell h},b^3_{\ell h})$	$(a^1_{\ell\ell},b^3_{\ell\ell})$
	O_{SM}	(a^3_{hh},b^1_{hh})	$(a^3_{h\ell},b^1_{h\ell})$	$(a^3_{\ell h},b^1_{\ell h})$	$(a^3_{\ell\ell},b^1_{\ell\ell})$
	O_{SS}	(a^2_{hh},b^2_{hh})	$(a^2_{h\ell},b^2_{h\ell})$	$(a^2_{\ell h},b^2_{\ell h})$	$(a^2_{\ell\ell},b^2_{\ell\ell})$
(Λ,Σ)	O_{MM}	(a^2_{hh},b^2_{hh})	$(a^2_{h\ell},b^4_{h\ell})$	$(a^2_{\ell h},b^2_{\ell h})$	$(a^2_{\ell\ell},b^4_{\ell\ell})$
	O_{MS}	(a^1_{hh},b^4_{hh})	$(a^1_{h\ell},b^3_{h\ell})$	$(a^1_{\ell h},b^4_{\ell h})$	$(a^1_{\ell\ell},b^3_{\ell\ell})$
	O_{SM}	(a^4_{hh},b^1_{hh})	$(a^4_{h\ell},b^2_{h\ell})$	$(a^4_{\ell h},b^1_{\ell h})$	$(a^4_{\ell\ell},b^2_{\ell\ell})$
	O_{SS}	(a^3_{hh},b^3_{hh})	$(a^3_{h\ell},b^1_{h\ell})$	$(a^3_{\ell h},b^3_{\ell h})$	$(a^3_{\ell\ell},b^1_{\ell\ell})$
(Σ,Λ)	O_{MM}	(a^2_{hh},b^2_{hh})	$(a^2_{h\ell},b^2_{h\ell})$	$(a^4_{\ell h},b^2_{\ell h})$	$(a^4_{\ell\ell},b^2_{\ell\ell})$
	O_{MS}	(a^1_{hh},b^4_{hh})	$(a^1_{h\ell},b^4_{h\ell})$	$(a^2_{\ell h},b^4_{\ell h})$	$(a^2_{\ell\ell},b^4_{\ell\ell})$
	O_{SM}	(a^4_{hh},b^1_{hh})	$(a^4_{h\ell},b^1_{h\ell})$	$(a^3_{\ell h},b^1_{\ell h})$	$(a^3_{\ell\ell},b^1_{\ell\ell})$
	O_{SS}	(a^3_{hh},b^3_{hh})	$(a^3_{h\ell},b^3_{h\ell})$	$(a^1_{\ell h},b^3_{\ell h})$	$(a^1_{\ell\ell},b^3_{\ell\ell})$
(Σ,Σ)	O_{MM}	(a^2_{hh},b^2_{hh})	$(a^2_{h\ell},b^4_{h\ell})$	$(a^4_{\ell h},b^2_{\ell h})$	$(a^4_{\ell\ell},b^4_{\ell\ell})$
	O_{MS}	(a^1_{hh},b^4_{hh})	$(a^1_{h\ell},b^3_{h\ell})$	$(a^2_{\ell h},b^4_{\ell h})$	$(a^3_{\ell\ell},b^3_{\ell\ell})$
	O_{SM}	(a^4_{hh},b^1_{hh})	$(a^4_{h\ell},b^2_{h\ell})$	$(a^3_{\ell h},b^1_{\ell h})$	$(a^2_{\ell\ell},b^2_{\ell\ell})$
	O_{SS}	(a^3_{hh},b^3_{hh})	$(a^3_{h\ell},b^1_{h\ell})$	$(a^1_{\ell h},b^3_{\ell h})$	$(a^1_{\ell\ell},b^1_{\ell\ell})$

4 The Game

For each scenario shown in Tables 1 and 2, the 4×4 preferences matrix is formed under a unique combination of government type and firm size. Given these preferences, I can now derive ranked payoffs for each firm under the varying scenarios. Because there are so many variations of firm size and government type, I will solve several configurations of interest and derive conclusions.

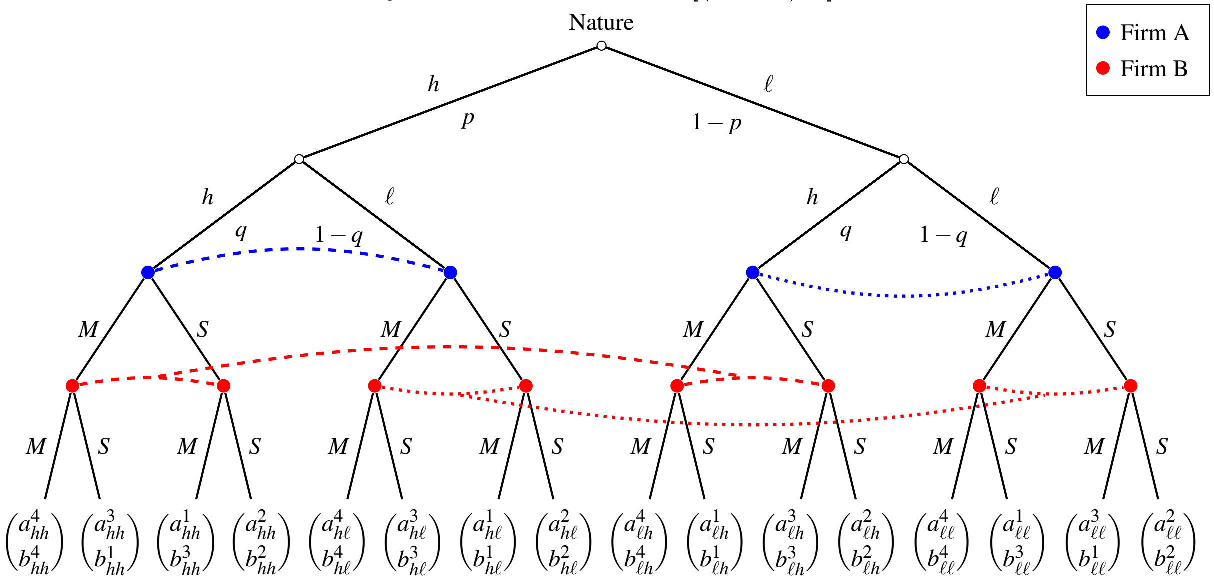
4.1 $[(A_\Lambda, B_\Lambda), \varepsilon]$

First, I will consider the case with two large firms A_Λ and B_Λ and an expropriative government ε.

4.1.1 Extensive Form

First, a word on notation. A firm choosing strategy profile $M^h S^\ell$ means that it will play M if its type is h and S if its type is ℓ. Each firm knows the other's strategy. If both firms play $M^h S^\ell$, a firm's payoffs for this strategy correspond to the sum of its payoffs for each possible combination of moves under this strategy ($M^h_A M^h_B$, $M^h_A S^\ell_B$, $S^\ell_A M^h_B$, $S^\ell_A S^\ell_B$, in this example) each multiplied by the probability of that move occurring (pq, $q(1-q)$, $(1-p)q$, $(1-p)(1-q)$, respectively). The extensive form of the game is shown in Figure 1.

Figure 1: Extensive form of $[(A_\Lambda, B_\Lambda), \varepsilon]$.



4.1.2 Normal Form

Table 3 shows the normal form of the game $[(A_\Lambda, B_\Lambda), \varepsilon]$, complete with payoffs.

Table 3: Normal Form of the game $[(A_\Lambda, B_\Lambda), \varepsilon]$.

		Government Type: ε	
(Firm A Size, Firm B Size):		M^hM^ℓ	M^hS^ℓ
(Λ,Λ)	M^hM^ℓ	$\begin{pmatrix} pqa^4_{hh}+p(1-q)a^4_{h\ell}+(1-p)qa^4_{\ell h}+(1-p)(1-q)a^4_{\ell\ell} \\ pqb^4_{hh}+p(1-q)b^4_{h\ell}+(1-p)qb^4_{\ell h}+(1-p)(1-q)b^4_{\ell\ell} \end{pmatrix}$	$\begin{pmatrix} pqa^4_{hh}+p(1-q)a^3_{h\ell}+(1-p)qb^4_{\ell h}+(1-p)(1-q)a^1_{\ell\ell} \\ pqb^4_{hh}+p(1-q)b^3_{h\ell}+(1-p)qb^4_{\ell h}+(1-p)(1-q)b^3_{\ell\ell} \end{pmatrix}$
	M^hS^ℓ	$\begin{pmatrix} pqa^4_{hh}+p(1-q)a^4_{h\ell}+(1-p)qa^3_{\ell h}+(1-p)(1-q)a^3_{\ell\ell} \\ pqb^4_{hh}+p(1-q)b^4_{h\ell}+(1-p)qb^3_{\ell h}+(1-p)(1-q)b^1_{\ell\ell} \end{pmatrix}$	$\begin{pmatrix} pqa^4_{hh}+p(1-q)a^3_{h\ell}+(1-p)qa^3_{\ell h}+(1-p)(1-q)a^2_{\ell\ell} \\ pqb^4_{hh}+p(1-q)b^3_{h\ell}+(1-p)qb^3_{\ell h}+(1-p)(1-q)b^2_{\ell\ell} \end{pmatrix}$
	S^hM^ℓ	$\begin{pmatrix} pqa^1_{hh}+p(1-q)a^1_{h\ell}+(1-p)qa^4_{\ell h}+(1-p)(1-q)a^4_{\ell\ell} \\ pqb^3_{hh}+p(1-q)b^1_{h\ell}+(1-p)qb^4_{\ell h}+(1-p)(1-q)b^4_{\ell\ell} \end{pmatrix}$	$\begin{pmatrix} pqa^1_{hh}+p(1-q)a^2_{h\ell}+(1-p)qa^4_{\ell h}+(1-p)(1-q)a^1_{\ell\ell} \\ pqb^3_{hh}+p(1-q)b^2_{h\ell}+(1-p)qb^4_{\ell h}+(1-p)(1-q)b^3_{\ell\ell} \end{pmatrix}$
	S^hS^ℓ	$\begin{pmatrix} pqa^1_{hh}+p(1-q)a^1_{h\ell}+(1-p)qa^3_{\ell h}+(1-p)(1-q)a^3_{\ell\ell} \\ pqb^3_{hh}+p(1-q)b^1_{h\ell}+(1-p)qb^3_{\ell h}+(1-p)(1-q)b^1_{\ell\ell} \end{pmatrix}$	$\begin{pmatrix} pqa^1_{hh}+p(1-q)a^2_{h\ell}+(1-p)qa^3_{\ell h}+(1-p)(1-q)a^2_{\ell\ell} \\ pqb^3_{hh}+p(1-q)b^2_{h\ell}+(1-p)qb^3_{\ell h}+(1-p)(1-q)b^2_{\ell\ell} \end{pmatrix}$
(Firm A Size, Firm B Size):		S^hM^ℓ	S^hS^ℓ
(Λ,Λ)	M^hM^ℓ	$\begin{pmatrix} pqa^3_{hh}+p(1-q)a^4_{h\ell}+(1-p)qa^1_{\ell h}+(1-p)(1-q)a^4_{\ell\ell} \\ pqb^1_{hh}+p(1-q)b^4_{h\ell}+(1-p)qb^1_{\ell h}+(1-p)(1-q)b^4_{\ell\ell} \end{pmatrix}$	$\begin{pmatrix} pqa^3_{hh}+p(1-q)a^3_{h\ell}+(1-p)qa^1_{\ell h}+(1-p)(1-q)a^1_{\ell\ell} \\ pqb^1_{hh}+p(1-q)b^3_{h\ell}+(1-p)qb^1_{\ell h}+(1-p)(1-q)b^3_{\ell\ell} \end{pmatrix}$
	M^hS^ℓ	$\begin{pmatrix} pqa^3_{hh}+p(1-q)a^4_{h\ell}+(1-p)qa^2_{\ell h}+(1-p)(1-q)a^3_{\ell\ell} \\ pqb^1_{hh}+p(1-q)b^4_{h\ell}+(1-p)qb^2_{\ell h}+(1-p)(1-q)b^1_{\ell\ell} \end{pmatrix}$	$\begin{pmatrix} pqa^3_{hh}+p(1-q)a^3_{h\ell}+(1-p)qa^2_{\ell h}+(1-p)(1-q)a^2_{\ell\ell} \\ pqb^1_{hh}+p(1-q)b^3_{h\ell}+(1-p)qb^2_{\ell h}+(1-p)(1-q)b^2_{\ell\ell} \end{pmatrix}$
	S^hM^ℓ	$\begin{pmatrix} pqa^2_{hh}+p(1-q)a^1_{h\ell}+(1-p)qa^1_{\ell h}+(1-p)(1-q)a^4_{\ell\ell} \\ pqb^2_{hh}+p(1-q)b^1_{h\ell}+(1-p)qb^1_{\ell h}+(1-p)(1-q)b^4_{\ell\ell} \end{pmatrix}$	$\begin{pmatrix} pqa^2_{hh}+p(1-q)a^2_{h\ell}+(1-p)qa^1_{\ell h}+(1-p)(1-q)a^1_{\ell\ell} \\ pqb^2_{hh}+p(1-q)b^2_{h\ell}+(1-p)qb^1_{\ell h}+(1-p)(1-q)b^3_{\ell\ell} \end{pmatrix}$
	S^hS^ℓ	$\begin{pmatrix} pqa^2_{hh}+p(1-q)a^1_{h\ell}+(1-p)qa^2_{\ell h}+(1-p)(1-q)a^3_{\ell\ell} \\ pqb^2_{hh}+p(1-q)b^1_{h\ell}+(1-p)qb^2_{\ell h}+(1-p)(1-q)b^1_{\ell\ell} \end{pmatrix}$	$\begin{pmatrix} pqa^2_{hh}+p(1-q)a^2_{h\ell}+(1-p)qa^2_{\ell h}+(1-p)(1-q)a^2_{\ell\ell} \\ pqb^2_{hh}+p(1-q)b^2_{h\ell}+(1-p)qb^2_{\ell h}+(1-p)(1-q)b^2_{\ell\ell} \end{pmatrix}$

To determine equilibria from this table, we first consider Firm A and Firm B's incentives to deviate from each cell and therefore eliminate strategy combinations that cannot be Nash Equilibrium. This eliminates certain combinations of strategies, leaving (S^hM^ℓ, S^hM^ℓ), (S^hS^ℓ, S^hM^ℓ), (S^hM^ℓ, S^hS^ℓ).

(S^hM^ℓ, S^hM^ℓ) will be played when both of the following conditions are satisfied:

$$q(a^1_{\ell h} - a^2_{\ell h}) > (1-q)(a^3_{\ell\ell} - a^4_{\ell\ell}) \tag{1}$$

$$p(b^1_{h\ell} - b^2_{h\ell}) > (1-p)(b^3_{\ell\ell} - b^4_{\ell\ell}) \tag{2}$$

We can begin to understand this equilibrium by reminding ourselves that a firm of type h will not move under a government ε out of fear of expropriation. Starting with Equation 1, a higher value for q means a greater likelihood B is h and lower likelihood that a large Firm A would face capacity competition in the new country. The intuition is that if Firm A of type ℓ values the supply chain benefits of moving more so than the risk of both firms moving simultaneously, Firm A will only move if it is more certain that Firm B is type ℓ (q must be low).

More specifically, if Firm A's belief that the chance of Firm B being ℓ is low (i.e. that q is high), and therefore that there is only a small chance Firm B will move for supply chain benefits, Firm A will only not play S^hM^ℓ if it fears moving when Firm B is type ℓ (i.e. that $a^3_{\ell\ell} - a^4_{\ell\ell}$ is large) far more so than it prefers moving when Firm B is type h (i.e. that $a^1_{\ell h} - a^2_{\ell h}$ is small). This essentially can be boiled down to Firm A fearing the quantity repercussions of running up against a country's capacity constraint far more than it valuing supply chain benefits.

Alternatively, if Firm A's belief that the chance of Firm B being ℓ is high (i.e. that q is low), and therefore that there is a large chance Firm B will move for supply chain benefits, Firm A will only play S^hM^ℓ if it prefers moving when Firm B is type h (i.e. that $a^1_{\ell h} - a^2_{\ell h}$ is large) far more so than it fears moving when Firm B is type ℓ (i.e. that $a^3_{\ell\ell} - a^4_{\ell\ell}$ is small). This essentially can be boiled down to Firm A valuing supply chain benefits far more than it fears the quantity repercussions of running up against a country's capacity constraint. Otherwise, Firm A will be conservative and play the equilibrium strategy of S^hS^ℓ.

Likewise, as shown in Equation 2, Firm B will be have the same when their beliefs p about A's type mirror this. It will only play the strategy S^hM^ℓ in two circumstances: when it believes Firm A is likely type ℓ (low p) and it fears the capacity constraint more so than it values the supply chain benefits of moving (i.e. $b^1_{h\ell} - b^2_{h\ell} < b^3_{\ell\ell} - b^4_{\ell\ell}$), or when it believes Firm A is likely type h (high p) and it fears the capacity constraint less so than it values the supply chain benefits of moving (i.e. $b^1_{h\ell} - b^2_{h\ell} > b^3_{\ell\ell} - b^4_{\ell\ell}$). If neither of these conditions are met, then Firm B will be conservative and play the equilibrium strategy of S^hS^ℓ.

4.1.3 Example

In response to the US-China trade war, capital-intensive manufacturing industries such as technology are refraining from investing in lower-property-rights countries, instead preferring to relocate to more established manufacturing hubs such as Taiwan, Vietnam, and Mexico.[33] However, even that may be more difficult than anticipated. Even countries close to China's manufacturing capability, such as Vietnam, lack the necessary labor, machinery, and safety certifications required for some goods such as smartphones, aluminum ladders, and vacuum cleaners. Instead, these firms are forced to come to terms with "preparing for a protracted fight between the world's two largest economies."[34] Less capital-intensive manufacturers are planning on

[33] Zhang (2019).
[34] Mandhana (2019).

relocating some or all of their production in response to the trade war from China, and are less reticent to move to countries with high- expropriation governments such as Cambodia. Fewer countries are choosing to relocate to India and Indonesia than to Taiwan, Vietnam, and Thailand.[35] Perhaps this is correlated with Indonesia's low rate of STEM graduates and both countries' high level of bureaucratic red tape.[36]

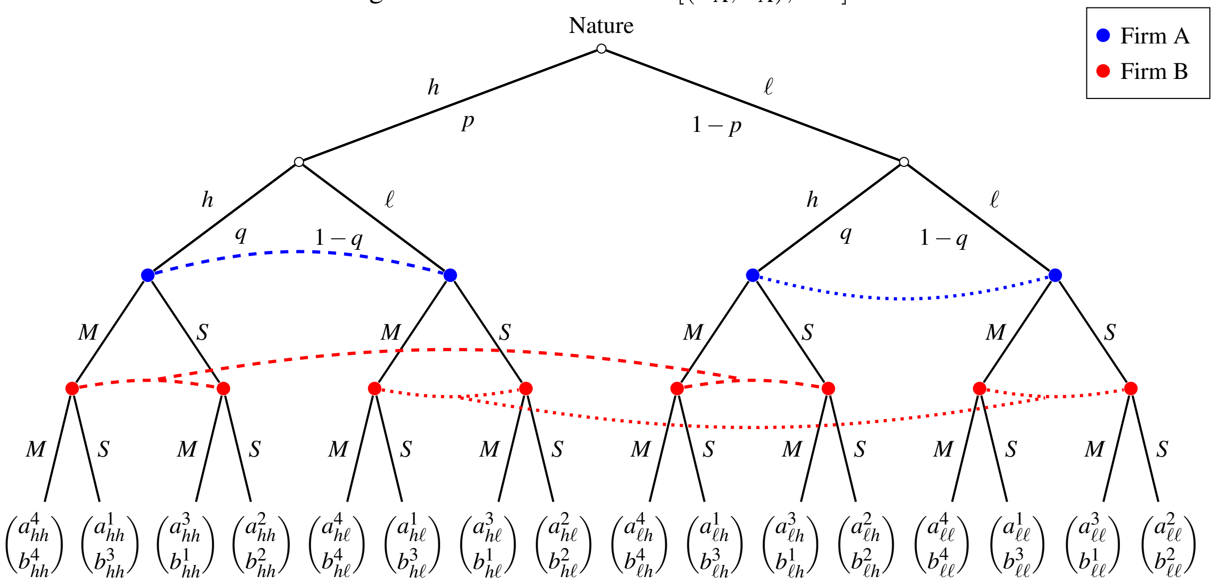
4.2 $[(A_\Lambda, B_\Lambda), \sim \varepsilon]$

The manufacturing sector, on the other hand, has more supplier diversity. In addition to large manufacturers that add value to their importers through innovation, it has manufacturers that produce well-established technologies that require little research and development. Consequently, large manufacturers end up competing with each other but differing over their value add. The second combination of firms we'll consider is two large firms and a government of type $\sim \varepsilon$.

4.2.1 Extensive Form

Using payoffs from Table 1, under regime $\sim \varepsilon$ this game takes the extensive form shown in Figure 2.

Figure 2: Extensive form of $[(A_\Lambda, B_\Lambda), \sim \varepsilon]$.



4.2.2 Normal Form

Table 4 shows the normal form of the game $[(A_\Lambda, B_\Lambda), \sim \varepsilon]$, complete with payoffs.

Without resulting to algebraic conditions restricting the values of p and q, I can eliminate ten strategy combinations as impossible Nash equilibria, leaving (S^hS^ℓ, M^hM^ℓ), (M^hS^ℓ, M^hS^ℓ), (S^hM^ℓ, M^hS^ℓ), (M^hS^ℓ, S^hM^ℓ), (M^hS^ℓ, S^hM^ℓ), and (M^hM^ℓ, S^hS^ℓ). It is clear that (S^hS^ℓ, M^hM^ℓ) and (M^hM^ℓ, S^hS^ℓ) are Bayesian Nash Equilibria because their payoffs are preferable to all alternatives for both players. To determine the circumstances

[35] Tanakasempipat (2019).
[36] ANI (2019); Tanakasempipat (2019).

Table 4: Normal Form of the game $[(A_\Lambda, B_\Lambda), \sim \varepsilon]$.

(Firm A Size, Firm B Size):		Government Type: ε — M^hM^ℓ	Government Type: ε — M^hS^ℓ
(Λ,Λ)	M^hM^ℓ	$\begin{pmatrix} pqa^4_{hh}+p(1-q)a^4_{h\ell}+(1-p)qa^4_{\ell h}+(1-p)(1-q)a^4_{\ell\ell} \\ pqb^4_{hh}+p(1-q)b^4_{h\ell}+(1-p)qb^4_{\ell h}+(1-p)(1-q)b^4_{\ell\ell} \end{pmatrix}$	$\begin{pmatrix} pqa^4_{hh}+p(1-q)a^1_{h\ell}+(1-p)qa^4_{\ell h}+(1-p)(1-q)a^1_{\ell\ell} \\ pqb^4_{hh}+p(1-q)b^3_{h\ell}+(1-p)qb^4_{\ell h}+(1-p)(1-q)b^3_{\ell\ell} \end{pmatrix}$
	M^hS^ℓ	$\begin{pmatrix} pqa^4_{hh}+p(1-q)a^4_{h\ell}+(1-p)qa^3_{\ell h}+(1-p)(1-q)a^3_{\ell\ell} \\ pqb^4_{hh}+p(1-q)b^4_{h\ell}+(1-p)qb^1_{\ell h}+(1-p)(1-q)b^1_{\ell\ell} \end{pmatrix}$	$\begin{pmatrix} pqa^4_{hh}+p(1-q)a^1_{h\ell}+(1-p)qa^3_{\ell h}+(1-p)(1-q)a^2_{\ell\ell} \\ pqb^4_{hh}+p(1-q)b^3_{h\ell}+(1-p)qb^1_{\ell h}+(1-p)(1-q)b^2_{\ell\ell} \end{pmatrix}$
	S^hM^ℓ	$\begin{pmatrix} pqa^3_{hh}+p(1-q)a^3_{h\ell}+(1-p)qa^4_{\ell h}+(1-p)(1-q)a^4_{\ell\ell} \\ pqb^1_{hh}+p(1-q)b^1_{h\ell}+(1-p)qb^4_{\ell h}+(1-p)(1-q)b^4_{\ell\ell} \end{pmatrix}$	$\begin{pmatrix} pqa^4_{hh}+p(1-q)a^3_{h\ell}+(1-p)qa^2_{\ell h}+(1-p)(1-q)a^1_{\ell\ell} \\ pqb^1_{hh}+p(1-q)b^3_{h\ell}+(1-p)qb^2_{\ell h}+(1-p)(1-q)b^3_{\ell\ell} \end{pmatrix}$
	S^hS^ℓ	$\begin{pmatrix} pqa^3_{hh}+p(1-q)a^3_{h\ell}+(1-p)qa^3_{\ell h}+(1-p)(1-q)a^3_{\ell\ell} \\ pqb^1_{hh}+p(1-q)b^1_{h\ell}+(1-p)qb^1_{\ell h}+(1-p)(1-q)b^1_{\ell\ell} \end{pmatrix}$	$\begin{pmatrix} pqa^3_{hh}+p(1-q)a^2_{h\ell}+(1-p)qa^3_{\ell h}+(1-p)(1-q)a^2_{\ell\ell} \\ pqb^1_{hh}+p(1-q)b^2_{h\ell}+(1-p)qb^1_{\ell h}+(1-p)(1-q)b^2_{\ell\ell} \end{pmatrix}$

(Firm A Size, Firm B Size):		S^hM^ℓ	S^hS^ℓ
(Λ,Λ)	M^hM^ℓ	$\begin{pmatrix} pqa^1_{hh}+p(1-q)a^4_{h\ell}+(1-p)qa^1_{\ell h}+(1-p)(1-q)a^4_{\ell\ell} \\ pqb^3_{hh}+p(1-q)b^4_{h\ell}+(1-p)qb^3_{\ell h}+(1-p)(1-q)b^4_{\ell\ell} \end{pmatrix}$	$\begin{pmatrix} pqa^1_{hh}+p(1-q)a^1_{h\ell}+(1-p)qa^1_{\ell h}+(1-p)(1-q)a^1_{\ell\ell} \\ pqb^3_{hh}+p(1-q)b^3_{h\ell}+(1-p)qb^3_{\ell h}+(1-p)(1-q)b^3_{\ell\ell} \end{pmatrix}$
	M^hS^ℓ	$\begin{pmatrix} pqa^1_{hh}+p(1-q)a^4_{h\ell}+(1-p)qa^2_{\ell h}+(1-p)(1-q)a^3_{\ell\ell} \\ pqb^3_{hh}+p(1-q)b^4_{h\ell}+(1-p)qb^2_{\ell h}+(1-p)(1-q)b^1_{\ell\ell} \end{pmatrix}$	$\begin{pmatrix} pqa^1_{hh}+p(1-q)a^1_{h\ell}+(1-p)qa^2_{\ell h}+(1-p)(1-q)a^2_{\ell\ell} \\ pqb^3_{hh}+p(1-q)b^3_{h\ell}+(1-p)qb^2_{\ell h}+(1-p)(1-q)b^2_{\ell\ell} \end{pmatrix}$
	S^hM^ℓ	$\begin{pmatrix} pqa^2_{hh}+p(1-q)a^3_{h\ell}+(1-p)qa^1_{\ell h}+(1-p)(1-q)a^4_{\ell\ell} \\ pqb^2_{hh}+p(1-q)b^1_{h\ell}+(1-p)qb^3_{\ell h}+(1-p)(1-q)b^4_{\ell\ell} \end{pmatrix}$	$\begin{pmatrix} pqa^2_{hh}+p(1-q)a^2_{h\ell}+(1-p)qa^1_{\ell h}+(1-p)(1-q)a^1_{\ell\ell} \\ pqb^2_{hh}+p(1-q)b^2_{h\ell}+(1-p)qb^3_{\ell h}+(1-p)(1-q)b^3_{\ell\ell} \end{pmatrix}$
	S^hS^ℓ	$\begin{pmatrix} pqa^2_{hh}+p(1-q)a^3_{h\ell}+(1-p)qa^2_{\ell h}+(1-p)(1-q)a^3_{\ell\ell} \\ pqb^2_{hh}+p(1-q)b^1_{h\ell}+(1-p)qb^2_{\ell h}+(1-p)(1-q)b^1_{\ell\ell} \end{pmatrix}$	$\begin{pmatrix} pqa^2_{hh}+p(1-q)a^2_{h\ell}+p(1-q)a^2_{\ell h}+(1-p)(1-q)a^2_{\ell\ell} \\ pqb^2_{hh}+p(1-q)b^2_{h\ell}+(1-p)qb^2_{\ell h}+(1-p)(1-q)b^2_{\ell\ell} \end{pmatrix}$

under which each of the other strategies will be equilibria, we must examine their accompanying probabilities.

- (M^hS^ℓ, M^hS^ℓ) is an equilibrium when
  - $p(1-q)[a^1_{h\ell}-a^4_{h\ell}] > (1-p)q[a^2_{\ell h}-a^3_{\ell h}]+(1-p)(1-q)[a^1_{\ell\ell}-a^2_{\ell\ell}]$ and
  - $p(1-q)[b^3_{h\ell}-b^4_{h\ell}]+(1-p)q[b^1_{\ell h}-b^2_{\ell h}] > pq[b^3_{hh}-b^4_{hh}]+(1-p)(1-q)[b^1_{\ell\ell}-b^2_{\ell\ell}]$
- (S^hM^ℓ, M^hS^ℓ) is an equilibrium when
  - $p(1-q)[a^1_{h\ell}-a^4_{h\ell}] < (1-p)q[a^2_{\ell h}-a^3_{\ell h}]+(1-p)(1-q)[a^1_{\ell\ell}-a^2_{\ell\ell}]$ and
  - $pq[b^1_{hh}-b^2_{hh}]+(1-p)(1-q)[b^3_{\ell\ell}-b^4_{\ell\ell}] > p(1-q)[b^1_{h\ell}-b^3_{h\ell}]+(1-p)q[b^3_{\ell h}-b^2_{\ell h}]$
- (M^hS^ℓ, S^hM^ℓ) is an equilibrium when
  - $pq[a^1_{hh}-a^2_{hh}]+(1-p)(1-q)[a^3_{\ell\ell}-a^4_{\ell\ell}] > p(1-q)[a^3_{h\ell}-a^4_{h\ell}]+(1-p)q[a^1_{\ell h}-a^2_{\ell h}]$ and
  - $p(1-q)[b^3_{h\ell}-b^4_{h\ell}]+(1-p)q[b^1_{\ell h}-b^2_{\ell h}] < pq[b^3_{hh}-b^4_{hh}]+(1-p)(1-q)[b^1_{\ell\ell}-b^2_{\ell\ell}]$
- (S^hM^ℓ, S^hM^ℓ) is an equilibrium when
  - $pq[a^1_{hh}-a^2_{hh}]+(1-p)(1-q)[a^3_{\ell\ell}-a^4_{\ell\ell}] < p(1-q)[a^3_{h\ell}-a^4_{h\ell}]+(1-p)q[a^1_{\ell h}-a^2_{\ell h}]$ and
  - $pq[b^1_{hh}-b^2_{hh}]+(1-p)(1-q)[b^3_{\ell\ell}-b^4_{\ell\ell}] < p(1-q)[b^1_{h\ell}-b^3_{h\ell}]+(1-p)q[b^3_{\ell h}-b^2_{\ell h}]$

All this algebra means that when a firm thinks that it is likely to be the only firm to move, or values the benefits of moving more than it fears exceeding the new supplier country's capacity, it will opt for (M^hS^ℓ, M^hS^ℓ) equilibrium. Otherwise, it will adopt the S^hM^ℓ strategy.

4.2.3 Example

Large companies across the world are planning on relocating some or all of their production in response to the trade war from China to countries with low- expropriation governments. Apple has asked its suppliers, including giants such as Foxconn, to consider the cost implications of moving some production from China to Southeast Asia.[37] Hewlett Packard Enterprise even managed to mitigate the impacts of tariffs in the second quarter of calendar year 2019 because of a diversified supply chain.[38] Home Depot Executive Vice President told investors in August 2019 that he was unaware of "a single supplier who is not moving some sort of manufacturing outside of China."[39]. Tech firms have tended to cluster in more developed manufacturing hubs such as Vietnam, Mexico, and Malaysia.

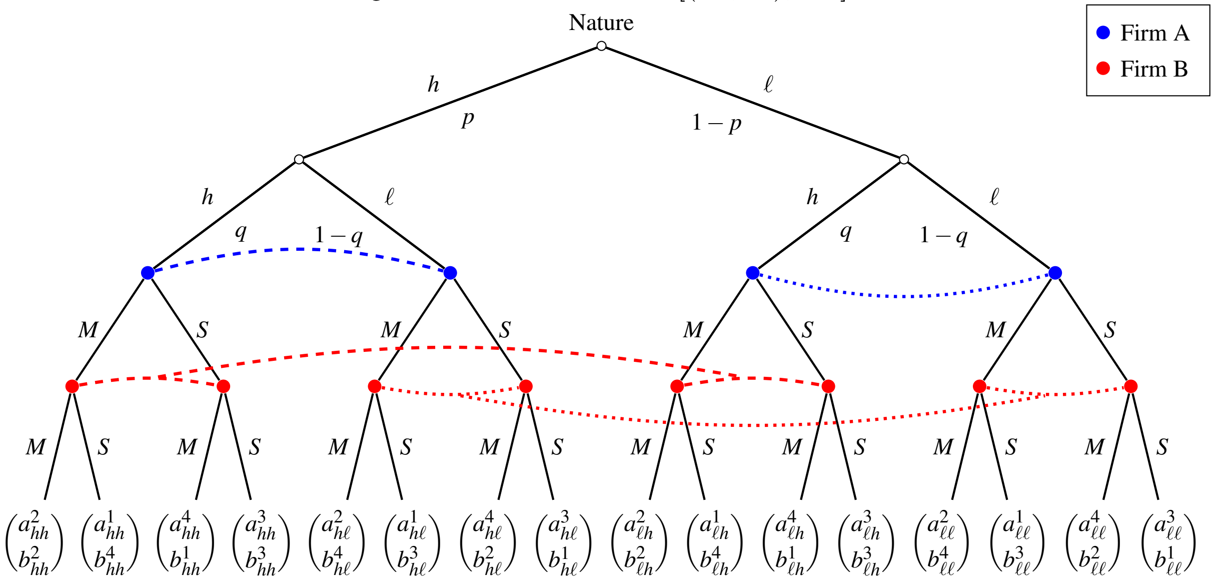
4.3 $[(A_\Lambda, B_\Sigma), \sim \varepsilon]$

Alternatively, let's consider a large and small firm competing. The tech sector, for example, finds large multinational corporations competing directly against small firms such as start-ups or specialty firms. For example, Dropbox has less than 2,500 employees, while Microsoft Azure and Amazon Web Services each employ tens of thousands.

4.3.1 Extensive Form

Using payoffs from Table 1, under regime $\sim \varepsilon$ this game takes extensive form shown in Figure 3.

Figure 3: Extensive form of $[(A_\Lambda, B_\Sigma), \sim \varepsilon]$.



4.3.2 Normal Form

Table 5 shows the normal form of the game $[(A_\Lambda, B_\Sigma), \varepsilon]$, complete with payoffs.

[37] Reed (2019).
[38] Reed (2019).
[39] Reed (2019).

Table 5: Normal Form of the game $[(A_\Lambda, B_\Sigma), \sim \varepsilon]$.

		Government Type: ε	
(Firm A Size, Firm B Size):		M^hM^ℓ	M^hS^ℓ
(Λ,Σ)	M^hM^ℓ	$\begin{pmatrix} pqa^2_{hh}+p(1-q)a^2_{h\ell}+(1-p)qa^2_{\ell h}+(1-p)(1-q)a^2_{\ell\ell} \\ pqb^2_{hh}+p(1-q)b^4_{h\ell}+(1-p)qb^2_{\ell h}+(1-p)(1-q)b^4_{\ell\ell} \end{pmatrix}$	$\begin{pmatrix} pqa^2_{hh}+p(1-q)a^1_{h\ell}+(1-p)qa^2_{\ell h}+(1-p)(1-q)a^1_{\ell\ell} \\ pqb^2_{hh}+p(1-q)b^3_{h\ell}+(1-p)qb^2_{\ell h}+(1-p)(1-q)b^3_{\ell\ell} \end{pmatrix}$
	M^hS^ℓ	$\begin{pmatrix} pqa^2_{hh}+p(1-q)a^2_{h\ell}+(1-p)qa^4_{\ell h}+(1-p)(1-q)a^4_{\ell\ell} \\ pqb^2_{hh}+p(1-q)b^4_{h\ell}+(1-p)qb^1_{\ell h}+(1-p)(1-q)b^2_{\ell\ell} \end{pmatrix}$	$\begin{pmatrix} pqa^2_{hh}+p(1-q)a^2_{h\ell}+(1-p)qa^4_{\ell h}+(1-p)(1-q)a^3_{\ell\ell} \\ pqb^2_{hh}+p(1-q)b^4_{h\ell}+(1-p)qb^1_{\ell h}+(1-p)(1-q)b^1_{\ell\ell} \end{pmatrix}$
	S^hM^ℓ	$\begin{pmatrix} pqa^4_{hh}+p(1-q)a^4_{h\ell}+(1-p)qa^2_{\ell h}+(1-p)(1-q)a^2_{\ell\ell} \\ pqb^1_{hh}+p(1-q)b^2_{h\ell}+(1-p)qb^2_{\ell h}+(1-p)(1-q)b^4_{\ell\ell} \end{pmatrix}$	$\begin{pmatrix} pqa^4_{hh}+p(1-q)a^3_{h\ell}+(1-p)qa^2_{\ell h}+(1-p)(1-q)a^1_{\ell\ell} \\ pqb^1_{hh}+p(1-q)b^1_{h\ell}+(1-p)qb^2_{\ell h}+(1-p)(1-q)b^3_{\ell\ell} \end{pmatrix}$
	S^hS^ℓ	$\begin{pmatrix} pqa^4_{hh}+p(1-q)a^4_{h\ell}+(1-p)qa^4_{\ell h}+(1-p)(1-q)a^4_{\ell\ell} \\ pqb^1_{hh}+p(1-q)b^2_{h\ell}+(1-p)qb^1_{\ell h}+(1-p)(1-q)b^2_{\ell\ell} \end{pmatrix}$	$\begin{pmatrix} pqa^4_{hh}+p(1-q)a^3_{h\ell}+(1-p)qa^4_{\ell h}+(1-p)(1-q)a^3_{\ell\ell} \\ pqb^1_{hh}+p(1-q)b^1_{h\ell}+(1-p)qb^1_{\ell h}+(1-p)(1-q)b^1_{\ell\ell} \end{pmatrix}$

(Firm A Size, Firm B Size):		S^hM^ℓ	S^hS^ℓ
(Λ,Σ)	M^hM^ℓ	$\begin{pmatrix} pqa^1_{hh}+p(1-q)a^2_{h\ell}+(1-p)qa^1_{\ell h}+(1-p)(1-q)a^2_{\ell\ell} \\ pqb^4_{hh}+p(1-q)b^4_{h\ell}+(1-p)qb^4_{\ell h}+(1-p)(1-q)b^4_{\ell\ell} \end{pmatrix}$	$\begin{pmatrix} pqa^1_{hh}+p(1-q)a^1_{h\ell}+(1-p)qa^1_{\ell h}+(1-p)(1-q)a^1_{\ell\ell} \\ pqb^4_{hh}+p(1-q)b^3_{h\ell}+(1-p)qb^4_{\ell h}+(1-p)(1-q)b^3_{\ell\ell} \end{pmatrix}$
	M^hS^ℓ	$\begin{pmatrix} pqa^1_{hh}+p(1-q)a^2_{h\ell}+(1-p)qa^3_{\ell h}+(1-p)(1-q)a^4_{\ell\ell} \\ pqb^4_{hh}+p(1-q)b^4_{h\ell}+(1-p)qb^3_{\ell h}+(1-p)(1-q)b^2_{\ell\ell} \end{pmatrix}$	$\begin{pmatrix} pqa^1_{hh}+p(1-q)a^3_{h\ell}+(1-p)qa^3_{\ell h}+(1-p)(1-q)a^3_{\ell\ell} \\ pqb^4_{hh}+p(1-q)b^1_{h\ell}+(1-p)qb^3_{\ell h}+(1-p)(1-q)b^1_{\ell\ell} \end{pmatrix}$
	S^hM^ℓ	$\begin{pmatrix} pqa^3_{hh}+p(1-q)a^4_{h\ell}+(1-p)qa^1_{\ell h}+(1-p)(1-q)a^2_{\ell\ell} \\ pqb^3_{hh}+p(1-q)b^2_{h\ell}+(1-p)qb^4_{\ell h}+(1-p)(1-q)b^4_{\ell\ell} \end{pmatrix}$	$\begin{pmatrix} pqa^3_{hh}+p(1-q)a^1_{h\ell}+(1-p)qa^1_{\ell h}+(1-p)(1-q)a^1_{\ell\ell} \\ pqb^3_{hh}+p(1-q)b^3_{h\ell}+(1-p)qb^4_{\ell h}+(1-p)(1-q)b^3_{\ell\ell} \end{pmatrix}$
	S^hS^ℓ	$\begin{pmatrix} pqa^3_{hh}+p(1-q)a^4_{h\ell}+(1-p)qa^3_{\ell h}+(1-p)(1-q)a^4_{\ell\ell} \\ pqb^3_{hh}+p(1-q)b^2_{h\ell}+(1-p)qb^3_{\ell h}+(1-p)(1-q)b^2_{\ell\ell} \end{pmatrix}$	$\begin{pmatrix} pqa^3_{hh}+p(1-q)a^3_{h\ell}+p(1-q)a^3_{\ell h}+(1-p)(1-q)a^3_{\ell\ell} \\ pqb^3_{hh}+p(1-q)b^1_{h\ell}+(1-p)qb^3_{\ell h}+(1-p)(1-q)b^1_{\ell\ell} \end{pmatrix}$

Solving for Nash equilibria in this game leaves only one possible strategy combination from which neither Firm A nor Firm B will have incentive to move: (M^hM^ℓ, M^hS^ℓ). Consequently, this is our lone Bayesian Nash Equilibrium.

4.3.3 Example

Piet Holten, whose company, Pactics, makes cloth items for other retailers, moved some of his company's production to Cambodia in 2010 because of political risk, rising wages, and supply chain concentration. His small company has not faced expropriation nor run up against capacity constraints in Cambodia.[40] Hasbro and Steve Madden, both large companies with low capital requirements, have relocated a large portion of their production to Cambodia.[41] Labor-intensive work has relocated to Cambodia as well as Bangladesh and Myanmar.[42]

4.4 Extension: Sequential Game

When a large and small firm are competing with each other, a small firm has the advantage of being able to move later than a large firm because it will never exceed the new supplier country's capacity constraint. Moving later would have the advantage of being able to see the effect of expropriation on a large firm's business. For this to occur, we have to set $\rho \in (0,1)$ so there exists some uncertainty about the expropriative type of the new supplier country government. With the government's uncertain type called $e \in [\varepsilon, \sim \varepsilon]$, the

[40] Stevenson (2018).
[41] Reed (2019).
[42] Tanakasempipat (2019).

extensive form of the game could look like Figure 4. Note that this is still an ongoing exploration and I have not yet solved the game.

4.4.1 Extensive Form

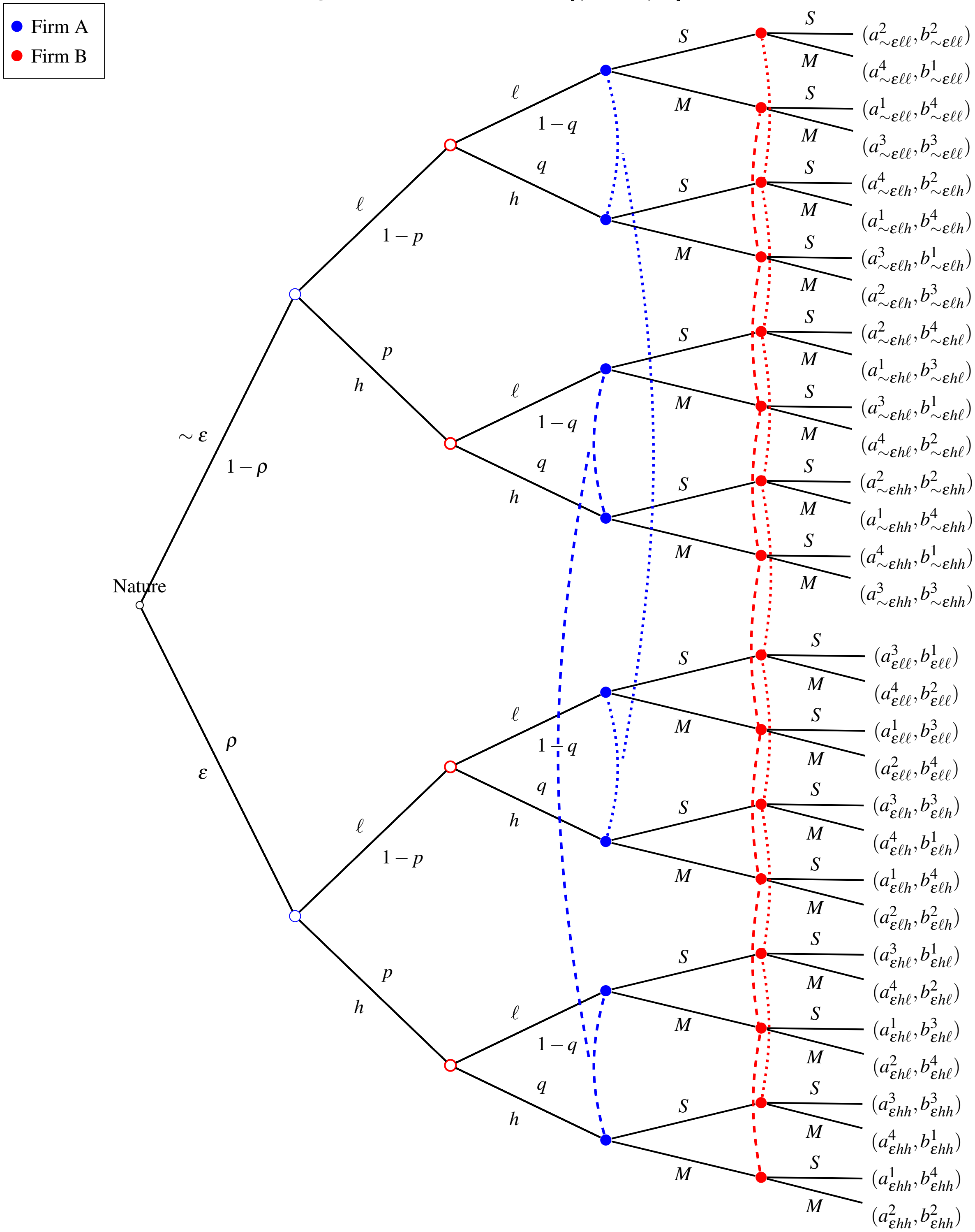
Using payoffs from Tables 1 and 2 consolidated into Table 6, the ranked preferences for the two firms under government type $\sim \varepsilon$ are:

Table 6: Ranked Preferences Under a Government *e*

		(Firm A Type, Firm B Type)			
(Firm A Size, Firm B Size)	Outcome	(h,h)	(h,ℓ)	(ℓ,h)	(ℓ,ℓ)
$(\Lambda,\Sigma),\sim\varepsilon$	O_{MM}	(a_{hh}^2,b_{hh}^2)	$(a_{h\ell}^2,b_{h\ell}^4)$	$(a_{\ell h}^2,b_{\ell h}^2)$	$(a_{\ell\ell}^2,b_{\ell\ell}^4)$
	O_{MS}	(a_{hh}^1,b_{hh}^4)	$(a_{h\ell}^1,b_{h\ell}^3)$	$(a_{\ell h}^1,b_{\ell h}^4)$	$(a_{\ell\ell}^1,b_{\ell\ell}^3)$
	O_{SM}	(a_{hh}^4,b_{hh}^1)	$(a_{h\ell}^4,b_{h\ell}^2)$	$(a_{\ell h}^4,b_{\ell h}^1)$	$(a_{\ell\ell}^4,b_{\ell\ell}^2)$
	O_{SS}	(a_{hh}^3,b_{hh}^3)	$(a_{h\ell}^3,b_{h\ell}^1)$	$(a_{\ell h}^3,b_{\ell h}^3)$	$(a_{\ell\ell}^3,b_{\ell\ell}^1)$
$(\Lambda,\Sigma),\varepsilon$	O_{MM}	(a_{hh}^3,b_{hh}^3)	$(a_{h\ell}^4,b_{h\ell}^2)$	$(a_{\ell h}^2,b_{\ell h}^3)$	$(a_{\ell\ell}^3,b_{\ell\ell}^3)$
	O_{MS}	(a_{hh}^4,b_{hh}^1)	$(a_{h\ell}^3,b_{h\ell}^1)$	$(a_{\ell h}^3,b_{\ell h}^1)$	$(a_{\ell\ell}^1,b_{\ell\ell}^4)$
	O_{SM}	(a_{hh}^1,b_{hh}^4)	$(a_{h\ell}^1,b_{h\ell}^3)$	$(a_{\ell h}^1,b_{\ell h}^4)$	$(a_{\ell\ell}^4,b_{\ell\ell}^1)$
	O_{SS}	(a_{hh}^2,b_{hh}^2)	$(a_{h\ell}^2,b_{h\ell}^4)$	$(a_{\ell h}^4,b_{\ell h}^2)$	$(a_{\ell\ell}^2,b_{\ell\ell}^2)$

Under regime *e* this game takes extensive form shown in Figure 4.

Figure 4: Extensive form of $[(A_\Lambda, B_\Sigma), e]$.



5 Discussion

The simultaneous-move game has three principal results:

- $[A_\Lambda, B_\Lambda, \varepsilon]$: BNE $(S^h M^\ell, S^h M^\ell)$.
- $[A_\Lambda, B_\Lambda, \sim \varepsilon]$: BNE: $(M^h M^\ell, S^h S^\ell)$, $(S^h S^\ell, M^h M^\ell)$, and an interior equilibrium of:
  - $(M^h S^\ell, M^h S^\ell)$ when
    * $p(1-q)[a^1_{h\ell} - a^4_{h\ell}] > (1-p)q[a^2_{\ell h} - a^3_{\ell h}] + (1-p)(1-q)[a^1_{\ell\ell} - a^2_{\ell\ell}]$ and
    * $p(1-q)[b^3_{h\ell} - b^4_{h\ell}] + (1-p)q[b^1_{\ell h} - b^2_{\ell h}] > pq[b^3_{hh} - b^4_{hh}] + (1-p)(1-q)[b^1_{\ell\ell} - b^2_{\ell\ell}]$
  - $(S^h M^\ell, M^h S^\ell)$ when
    * $p(1-q)[a^1_{h\ell} - a^4_{h\ell}] < (1-p)q[a^2_{\ell h} - a^3_{\ell h}] + (1-p)(1-q)[a^1_{\ell\ell} - a^2_{\ell\ell}]$ and
    * $pq[b^1_{hh} - b^2_{hh}] + (1-p)(1-q)[b^3_{\ell\ell} - b^4_{\ell\ell}] > p(1-q)[b^1_{h\ell} - b^3_{h\ell}] + (1-p)q[b^3_{\ell h} - b^2_{\ell h}]$
  - $(M^h S^\ell, S^h M^\ell)$ when
    * $pq[a^1_{hh} - a^2_{hh}] + (1-p)(1-q)[a^3_{\ell\ell} - a^4_{\ell\ell}] > p(1-q)[a^3_{h\ell} - a^4_{h\ell}] + (1-p)q[a^1_{\ell h} - a^2_{\ell h}]$ and
    * $p(1-q)[b^3_{h\ell} - b^4_{h\ell}] + (1-p)q[b^1_{\ell h} - b^2_{\ell h}] < pq[b^3_{hh} - b^4_{hh}] + (1-p)(1-q)[b^1_{\ell\ell} - b^2_{\ell\ell}]$
  - $(S^h M^\ell, S^h M^\ell)$ when
    * $pq[a^1_{hh} - a^2_{hh}] + (1-p)(1-q)[a^3_{\ell\ell} - a^4_{\ell\ell}] < p(1-q)[a^3_{h\ell} - a^4_{h\ell}] + (1-p)q[a^1_{\ell h} - a^2_{\ell h}]$ and
    * $pq[b^1_{hh} - b^2_{hh}] + (1-p)(1-q)[b^3_{\ell\ell} - b^4_{\ell\ell}] < p(1-q)[b^1_{h\ell} - b^3_{h\ell}] + (1-p)q[b^3_{\ell h} - b^2_{\ell h}]$
- $[A_\Lambda, B_\Sigma, \sim \varepsilon]$: BNE $(M^h M^\ell, M^h S^\ell)$.

Substantively, these results imply that large firms with high investment in research and development will alter their behavior when facing the prospect of relocating to a country with an expropriative government. In equilibrium, each will prefer to stay and face the cost of tariffs on production rather than face the prospect of expropriation, but will move to a third country if there's no risk of expropriation (type ℓ) for the supply chain diversification benefits.

When considering moving to a non-expropriative government with constrained capacity, two large firms will compete to get the most substantial chunk of the capacity. Firms of both high- and low-R&D types will in general move rather than face tariffs in their original country of production. However, when they are prevented from moving so by the size of their competitor and capacity constraints in the new country, their equilibrium strategy depends on their payoffs and beliefs about the likely type of their competitor firm. In this situation, if a firm thinks it is likely to be the only firm to move, or values the benefits of moving more than it fears exceeding the new supplier country's capacity, it will opt to move if it is high-R&D. Otherwise, it will adopt the $S^S M^\ell$ strategy.

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