Dynamic Impacts of Intermittent Trade Conflicts

on Chinese Manufacturers

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Abstract

This paper examines how intermittent trade conflicts affect production, capital, investment, and exports of Chinese manufacturing firms. We construct a dynamic stochastic model of a representative profit maximizing manufacturing firm that is exposed to intermittent trade conflicts of indefinite duration during which tariffs are imposed on the goods it sells on international markets. We then extend the firm-level model to an industry comprising a large number of heterogeneous firms that differ in size and costs of production, and calibrate the parameters of the model to reflect the stylized facts of Chinese manufacturers between 2005 and 2007. Our model predicts how much industry production and exports, in both the short- and long-run, depend on the severity, likelihood, and expected duration of conflicts. Our model also predicts that if the government desires to fully restore the number of firms that export to the pre-conflict levels, the most efficient policy is to subsidize firms’ investment; if the government desires to restore the percent of industry output exported, subsidizing firms’ entry into the export market is the most efficient. Subsidizing production, however, is always more costly than alternative policy interventions.

Keywords: Exports; Production; Investment; Chinese manufacturers; Trade conflicts; Tariffs.

JEL Codes: C61; C82; F17; O14; O32.
1. Introduction

Globalization has become a topic of great interest among economists in recent years. Operating in global markets not only expands marketing opportunities for firms, it also exposes them to competition and state-of-the-art technologies and practices. As such, exporting can promote economic growth and technological advancement at firm, industry, and national levels. However, exporting imposes additional production and marketing costs on the firm and exposes it to the vagaries of global markets and international trade relations. As a result, only the most productive and diversified firms can afford to export on a large scale (Bernard et al., 2003, 2006; Tomiura, 2007; Wagner, 2007; Bigsten & Gebreeyesus, 2009).

China has experienced tremendous economic development over the past twenty years and has seen dramatic growth in exports, particularly to the United States. However, its path has been punctuated by global trade market disruptions. Perhaps the most momentous is the US-China trade war that erupted in January 2018. In that month, the US government imposed import tariffs on Chinese solar panels and washing machines, followed soon thereafter with tariffs on steel and aluminum. In August, the US government subjected an additional 279 Chinese goods valued at over $16 billion to a 25% import tariff. China retaliated with its own import tariffs on US goods of equal value. In the following month, the US government imposed an additional 10% tariff on $200 billion worth of Chinese goods that increased to 25% by the end of the year. China retaliated yet again by imposing a 10% import tariff on an additional $60 billion of US imports.

The US-China trade conflict profoundly affected trade between China and the US. Figure 1 displays the China-US trade balance, defined as the value of China’s exports to the US less the value of its imports from the US, expressed in billions of US dollars ($), between September 2017 and March 2019. The trade balance had reached a historical peak of $43 billion in October of 2018, but dropped precipitously over the following months as the impact of the trade war began to reach full force. By March of 2019, Chinese net exports to the US had dropped by more than 50% to $20 billion. The US-China trade war has since been punctuated by on-again, off-again negotiations between the two countries, but has generally continued to escalate with additional tariffs imposed by both sides. At present, considerable uncertainty remains regarding prospects for a swift and permanent resolution.
In this paper, we examine how intermittent trade conflicts affect production, capital, investment, and exports of Chinese manufacturing industries. To this end, we begin by constructing a stochastic dynamic model of a representative profit maximizing manufacturing firm that sells part or all of its output on an international market that randomly switches between periods of cooperation and periods of conflict during which the firm is faced with import tariffs imposed by China’s trading partners.

We then extend the firm-level model to an industry comprising a large number of heterogeneous firms that differ in size and costs of production. We calibrate the parameters of our industry model to reflect stylized facts observed from 2005-2007 Chinese manufacturing data. To be specific, we calibrate the model to replicate two key facts: the percentage of firms that export, and the percentage of industry output that is exported. We then perform counterfactual simulations that examine how total industry production, capital, investment, and exports are affected by trade conflicts and how firms’ long-term strategies depend on the potential severity, expected duration, and likelihood of such conflicts. We find that exposure to trade conflicts depresses industry production, capital, investment, and exports in the long run to a degree that is directly related to the expected severity, duration and likelihood of these conflicts.

Source: US Census Bureau.

Figure 1: China–US Trade Balance, September 2017 and March 2019
We also explore alternative means by which the Chinese government might employ subsidies to restore industry exports to pre-conflict levels, including: subsidizing firms’ production by enhancing production technology, subsidizing the export price received by the exporters from the international market, relaxing barriers to access the export market, and subsidizing investment by reducing the firm capital investment cost. We find that if the government prefers to restore the number of firms that export to pre-conflict levels, subsidizing investment is most efficient. If the government prefers to restore the percentage of industry output that is exported to pre-conflict levels, subsidizing entry into the export market is most efficient. Subsidizing firms’ production, however, is always the most costly.

The rest of this paper is organized as the follows. In section 2, we review relevant literature and explain the novel contribution made by our study. In section 3, we develop a stochastic dynamic model of firm decision making under trade conflict uncertainty. In section 4, we describe our data and parameterize our base-case model to reflect recent Chinese manufacturing experience. In section 5, we analyze how the sudden onset of a trade conflict affects an industry, and how the industry recovers when the trade conflict subsides. In section 6, we analyze the how exposure to intermittent trade conflicts affect industry long-run production, investment, and exports, and how these depend on the expected severity, duration, and likelihood of these conflicts. In section 7, we compare alternative government policies for stabilizing the Chinese manufacturing when trade conflicts arise. Section 8 summarizes our findings and suggests directions for future research.

2. Literature Review

There is now an ample and growing literature on how globalization affects firm production, investment and export decisions. Hallward-Driemeier et al. (2002) and Baldwin & Gu (2003) find empirical evidence that firms’ export market entry decisions are positively related to R&D investment and the adoption of advanced technology. Constantini & Melitz (2008), Ederington & McCalman (2008), Atkeson & Burstein (2010), and Lileeva & Trefler (2010) find that firm-level innovation has significantly boosted productivity and exporting over time.

Numerous theoretical and empirical studies have explored the impacts of trade expansion on the dynamics of production, exports, and investment dynamics at the firm and industry level. Aw et
al. (2007, 2008, 2011) analyze dynamic models that explain export decisions made by firms that are heterogeneous with regard to productivity. They find a positive relationship between Taiwanese electronics producers’ choices of export status and investment, and that investment increases with prior exporting experience. Using a panel datasets for Spanish manufacturing firms, Cassiman et al. (2010) and Mañaez et al. (2015) find that product innovation encourages productivity growth and induces productive firms to enter the export market; conversely, they also find that firms that export increase their return to investment in innovation. Bustos (2011) introduces a model allowing firms to jointly decide whether to upgrade technology and export, and found trade liberalization positively influences the performance of Argentinian manufacturers. Rho & Rodrugue (2016) evaluate the impact of Indonesian manufacturers’ investment on their export decisions, and estimate how trade liberalization affects aggregate exports and investments; 10 years after eliminating tariffs faced by exporters, aggregate exports are expected to increase by 19-30%, while the aggregate investment is expected to increase by 1%. Using firm-level data from India, Topalova and Khandelwal (2011) find that tariff reductions significantly boost firm productivity. Hegre et al. (2010) and Vicard (2012) provide empirical evidence that trade agreements significantly reduce the likelihood of trade conflicts between countries.

Numerous studies have explored the economic impacts of trade conflicts at the macro-economic level. The International Monetary Fund (2018) used its Global Monetary and Fiscal Model to perform simulations of the escalating trade disputes between China and found that global GDP will be reduced and that the adverse impacts of tariffs would be greater for the US than for other economies. Using the Asian Development Bank’s Multiregional Input-Output Model, Abiad et al. (2018) estimated the impact of the US-China trade conflict on US, China, and developing Asia’s GDP, employment, and trade flows. They predicted that a full escalation of the trade conflict would decrease China’s GDP by 1%, and US’s GDP by 0.2%; the rest of developing Asia would slightly benefit because of the trade redirection. Rosyadi & Widodo (2018), Li et al. (2018), and Tsutsumi (2018) also analyze the impacts of the US-China trade war and find that both the US and China would experience GDP losses, though other countries might gain from trade diversion; however, globally, losses would exceed gains.

Our paper further examines the impact of globalization and exposure to trade conflicts on firm- and industry-level production, investment, and export decisions, using the experience of Chinese manufacturers as a case study. Our paper makes novel contributions to the existing literature in various ways. First, our model features a fixed cost of entering the market, thus effectively requiring the firm to decide first whether to export, and, conditional on that decision, how much to produce and invest. Our mixed discrete-continuous choice model is thus richer than the many purely discrete choice models found in the literature (Cassiman et al., 2010; Aw et al., 2007, 2011; Bustos, 2011; Máñez et al., 2015). Second, our model allows firms in an industry to be heterogeneous with respect to costs of production. In combination, these two features of our model guarantee that only the largest firms with the lowest costs enter the export market, as is consistent with the stylized facts of Chinese manufacturers. Third, our model allows trade conflicts to be intermittent and of finite, if indefinite, duration, distinguishing it from most other models analyzed in the literature, which assume that trade conflicts are permanent. The assumption that trade conflicts are permanent is convenient, but unrealistic because, in reality, tensions in US-China trade relations vary over time.

3. A Dynamic Model of Firm Production, Capital, Investment, and Export Decisions

Consider a competitive profit maximizing firm that begins each period either as a “nonexporter”, \( i = 0 \), or an “exporter”, \( i = 1 \), with a predetermined capital stock \( k \), and which must decide how much to produce \( q \), how much to invest in new capital stock \( x \), and whether to access the international market the following period, \( i' = 1 \), or not \( i' = 0 \), given that the international market is either in a state of “cooperation”, \( j = 0 \), or in a state of “conflict”, \( j = 1 \).
A non-exporter that markets its output in the domestic market receives a price $p_0$ per unit of output. An exporter that markets its output in the international market receives a higher price $p_1$ per unit of output, if the international market is in state of cooperation. However, if the international market is in a state of conflict, exports are subjected to a pro rata tariff $\tau \geq 0$ that reduces the firm’s price to $p_1(1 - \tau)$.

Trade conflicts are exogenous and intermittent and described by a first-order Markov chain. If the international market is in a state of cooperation this period, it remains in that state the following period with probability $\rho_0$ and enters into conflict with probability $1 - \rho_0$. If the international market is in a state of conflict this period, it remains in that state the following period with probability $\rho_1$ and returns to cooperation with probability $1 - \rho_1$.  

In the short-run, with the firm’s capital stock and export status fixed and the state of the international market given, the firm sells its output at the competitive price $p$ prevailing in its respective market (domestic, if a non-exporter, international, if an exporter), and chooses output $q$ so as to maximize short-run variable profit

$$
\pi(k, p) = \max_q \{pq - C(q, k)\}.
$$

(1)

Here, $C(q, k)$ is the total cost of producing and marketing a quantity $q$, given capital $k$. The firm employs a Cobb-Douglas decreasing returns to scale production technology, with total cost function of the form

$$
C(q, k) = c k^{-\alpha} q^\beta
$$

(2)

where $c > 0$, $\alpha > 0$, and $\beta > 1 + \alpha$. As such, the firm will optimally produce

$$
q(k, p) = \left(\frac{p}{\beta c}\right)^{\frac{\alpha}{\beta - 1}}
$$

(3)

and earn maximum short run profits

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1 Under these assumptions, in the long-run, the international market will spend portion $(1 - \rho_1)/(2 - \rho_0 - \rho_1)$ of its time in a state of cooperation and a portion $(1 - \rho_0)/(2 - \rho_0 - \rho_1)$ of its time in a state of conflict. Moreover, if the international market is in a state of cooperation, it is expected to remain in that state for $\rho_0/(1 - \rho_0)$ additional periods; if the international market is in a state of conflict, it is expected to remain in that state for $\rho_1/(1 - \rho_1)$ additional periods.
\[
\pi(k) = \left(\frac{\beta-1}{\beta}\right)pq(k). \tag{4}
\]

Capital depreciates at a constant per-period rate \( \gamma \in (0, 1) \) and new capital investment \( x \) can be acquired at a constant unit price \( \kappa > 0 \). Therefore, the firm’s capital in the following period is

\[
k' = (1 - \gamma)k + x. \tag{5}
\]

The firm must pay a fixed cost \( K > 0 \) this period in order to access the international market the following period.

The firm maximizes the present value of current and expected future profits discounted at a per-period rate \( r > 0 \). Let \( V_{ij}(k) \) denote the value of the firm conditional on its capital stock \( k \), its export status \( i \), and the state of the international market \( j \). Then, by Bellman's Principle of Optimality (Bellman, 1957), the firm's optimization problem is characterized by the Bellman equation

\[
V_{ij}(k) = \max_{x \geq 0, i' \in \{0, 1\}} \{\pi_i(k, p_i(1 - ij\tau)) - \kappa x - i'K + \delta \sum_{j'=0,1} \rho_{jj'} V'_{ij'}((1 - \gamma)k + x)\} \tag{6}
\]

where \( \rho_{jj'} \equiv \rho_j \) and \( \rho_{jj'} \equiv 1 - \rho_j \) for \( j' \neq j \).

The Bellman equation (6) characterizes the value function \( V_{ij} \) as the functional fixed-point of a strong contraction map with modulus \( \delta < 1 \). As such, the Contraction Mapping Theorem guarantees that \( V_{ij} \) exists and is unique (Royden & Fitzpatrick, 1988). The value function lacks closed form expression, but may be readily computed numerically to any desired degree of accuracy using standard collocation methods (Miranda & Fackler, 2002; Judd, 1998). For this paper, the value function was computed in Matlab using the CompEcon Toolbox that accompanies the Miranda and Fackler book.

### 4. Estimation and Calibration of Model Parameters

Consider now an industry of many firms that are heterogeneous with respect to costs of production, but are otherwise identical. More specifically, assume that all firms in the industry possess the same Cobb-Douglas total cost function (2), with common capital elasticity \( \alpha \) and output elasticity \( \beta \), but different constant multipliers \( c \), which we will refer to simply as the “cost
of production”. Further assume that the costs of production are distributed within the industry lognormally with mean $\bar{c}$ and log standard deviation $\sigma_c$.

In order to specify the parameters of our model, we refer to data published by the National Bureau of Statistics of China. The Bureau regularly conducts the Chinese Enterprise Survey, which annually collects detailed production, investment, trade and other business-related data from over 300,000 firms. The survey produces the largest and most comprehensive firm-level dataset on Chinese manufacturers. We restrict our attention to firms that continuously operated between 2005 and 2007 and which reported valid information on production, capital, investment, and exports during that period. Approximately 29% of these firms are exporters and export 89% of their total production.

Table 1 lists the parameters of our industry model, gives the base-case values used to solve and simulate the model, and the method used to specify these values. The base-case parameters were specified in four different ways. First, we normalized the price of goods marketed domestically $p_0$ to 1. Second, based on the normalization of $p_0$, the estimates of the unit price of goods marketed internationally $p_1$, the mean cost of production $\bar{c}$, total cost function capital elasticity $\alpha$ and production elasticity $\beta$, the per-period capital depreciation rate $\gamma$, and the unit cost of investment $\kappa$, were estimated econometrically using OLS (ordinary least squares) based on equation (1), (2), (4), and (5). Third, the export market entry cost $K$ and the log standard deviation of production costs $\sigma_c$ were calibrated so that the base-case model, when simulated under the naïve assumption that firms do not conceive the possibility of trade conflicts and no tariff is actually imposed, generates long-run ergodic means that replicate stylized facts of Chinese manufacturing firms between 2005 and 2007, namely, 29% of the firms in the industry export and 89% of the total industry output is exported. Fourth, the per-period discount factor $\delta$ was judiciously chosen to agree with values frequently assumed for dynamic models in the economics literature (Costantini & Melitz, 2008; Wu & Miranda, 2015). Since our base-case

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2 The Chinese Enterprise Survey was conducted annually since 1998, and its latest data were released in 2013. However, the survey method employed by National Bureau of Statistics of China has been changed after 2008, and many variables were no longer consistent afterwards. Thus, we chose not to use the data after 2008. Also, the quality of data after 2010 appears suspect (Wei et al. 2017). Therefore, we purposefully chose 2005-07 data that both quantitatively and qualitatively provide sufficient information for our calibration.

3 Notice that in our model, an exporter will export all its production. Therefore, exporters’ production is equivalent to the production exported. Hereafter, we will refer to this variable as “production exported” for simplicity.
model simulates the no-conflict scenario when no firms expect any trade conflicts and no conflicts ever take place, \( \rho_0 = \rho_1 = 0; \tau = 0 \).

### Table 1: Base-case Model Parameters Values and Methods of Specification

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>( p_0 )</td>
<td>Unit price, goods marketed domestically</td>
<td>1.00</td>
<td>Normalization</td>
</tr>
<tr>
<td>( p_1 )</td>
<td>Unit price, goods marketed internationally</td>
<td>1.83</td>
<td>Econometric estimation</td>
</tr>
<tr>
<td>( \alpha )</td>
<td>Total cost function capital elasticity</td>
<td>0.21</td>
<td>Econometric estimation</td>
</tr>
<tr>
<td>( \beta )</td>
<td>Total cost function production elasticity</td>
<td>1.61</td>
<td>Econometric estimation</td>
</tr>
<tr>
<td>( \gamma )</td>
<td>Per-period capital depreciation rate</td>
<td>0.04</td>
<td>Econometric estimation</td>
</tr>
<tr>
<td>( \kappa )</td>
<td>Unit investment cost</td>
<td>3.09</td>
<td>Econometric estimation</td>
</tr>
<tr>
<td>( K )</td>
<td>Export market entry cost</td>
<td>1.01</td>
<td>Calibration</td>
</tr>
<tr>
<td>( \bar{c} )</td>
<td>Mean production cost</td>
<td>0.99</td>
<td>Econometric estimation</td>
</tr>
<tr>
<td>( \sigma_c )</td>
<td>Log standard deviation of production costs</td>
<td>0.35</td>
<td>Calibration</td>
</tr>
<tr>
<td>( \delta )</td>
<td>Per-period discount factor</td>
<td>0.95</td>
<td>Chosen</td>
</tr>
</tbody>
</table>

5. **Short-Run Impacts of Exposure to Trade Conflicts**

In this section, we analyze how the sudden onset of a trade conflict temporarily affects an industry, and how the industry recovers when the trade conflict subsides. We begin by simulating the industry assuming that the industry has settled into a “naïve” long-run equilibrium in which it has been proceeding as if it had no knowledge that trade conflicts were possible. We then introduce the sudden and unanticipated eruption of an international market conflict in year 20, in which a 10% tariff rate (\( \tau \)) is placed on output marketed internationally. The trade conflict lasts 20 periods, after which the market returns to a state of cooperation.

We assume that upon the onset of the conflict, firms in the industry begin to account for a possibility that trade conflicts could continue to arise in the future. Specifically, firms assume that, in the future, if the international market is in a state of cooperation one period, it will remain in that state the following period with probability \( \rho_0 = 90\% \) and enter into conflict with probability 10%; also, firms assume that, in the future, if the international market is in a state of conflict one period, it will remain in that state the following period with probability \( \rho_1 = 90\% \), and will return to cooperation with probability 10%.
Figure 2: Impact of a Baseline Trade Conflict on Industry Exports and Production

Figure 2 illustrates the impact of the sudden onset on the percentage of firms that export (panel a), the percentage of industry output that is exported (panel b), domestic production (panel c), and exported production (panel d). At period 0 and for the subsequent 20 periods, the industry is in its long-run equilibrium “naïve” equilibrium. During this period, 19.1% of the firms in the industry export, while 83.9% of the industry’s production is exported. Moreover, production marketed domestically equals 0.17, and production exported equals 0.88.

When the trade conflict erupts in period 20, the percentage of exporting firms remain unaffected at first, but then begin to decline from period 36, from 19.1% to 14.3%. The percentage of industry output that is exported begins to decline once the conflict starts; at period 36 when the percentage of exporters is at trough, the percentage of exported production drops to its lowest level of 68.2%. Also at period 36, domestic production approaches its maximum (0.28) while exported production approaches its minimum (0.60).

Figure 3 reports the impacts on industry capital (panel a) and investment (panel b). Initially, the capital stock maintains at 0.628 and investment at 0.028 so that new capital stock exactly replaces depreciated stock. At period 36, investment in new capital drops immediately to 0.016, and capital begins to decline slowly at the rate of depreciation until the end of the conflict. Over the whole course of the conflict, industry capital declines 16% from 0.628 to 0.525.
When the trade conflict ends and the international market returns to a state of cooperation in period 40, the industry quickly recovers and restores its initial equilibrium. This is accomplished by massive investment in new capital in the period in which cooperation is restored.

Next we investigate how the industry’s response to a trade conflict varies with the severity of the conflict. Specifically, we compare the impacts of a “mild” conflict that leads to a temporary 5% tariff on exported goods and a “severe” conflict that leads to a temporary 15% tariff on exported goods. As seen in figure 4, the impacts of both mild and severe trade conflicts are qualitatively similar to those of the baseline trade conflict examined above. However, the impacts of the two conflicts differ dramatically in their magnitude. A mild conflict has only negligible impact on the percentage of firms exporting and the percentage of production exported; the former remains stable at 23.8%, while the latter drops only by 1.3%, from 87.4% to 86.3%. Domestic production is not affected, while the exported production drops by 9.7%.

However, in the event of a severe conflict, the percentage of firms exporting drops immediately from 19.1% to 14.3%, and continues to drop to 9.5% at period 35; the percentage of production exported also drops immediately from 83.5% to 66.6%, and eventually reaches a low of 54.7% also at period 35. During this severe conflict, domestic production increases by as much as 93.2%, while exported production drops by as much as 54%.
As seen in figure 5, a mild conflict also affects industry capital and investment less than a severe conflict. With a mild conflict, capital drops by 5.5% and investment drops by 52.3%; with a severe conflict, industry investment instantly drops by 62.7% once the conflict starts, and capital drops by as much as 26.7% by the end of the conflict. Regardless of whether the conflict is either mild or a severe, the industry always quickly recovers once cooperation is restored, led by an initial massive investment in new capital stock.

Figure 4: Impact of Trade Conflicts on Industry Exports and Production, by Severity of Conflict

Figure 5: Impact of Trade Conflicts on Industry Capital and Investment, by Severity of Conflict
6. Long-Run Impacts of Exposure to Trade Conflicts

In this section, we analyze how exposure to intermittent trade conflicts affect the industry in the long run, and how these effects depend on the expected severity, duration, and likelihood of conflicts. Again, the severity of a conflict is measured as the magnitude of the tariff rate. In the long run, the expected duration of a trade conflict equals \( 1 / (1 - \rho_1) \) periods. We also define a conflict’s likelihood as the probability that an international market in a state of cooperation will enter into conflict in the following period, \( 1 - \rho_0 \).

Table 2 reports the long-run (ergodic) means of the percentage of firms exporting, the percentage of production exported, domestic production, exported production, and industry capital stock. The top row reports the ergodic means for key variables of our baseline scenario in which we assume that: a) a conflict leads to a 10% tariff rate; b) a conflict’s expected duration is 10 periods; c) and the probability that an international market in a state of cooperation will enter into conflict in the following period is 10%.

The remainder of table 2 explains how percentage of firms exporting, percentage of production exported, production for domestic market, production exported, and capital vary with the expected severity, duration, and likelihood of conflicts in the long run. More specifically, we vary the severity, expected duration, and likelihood of conflicts relative to the baseline scenario. Conflicts are expected to be milder if they lead to a 5% tariff, and more severe if they lead to a 15% tariff. Conflicts are shorter if they last 5 periods on average, and longer if they last 15 periods on average. Conflicts are less likely if the international market in a state of cooperation devolved into conflict the following with 5% probability, and more likely if it devolves into conflict with 15% probability. In table 2, the numbers in parentheses indicate percentage changes from the baseline scenario results, which are reported in the top row.

<table>
<thead>
<tr>
<th>Baseline Scenario</th>
<th>Percentage of Firms Exporting</th>
<th>Percentage of Production Exported</th>
<th>Production for Domestic Market</th>
<th>Production Exported</th>
<th>Capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline Scenario</td>
<td>18.60</td>
<td>81.95</td>
<td>0.17</td>
<td>0.79</td>
<td>0.60</td>
</tr>
</tbody>
</table>
### Severity of Conflict

<table>
<thead>
<tr>
<th>Severity of Conflict</th>
<th>Less Likely</th>
<th>More Likely</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milder</td>
<td>23.81</td>
<td>18.52</td>
</tr>
<tr>
<td>More Severe</td>
<td>16.24</td>
<td>17.88</td>
</tr>
<tr>
<td>Duration of Conflict</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shorter</td>
<td>23.56</td>
<td>17.88</td>
</tr>
<tr>
<td>Longer</td>
<td>17.88</td>
<td>18.52</td>
</tr>
<tr>
<td>Likelihood of Conflict</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less Likely</td>
<td>22.84</td>
<td>18.52</td>
</tr>
<tr>
<td>More Likely</td>
<td>18.52</td>
<td>18.52</td>
</tr>
</tbody>
</table>

#### Severity

The severity of conflicts has the most significant impact upon exports and production. Compared to the baseline scenario, with milder conflicts, the percentage of firms that export is 28.0% greater; the percentage of production exported is 6.0% greater; the quantity produced for the domestic market is 15.3% lower; the quantity produced for the export market is 23.7% greater; and average firm capital is 20.6% greater. In contrast, with a more severe conflicts, the percentage of firms that export is 12.7% lower; the percentage of production exported is 5.8% lower; the quantity produced for the domestic market is 15.2% greater; the quantity produced for the export market is 14.2% lower; and average firm capital is 9.7% lower.

#### Duration

Less dramatic outcomes obtain when we vary the expected duration of the trade conflict. Compared to the baseline scenario, with shorter conflicts, the percentage of firms that export is 26.6% greater; the percentage of production exported is 5.4% greater; the quantity produced for the domestic market is 13.7% lower; the quantity produced for the export market is 20.8%
greater; and average firm capital is 18.5% greater. In contrast, with longer conflicts, the percentage of firms that export is 3.9% lower; the percentage of production exported is 1.6% lower; the quantity produced for the domestic market is 3.5% greater; the quantity produced for the export market is 5.1% lower; and average firm capital is 3.5% lower.

**Likelihood**

The smallest outcomes are detected when we change the likelihood of a trade conflict. Compared to the baseline scenario, with less likely conflicts, the percentage of firms that export is 22.8% greater; the percentage of production exported is 4.5% greater; the quantity produced for the domestic market is 9.7% lower; the quantity produced for the export market is 18.4% greater; and average firm capital is 16.8% greater. In contrast, with more likely conflicts, the percentage of firms that export is 0.44% lower; the percentage of production exported is 0.51% lower; the quantity produced for the domestic market is 0.44% greater; the quantity produced for the export market is 2.36% lower; and average firm capital is 1.43% lower.

7. **Policy Measures**

As demonstrated in the preceding sections, intermittent trade conflicts that lead to increased tariffs on exported goods will have significant impacts on export manufacturers: the percentage of firms exporting, the percentage of production exported, capital stock and investment can drop dramatically during a conflict, and dramatically so if the tariffs are large. In this section, we explore alternative responses by the government to counteract the impacts of these tariffs.

We examine four possible government policy responses: raising the price received by exporters, reducing the costs of production, reducing the entry costs of entering the export market, and reducing the cost of investment. The actual means by which these measures can implement are varied, but will generally involve subsidies. For example, to reduce production costs, the government could subsidize exporters’ production by subsidizing the adoption of advanced production technologies. To reduce the fixed costs of entering the export market, the government could lower the costs of obtaining an export license, help firms search for new international markets, and offer government funded professional training to prepare firms for global competition. To increase investment and maintain capital stock, the government could offer investment credits, subsidize research and development, or reduce capital gains taxes.
To explore these policy alternatives, we determine how much the unit investment cost ($\kappa$), the export market entry cost ($K$), the export price ($p_1$), or the mean production cost ($\overline{c}$) would need to be reduced to restore industry exports to base-case levels – namely the percentage of firms exporting is restored to 29%, or the percentage of production exported is restored to 89%. We then compute total subsidies required. Four subsidies were computed respectively: a) subsidizing the cost of capital investment; b) subsidizing the cost of entering the export market; c) subsidizing the export price; d) and subsidizing production costs.
| Subsidies Required to Restore Exports to Pre-Conflict Levels by Severity, Duration, and Likelihood of Trade Conflicts as Percentages of Pre-Conflict Average Industry Annual Revenue | To Restore Percentage of Firms Exporting | To Restore Percentage of Production Exported |
|---|---|---|---|---|---|---|
| | Subsidizing Investment | Subsidizing Export Entry | Subsidizing Export Price | Subsidizing Production | Subsidizing Investment | Subsidizing Export Entry | Subsidizing Export Price | Subsidizing Production |
| Baseline Scenario | 5.0% | 6.7% | 10.5% | 13.5% | 12.4% | 7.8% | 8.9% | 18.3% |
| Severity of Conflict | | | | | | | | |
| Milder | 4.1% | 5.1% | 6.7% | 11.0% | 7.0% | 1.6% | 4.8% | 9.8% |
| More Severe | 7.9% | 8.9% | 19.6% | 21.0% | 31.2% | 12.8% | 19.3% | 34.4% |
| Duration of Conflict | | | | | | | | |
| Shorter | 4.7% | 6.0% | 9.9% | 12.3% | 5.6% | 3.9% | 4.8% | 9.4% |
| Longer | 6.2% | 7.4% | 16.2% | 17.2% | 17.7% | 9.1% | 13.1% | 21.1% |
| Likelihood of Conflict | | | | | | | | |
| Less Likely | 4.5% | 5.1% | 7.9% | 11.3% | 10.7% | 5.0% | 6.5% | 12.0% |
| More Likely | 6.0% | 7.9% | 14.4% | 16.7% | 16.5% | 8.7% | 11.6% | 20.7% |
Which policy is least costly depends on the government’s priorities. Table 3 presents the total government subsidies required to reverse the effects of trade conflicts, expressed as a percent of pre-conflict average annual industry revenue. As seen in table 3, under our baseline scenario, to restore the percentage of firms exporting, one would need to subsidize investment by 5.0% of industry revenue, subsidize export market entry expenses by 6.7% of industry revenue, subsidize the price received by exporters by 10.5% of industry revenue, or subsidize production costs by 13.5% of industry revenue. To restore the percentage of production exported, one would need to subsidize investment by 12.4% of industry revenue, subsidize export market entry expenses by 7.8% of industry revenue, subsidize the price received by exporters by 8.9% of industry revenue, or subsidize production costs by 18.3% of industry revenue. Thus, if the government wishes to restore the number of firms exporting, subsidizing investment is notably less expensive, or more efficient than other policy alternatives. Subsidizing firms’ entry into the export market is the second most efficient policy, while subsidizing production is the least. However, if the government wishes to restore the percentage of industry output exported, subsidizing export market entry is the most efficient; subsidizing the export price is the second most efficient, while subsidizing production is again the least.

We further examine the subsidies needed to restore exports to base-case levels under varying assumptions regarding the expected severity, duration, and likelihood of trade conflicts. As seen in table 3, the subsidies required to fully restore industry exports to pre-conflict levels rise as the conflicts become more severe, longer, or more likely. As we compare across different policy interventions, it is clear that restorative subsidies applied to production costs are always the greatest, regardless of the expected severity, duration, and likelihood of conflicts. Under all scenarios, if the government wishes to restore the number of exporters, subsidizing investment is most efficient; if the government prefers to restore the percentage of output exported, subsidizing export market entry costs is most efficient. Subsidizing production is always the least efficient policy intervention to fully recover an industry from a trade conflict.

8. **Summary and Conclusion**

In this paper, we examine how intermittent trade conflicts affect production, exports, capital, and investment among Chinese manufacturing firms. We construct a dynamic stochastic model of a representative profit maximizing firm that is exposed to intermittent trade conflicts of indefinite
duration during which tariffs are imposed on the goods it produces and sells. We then extend the firm-level model to an industry comprising a large number of heterogeneous firms that differ in size and costs of production, and calibrate the parameters of the model to reflect the stylized facts of Chinese manufacturers between 2005 and 2007.

We use our model to examine how the onset of a trade conflict that causes export tariffs to be imposed dynamically affects the path taken by the industry during the conflict and after its conclusion. We find that trade conflicts cause investment to drop dramatically and capital to slowly decline at the rate of depreciation. As such, production and exports decline until they reach a new, but temporary bliss point. However, once the trade conflict ends, production, exports and investment are quickly restored to non-conflict levels through massive restorative investments in capital.

We also find that alternative government policies to mitigate the adverse impacts of trade conflicts can differ significantly in their cost effectiveness. Among the various government policies examined, we find that subsidizing firms’ production is less efficient than subsidizing export price, reducing the fixed costs of entry into the export market, or promoting capital investment. More importantly, if the government’s priority is to restore the number of the exporters, subsidizing firms’ investment is most efficient; if the priority is to restore the percentage of output exported, subsidizing firms’ entry into the export market is the best.

Of course, the most significant, if obvious, conclusion that can be drawn is that countries should make efforts to avoid trade conflicts altogether. An increase in export tariffs due to a trade conflict can have profound adverse impacts on export industries, causing them to reduce production and investment, as well as having serious adverse effects on employment. Tariffs no doubt cause significant impediments to globalization and national economic development. In an age of globalization, the importance of negotiations to ease political and economic tensions to avoid trade conflicts becomes increasingly important.

Our study opens new avenues for potentially useful future research. For example, in this study we focus exclusively on the supply-side of the market. But trade disruptions can also affect demand-side, and should be explored further. Another possible extension of the current paper would be to introduce idiosyncratic production shocks faced by individual firms. Our model
could also be adapted to allow for firms that simultaneously produce for both the domestic and export markets.

References


