

ECONOMIC INTERDEPENDENCE, TRADE, AND WAR: A THEORETICAL AND EMPIRICAL ANALYSIS

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Abstract

The debate within International Relations between liberals and realists on economic interdependence and war is still largely unresolved, both theoretically and empirically. This thesis provides a simple formal model to highlight the problems of the liberal argument that war is less likely due to the future loss of trade. According to liberals, economic interdependence increases both the likelihood and size of trade flows, and subsequently decreases the likelihood of war. Although our model can support the liberal argument, we show that the pacifying effects of economic interdependence are extremely contingent on a set of other factors, stemming from realist theory. In addition, we test empirically whether economic interdependence leads to peace or war using two data-sets. We find mixed evidence of the causes of war; in the short-term before a war, we find that bilateral trade decreases the likelihood of a war. On the other hand, we find evidence for the realist hypothesis that wars are preceded by increasing trade-flows when we look at the longer trend before a war. In addition, we find evidence for less bilateral trade flows after a war than otherwise, supporting the idea that war has a future opportunity cost. Our analysis of the relationship between trade and international conflict in the whole world shows that the amount of yearly Militarized Interstate Disputes are correlated with yearly trade flows. We find that in general, evidence points us to liberal theory when it comes to economic interdependence and war, but we also find evidence that the effect of interdependence may be contingent on several factors.

Keywords: economic interdependence; trade; war; liberalism; realism; game theory; prisoners' dilemma; international relations; military conflict

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List of Abbreviations

Abbreviation	Meaning
ADF	Augmented Dickey Fuller
AIC	Akaike Information Criterion
Δ	First Difference
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
HAC	Heteroskedasticity- and Autocorrelation Consistent
I(x)	Integrated of Order (x)
IR	International Relations
L	Liberalism
LHS	Left Hand Side
MID	Militarized Interstate Dispute
OLS	Ordinary Least Squares
PD	Prisoners' Dilemma
PWT	Penn World Table
R	Realism
R ²	R-squared
RHS	Right Hand Side

Foreword

With great pleasure have I worked on this thesis. From the start, I was genuinely interested in finding an answer to the research question of this thesis. I find it fascinating how economics affects political relations, and in particular in the field of conflict in the international realm. As a strong supporter of the free market, I was strongly biased toward the liberal view that economic interdependence and trade must always lead to peaceful co-existence. Now, after writing this thesis, I am more nuanced in this view and genuinely accept that under certain conditions there is no pacifying effect of economic interdependence, and I believe that it may even be the case that economic interdependence increases the likelihood of conflict. I hope the thesis brings new ideas to the reader and that the reader will above all enjoy it.

Before we start off with the thesis, I would like to give thanks to all the people who have supported me in writing this Master thesis. First and foremost, I would like to thank my supervisor Prof. dr. Markus Haverland for being readily available and patient at all times, and for always being critical on my argumentation. Without him, I would not have been able to deliver this thesis in this state. I would also like to thank my second reader, dr. Peter Marks for a number of useful critical comments. Moreover, I would like to thank several of my friends and fellow students; Alicia McNeill, Jeannine van Reeken, and Stein Trimbos, for providing useful comments and ideas at certain stages. Additionally, I would like to thank my parents and sister for providing the necessary support in working on this thesis.

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“... The peculiar action of Competition is to render general what was before exclusive. ... Thus, advantages and disadvantages, that have any permanence only glance upon individuals, classes, or nations. Their providential destination in the long run is to affect humanity at large, and elevate or lower the condition of mankind. Hence to envy a certain people ..., is to overlook the advantages in which we are called to participate. ... Hence national jealousies are not only perverse feelings—they are absurd. To hurt others is to injure ourselves. To place obstacles in the way of others—tariffs, coalitions, or wars—is to obstruct our own progress. Hence bad passions have their chastisement just as generous sentiments have their reward.”

— Frédéric Bastiat (1850, pp. 771-772)

1 Introduction

In a recent dispute over the use of the Nile river, the Egyptian and Ethiopian states disagreed over whether Ethiopia has the freedom to build a dam. The dam would dramatically decrease the water supply to the downstream state Egypt. For Egyptian politicians — unaware that their meeting was broadcasted live — this was a reason to openly discuss the options of war and/or sabotage of the dam to ensure that enough water is supplied. Even in the 21st century, states still care about economic resources, and they care enough about them to consider war. As the case shows, war over economic resources is not a historical artifact, but it still motivates state behavior.

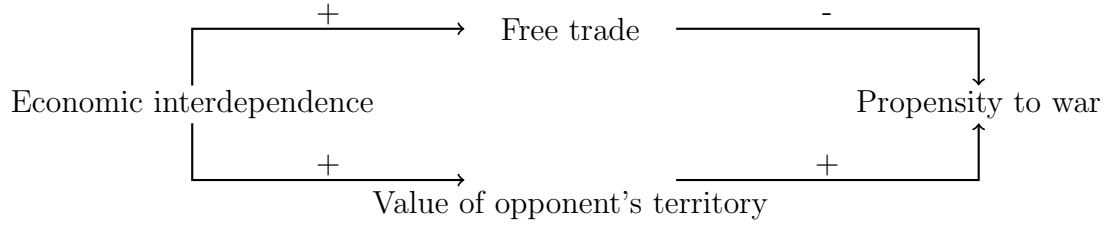
States can have different kinds of relationships. Their relationship can be characterized by low and high economic interdependence. This may affect a state's decision to trade with the other state, and also the decision to go to war with the other state. The mainstream liberal idea is that economic interdependence leads to peace, however, the Egyptian-Ethiopian dispute over the Nile dam shows that high economic interdependence provides a reason to consider war.¹ Saying that economic interdependence always leads to peace is a statement that is too simple. The causal relationship is much more complex. However, to start the thesis, we provide the simple research question as a point of departure: *“Does economic interdependence lead to less inter-state wars?”*

The main proposition of this thesis is that economic interdependence can have different effects on the likelihood of war, depending on which assumptions hold. On the one hand, economic interdependence increases the profitability of free trade, which subsequently reduces incentives for war. On the other hand, economic interdependence means that the value of the opponent's territory goes up, and since wars are often about the obtainment of territories,² this will increase the propensity to war. We will discuss this in further detail in the theoretical framework. The flow chart presented below is by no means exhaustive, but it is a first rebuttal against the idea that economic interdependence only has pacifying effects.

To be sure, a state's decision to go to war in general has a high degree of societal relevance, as a state uses a lot of resources to go to war and many individuals (both soldiers and civilians) die as a result of military conflict. When we know whether economic

¹It may be the case that dependence is not symmetrical; we will discuss the distinction between dependence and interdependence, and its consequences, in a later stage.

²Fearon, 1995

Figure 1: Flow Chart: Economic Interdependence and War

interdependence leads to war or peace, this can alter a state's future decision-making. If states prefer peace over war, it follows that they can alter their relationships with other states in order to prevent war. In some occasions, states can alter the domestic economy in order to become more self-sufficient. By using protectionism to help domestic producers, a state ensures that a number of economic resources are available without the need to import them. This thesis will provide an informative answer to the question of whether this is positive for the likelihood of peace.

In addition, the thesis has theoretical relevance, as the debate on economic interdependence and war is still largely unresolved. Liberalism and (neo-)realism as two of the main International Relations (IR) theories, have diametrically opposed standpoints with regard to economic interdependence and war.

In order to answer our research question, we provide a detailed theoretical framework. First we explain what economic interdependence is and how it affects a state's decision to trade with the other state, and how it affects its decision to use military aggression against the other state. We will primarily focus on the perspective of the (potential) aggressor. Note that we do not provide a full theory of war, but we rather provide arguments to show how economic interdependence affects the decision to go to war.

Furthermore, we provide a thorough explanation of both the liberal and the realist thesis. In our thesis, we provide a game theoretical model that explains the strategical relationship between economic interdependence, trade, and war. We use the Prisoners' Dilemma (PD) framework to make a connection with the liberal and realist thesis on the one hand, and game theory on the other hand. A game theoretical model aids our purpose of contrasting both IR-theories. By contrasting both theories, we obtain a deeper understanding of their different expectations. In the formal model, we show that liberal and realist arguments correspond to the PD framework. In addition, by using the model we explain that economic interdependence has an effect on a state's payoffs and strategy in the 'trade-game' and in the 'war-game'. We show that the likelihood of peace (cooperation in the PD-framework), depends on the number of players in the game, time preference, the threat of elimination, uncertainty about the opponent's type, and relative gains. In the iterated PD, when the opponent uses a conditional cooperative strategy, cooperation is only an equilibrium outcome when peace is valued more than war, also taking into account future pay-offs. Going to war and succeeding provides some short run benefits and some long run costs, so that a state's subjective valuation of the costs, benefits and time determines whether a state prefers peace or war.

Afterwards, we provide an empirical strategy in order to empirically test whether economic interdependence leads to peace or war. We give a list of all the variables we use for our statistical analyses. We then collect the data and analyze the results, connecting them with the theoretical framework, in order to conclude which of the two theories has more explanatory power for our data.

The structure of the thesis is as follows. In the next section (2) we provide a literature review of empirical studies on economic interdependence and war. Afterwards, in sections (3) and (4) respectively we provide a theoretical framework to show the liberal and realist arguments and we develop a game-theoretical model in order to contrast both theories. The non-mathematical reader can skip the mathematical parts and will only suffer marginal disadvantages. There is a summary provided at the end of section (4), which contains a brief description of the main results of the model. In section (5) we develop the research design for the empirical part of the thesis. In section (6) we provide the results of the empirical study. In section (7), we summarize and discuss these results and we end with a conclusion, where we also discuss the limitations of the research and provide some ideas for future research. In the final section (8) we provide a reflection on some of the main issues of the thesis.

2 Literature Review

There exists a vast amount of literature on economic interdependence, trade, and war, which is still being developed at this point in time, indicating that it still is a popular and unresolved issue. Most empirical studies find that more economic interdependence and more trade leads to fewer wars and less militarized interstate disputes.³ Scholars have developed many statistical methods to identify the sign of the effect of interdependence and trade on war. Most research takes dyads (a group of two states) or monads (one state) as the units of analysis, but there are also scholars who look at the effect of world trade on the total amount of military conflicts in the world.

The majority of research on this topic uses trade volumes to be able to draw conclusions about economic interdependence. Although trade is not the same as economic interdependence, it is used as a proxy for the concept. A recent study by Harrison and Wolf (2012) shows with an empirical study that an increase in openness — which is the total amount of world imports and exports divided by Gross Domestic Product (GDP) — does not lead to a decrease in wars. It has no effect on wars at all. They rather find that an increase in the total amount of states leads to an increase in the number of wars. The level of democratization of the world, and the level of globalization have no effect on the likelihood that a war takes place in any given year between 1870 and 2001.

A possible problem of using the world as the unit of analysis however, is that data is highly aggregated. Any theoretical hypothesis on economic interdependence and war is almost always based on causal relationships between different states, and not based on the world as a whole. If no statistically significant relations are to be found using a global data-set, this does not necessarily mean that the same holds for more dis-aggregated data-sets, such as monadic and dyadic data-sets. It may well be that wars take place in areas where globalization has not taken place, while areas in the world where globalization *does* take place experience relative peace. In a global data-set, such differences may cancel out, which means that although in some areas economic interdependence does have an effect, this effect is not observable from the results of a global data-set. Monadic and dyadic data-sets are therefore more valuable in terms of precision.

The overwhelming majority of research on trade and war uses the fraction of bilateral trade with respect to the sum of the GDPs of both states within a dyad. Oneal, Russett

³A Militarized Interstate Dispute (MID) is an event where one or more states threaten, display or use force against one or more other states. For more details, see Ghosn et al (2004).

and Berbaum (2003) find that economically important trade reduces the likelihood of dyadic militarized disputes. The authors use a data-set which contains dyad-year observations from 1885-1992. The research contains an empirical analysis with distributed lags.⁴ In addition, Oneal *et al.* (2003) find that disputes also reduce the amount of trade. Oneal and Russett (1999) do a similar analysis, using a data-set from 1950-1992. They find no statistically significant relationship between trade and military disputes for *all* dyads, but they do find such a relationship for politically relevant dyads, which are defined as dyads with at least one major power, or with two contiguous states. Moreover, Hegre, Oneal and Russett (2010) also find that trade does promote peace, using a yearly dyadic data-set with data from a time-span of 115 years (1885-2000). Polachek (1980) also finds that trade leads to peace using a ten-year thirty-country cross section data-set from four separate data sources. He finds a negative relationship between conflict and trade; countries with the greatest levels of economic trade are the least hostile. On average, a doubling of trade leads to a 20% decrease of belligerence.⁵ The relationship appears to be very robust after taking several statistical adjustments for causality. Polachek, Robst and Chang (1999) also examine the relationship between trade and peace, and find that — controlling for foreign aid, tariffs, contiguity and relative country size, as they affect the gains from trade — that more trade leads to peace. In a study using data between 1950 and 1992, Gelpi and Grieco (2008) find that trade integration leads to less international conflict. This negative effect is however contingent on the internal structure of the states, as democratic states experience less wars due to trade, but autocratic states do not. Similarly, Martin, Mayer, and Thoenig (2008) find that regional and bilateral trade agreements which foster regional and bilateral trade flows have positive consequences for political relations, so that these relations are more peaceful. They also find that bilateral and multilateral trade flows have different effects. Bilateral trade decreases the opportunity cost of war, while multilateral trade increases the likelihood of war, as an increase in multilateral trade is accompanied with a decrease in bilateral dependence.

There are however also articles who raise doubt about these pacifying effects of economic interdependence. One of the more influential empirical articles comes from Barbieri (1996). She finds that more dyadic trade leads to an increase in the likelihood that a dyad falls into a militarized dispute. Using an extremely large data-set, with data between 1870-1938 and over 14,000 observations (dyadic years), she finds that trade does not have any effect on the likelihood of war, but does have an effect on the likelihood of a MID to take place. Surprisingly, dyadic trade flows have a curvilinear effect on MIDs, more trade leads to more MIDs. Higher economic interdependence, both symmetrical and asymmetrical leads to more MIDs, even after controlling for contiguity, regime type, relative capabilities and alliance commitments. In the same way, De Vries (1990) finds that there exists a curvilinear relationship between interdependence and conflict. Interestingly, this relationship does not only hold for economic interdependence, but also for political/military, institutional, and diplomatic interdependence. Additionally, Gasiorowski (1986) finds that interdependence has mixed consequences, stating that the sign of the relationship is extremely dependent on which statistical technique is chosen, meaning that any positive or negative findings are not robust.⁶

The level of bilateral or multilateral trade is not the only independent variable which

⁴This method entails that different lags of the variables (i.e. earlier data-points) get different weights.

⁵This means that, on average, a doubling of trade will reduce the amount of dyads which are in conflict.

⁶See Barbieri and Schneider (1999a) for another survey of empirical literature on economic interdependence, trade, and war.

is used as a proxy for economic interdependence, there are also several other variables. Bussmann (2010) for example, looks at foreign direct investment (FDI) as a proxy for economic interdependence. She finds that an increase in FDI-flows leads to a decrease in the amount of MIDs between 1980 and 2000. The research is done on the monadic and dyadic level and accounts for the endogeneity bias (reverse causality) so that the causal relationship is that FDI leads to less MIDs, and not the other way around. The same result is found by Gartzke *et al.* (2001), who show that capital interdependence has pacifying effects, regardless of democracy, trade, interest, and other variables. Some argue that it is not trade-flows which lead to peaceful interaction, but rather the height of tariffs. McDonald (2004) finds that trade-flows do not necessarily result in peace, but rather the level of freedom to trade that exists. *Free* trade, rather than trade alone, reduces military conflict between states. Free trade however cannot be taken as a proxy for economic interdependence, as it is a result of governmental policy, rather than economic activities of nations. Economic interdependence can still be high, even if one day a government decides to ban all trade with another country. The most recent research that we review, by Caselli, Morelli and Rohner (2013) is also the most interesting. Their independent variable comes closest to what economic interdependence really is. The authors start with a game theoretical model which looks at a situation with two players who both control half of the world's territory. Both players (i.e. countries) can decide to engage in a war, which may alter the location of the border. If a war is successful, a natural resource (in this case, oil resources) may be won, while if it is unsuccessful, the resource is not won, or even lost. The authors deduce from the model that both asymmetry of the possession of oil resources and the proximity of the oil resources to the border lead to an increase in the likelihood of a MID and war. They proceed to empirically investigate their model and find that their hypotheses are indeed correct and parameter estimates are statistically significant. When at least one country has natural resources, and when these resources are closer to the border, violent conflict is more likely to occur in the post-World War Two era. The discovery of oil is highly exogenous to a state's decision to go to war, so that any statistically significant effect that is found has an extremely small likelihood to be spurious.

An additional element that is important for trade to have a pacifying effect is that trade-flows are reduced after a war has taken place. Otherwise, there is no theoretical reason for trade to be important (we will come back to this below). Most articles find that bilateral trade-flows decrease after a war (e.g. Oneal *et al.* (2003)), but Barbieri (1999b) finds the opposite. Looking at seven dyads, she finds that war does not result in less trade in some occasions. At best she can find a temporary decline, but no permanent one. The sample size in Barbieri (1999b) is however not particularly large, so that her conclusion is not very strong.

3 Theoretical Framework

Now we move to the theoretical part of this thesis. Before we explain liberalism and realism in more detail, it is helpful to show how economic interdependence affects interaction in a simple economy. We use the concept of the Crusoe economy, which is commonly known in economics as a small society with one individual on an island who faces decision-making under scarcity. In a Crusoe economy it is also common to add another individual to see how this affects decision-making. Although a Crusoe economy

is an abstraction from the real economy, due to its simplicity, its conclusions can be very strong. It can explain that cooperation arises even between individuals who are very dissimilar in productive capabilities; even when one person is much better at producing everything, everyone can gain by dividing and coordinating labor. Our goal in the next subsection is to show how and why players choose to trade or to use violent aggression in a simple economy. Taking a Crusoe economy as a starting point, we can also say something about more complex situations.

3.1 Crusoe Economics

In a simple Crusoe framework with two individuals on an island, we can deduce many elementary aspects in the relationship between economic interdependence, trade and aggression. Let us imagine an economy with two individuals, Crusoe and Friday. Under what conditions will both individuals choose to trade? First, there must be a situation where there is a division of labor. Both individuals must specialize in the production of different goods. Specialization occurs for one or more out of the following three reasons:

*(a) differences in suitability and yield of the nature-given factors; (b) differences in given capital and durable consumers' goods; and (c) differences in skill and in the desirability of different types of labor.*⁷

If differences exist in any of the three above factors, then the value of participating in the division of labor increases. The division of labor and specialization lead to an increase in the total amount of produced goods. Both parties should in principle be able to benefit from this increase in production. A choice for self-sufficient production is possible, but must by definition lead to a decrease in welfare. When labor is divided over more individuals and over a larger range of goods, economic interdependence is said to be relatively high. The mutual benefits thus increase along with the level of economic interdependence.

In a system where labor is divided over multiple individuals and mutual benefits are achieved due to voluntary exchange, there is a major incentive for potential aggressors to restrain aggression. Individuals decide that the benefits of specialization and voluntary exchange outweigh the advantages that war might bring. In the simple Crusoe economy with two goods (e.g. fish and berries), where production is repeated (i.e. Crusoe and Friday produce goods repeatedly instead of merely once), war brings about a major opportunity cost. When Crusoe decides to attack Friday, and Crusoe wins the attack, Friday will simply decide to end all future relations.⁸ Friday knows that whatever he produces might simply be lost again due to Crusoe's aggression. When economic interdependence is high, the value of the opportunity cost increases for multiple reasons.

First, Friday will cease all exchanges of goods with Crusoe and will move to self-sufficient production. If economic interdependence is high, e.g., if Friday is much more efficient in the production of berries, then Crusoe incurs a relatively high cost. Crusoe will no longer reap the large mutual benefits of specialization.

Second, due to the first reason, Crusoe himself must produce all his desired goods himself. The argument runs similarly to the previous one, when economic interdepen-

⁷Rothbard, 2009: p. 95

⁸If Crusoe's attack leads to Friday's death, Crusoe obviously also incurs future losses, as Friday is no longer able to produce.

dence is high, and Crusoe is far worse than Friday in the production of berries, he no longer reaps these benefits and must be content with a smaller amount of berries.

A third reason is that aggression induces a set-back in the natural decrease in the rate of time preference.⁹ Friday moves his productive activities away from berries and capital goods to aid production, to production of defensive goods, in order to defend his production. Again, when economic interdependence is high, this set-back in the decline of time preference is more costly than otherwise.¹⁰

In sum, in a simple economy as the Crusoe economy, we are able to show that war is a worse option when economic interdependence is high, than when economic interdependence is low. It is also important here that there is *interdependence*, rather than simple dependence. If Crusoe depends on Friday, but Friday does not depend on Crusoe, then Friday's incentive to use violent aggression is not reduced, due to the lack of dependence. Using aggression does not bring about a long-run opportunity cost, hence, the division of labor only brings about an increase in production, but not a decrease in aggression.

3.2 Private Individuals and States

The implications of Crusoe economics are however based on an analysis of individuals rather than states. There are naturally some important distinctions between states and private individuals.¹¹ Firstly, a state is a territorial monopolist of ultimate decision-making and of taxation. As such, it has different incentives and constraints than private individuals. A territorial monopolist derives his income from taxation while a private individual must generally do so by working and trading. As the benefits of trade are more important for private individuals than for states, it follows that states are less constrained by the 'opportunity cost' of aggression than private individuals. Also, a state is more able to be self-sufficient. It may survive in such an occasion, while a private individual is generally not able to produce all his desired goods himself, and he must have a certain degree of luck when it comes to production endowments in order to be able to produce a minimal amount of goods necessary for sustenance. In addition, we believe that contemporary states (especially democratic ones) must have higher degrees of time preference than private individuals. A government's ownership of the state's 'capabilities' is not secure in the long run, as they may always lose in an election or they may be deposed by the people. Hence, politicians and civil servants within government must see themselves as mere care takers, rather than individuals with ownership of a good. The lack of ownership of the state's capabilities implies that it cannot be sold in the market, and it implies that one cannot take the 'long view.' In that case, one is more present oriented and will maximize current income rather than a combination of current income and the capital value of a good.¹² We have shown before that a decrease in time preference (being more patient) has a positive impact on the likelihood of peace. Economic theory predicts that governments must have short time horizons, and because

⁹Hoppe (1994, p. 323) argues that there is tendency for time preference rates falling to zero. This is caused by the fact that saving and investing lead to a higher amount of goods (otherwise an individual would not invest), further decreasing his future rate of time preference.

¹⁰Hoppe (2007, p. 11) explains this with respect to a different type of aggressive activity, namely crime.

¹¹We will however stick with our Crusoe analysis, as we believe that in general, the results will be very similar to the analysis of states, which we will explain in more detail in the next subsection, and in our model.

¹²Rothbard, 2009, pp. 956-957

of this, they are more likely to be aggressive. They will take the long-run costs of warfare less into account, so that economic interdependence will not have such large pacifying influences relative to private individuals.

3.3 Economic Interdependence

We move away from a Crusoe analysis to an analysis of nations and states. In international relations, economic interdependence is symmetrical economic dependence between countries. Consumers and producers depend on the economic activities in foreign areas if economic dependence is high. Keohane and Nye (1977) distinguish sensitivity and vulnerability; the former entails the size of the effect of economic activities in the one country on the other. The vulnerability dimension of interdependence entails the availability and costliness of the alternatives that actors face. A state is vulnerable when it has no alternative to trade with a certain state.¹³ We mostly focus on the vulnerability aspect. Economic interdependence is said to be beneficial as it brings the mutual benefits in the way we explained above. In an interdependent system, states will tend to avoid conflict, as they are vulnerable and the punishment imposed by other states is more severe.

In this light, we will review the realist and liberal thesis with regard to economic interdependence, trade and war. Realists emphasize that economic interdependence must lead to war, while liberals point to the beneficial long-run implications of economic interdependence. It is thus necessary to understand that economic interdependence has implications for both wealth and power.¹⁴

3.4 The Realist Thesis

According to neorealists, trade and economic interdependence lead to war.¹⁵ The main thesis of the neorealists is portrayed by the following quote of Kenneth Waltz:

*“(...) close interdependence means closeness of contact and raises the prospect of occasional conflict. (...) Interdependent states whose relations remain unregulated must experience conflict and will occasionally fall into violence. If interdependence grows at a pace that exceeds the development of central control, then interdependence hastens the occasion for war.”*¹⁶

States thus avoid becoming economically dependent, as such dependency results in great risks. Especially the last sentence of the quote above shows the central point of neorealism. If interdependence grows beyond a state's control, then the likelihood of war increases, as when interdependence grows too swiftly, a state's future is at stake. This is especially costly for states, as they ultimately care about their survival according to Waltz:

*“Because states are in a self-help system, they try to avoid becoming dependent on others for vital goods and services.”*¹⁷

¹³Keohane and Nye, 1977, pp. 10-13

¹⁴Katzenstein *et al.*, 1998, p. 684

¹⁵The classical realist position is that economic interdependence is part of low politics and therefore does not matter for a state's decision-making. We will primarily focus on the neorealist position however.

¹⁶Waltz, 1979, p. 138

¹⁷Ibid., p. 155. Similarly, Waltz (p. 107) argues that states do not voluntarily put themselves in a dependent situation, and he argues that the issue of security subordinates economic (i.e. welfare maximizing) to political interest.

The goal of survival must precede any other goal. Economic welfare has no importance when the threat of extinction is present. Because of this, economic interdependence is not as important as military goals.¹⁸ When those vital goods and services are no longer secure, a state faces great difficulties in surviving, hence such a situation must be prevented.

3.4.1 The Desire for Autarky

Neorealists thus point to the fact that economic interdependence brings great costs to a state. In an increasingly interdependent system, states increasingly lose autonomy over their territory. Additionally, they depend on access to foreign markets and on foreign sources of raw materials. Due to the fact that economic ties are closely knit, financial crises and other problems in other countries have a greater impact on the own country.¹⁹ In addition, economic interdependence means that a state *depends* on another state. This is very costly, because this means that at any point in time, the future of a state is in the hands of another state. Trade can then be used as a means to coerce a state when interdependence is high. As neorealists posit that the ultimate goal of states is survival, dependency should be avoided at all costs.

For this reason, Waltz proposes that economic interdependence increases the likelihood of war. First, states wish to avoid dependency (in other words, they prefer autarky over dependency),²⁰ therefore interdependent relationships are more likely to erupt into conflicts than independent relationships. Therefore, when a state has to decide which target he wishes to attack to obtain a given territory, he will choose a state which he depends on strongly. State A has less reason to attack state B if economic dependence is low, as even in the case that the war is won and the territory is captured, autarky is still not reached. It is therefore better to try to capture a territory that state A depends on strongly, as the capture of the territory would lead to an autarkic position. Only in that case is dependency avoided, and the desire for territorial expansion reduced.²¹

3.4.2 Relative Gains and the Negative Security Externality

Although realists acknowledge that free trade brings benefits which may be lost after the cessation of trade, they point to the great importance of relative gains and losses in a state's decision-making. Due to the importance of balancing in order to survive, it may be rational to decline cooperation, even if it brings absolute benefits.²² Relative power determines whether survival is secured. Survival and independence depend on a state's efforts and thus its relative capabilities.²³

If there are asymmetrical gains in trade, then this increases the likelihood of conflict. The economic benefits from trade are related to the amount of power of a state. The

¹⁸Ibid., 1979, p. 126; Grieco, 1990, p. 39

¹⁹Keohane and Nye, 1977

²⁰See Waltz, 1979, p. 104: *"In an anarchic realm, the units are functionally similar and tend to remain so. Like units work to maintain a measure of independence and may even strive for autarky."*

²¹Waltz 1979

²²See also Powell, 1991 for a discussion about absolute and relative gains theory in international relations.

²³Grieco, 1990, p. 10. For liberals, a state's utility function is not dependent on the pay-offs of another player, state egoism "means that their utility functions are independent of one another; they do not gain or lose utility simply because of the gains or losses of others" (Keohane, *After Hegemony*, p. 27, quoted in Grieco, 1990, pp. 34, 35). For realists, a state's core interest is to survive, while for neoliberal institutionalism a state's core interest is rather "to advance in utility defined individually." See also Grieco, 1988, p. 503 for a comparison of the two theories.

more a state benefits by trading, the more resources can be used for aggression. When one party has a relative gain compared to the other party in the trade, then trade has a negative *security externality*.²⁴

Asymmetrical gains in trade lead to war via multiple paths. First, after trade has taken place, the party who gained relatively to the other party has more resources, which can be used for military aggression. Another reason could be that the one that loses relatively to the other party is more likely to start a war if he expects that the other party will start a war in the future with his superior military capabilities. A third way asymmetrical gains in trade can lead to war, is a scenario where trade will not take place at all. Even in cases when economic interdependence is high, and free trade generates enormous absolute benefits, the asymmetry in these benefits may lead parties to rationally choose to stop free trade.²⁵ If trade is not available, war may be the only way to obtain highly needed resources. Economic interdependence increases the need for these resources, and therefore also increases the likelihood of war.

3.4.3 *Instability of an Interdependent System*

Some neorealists agree that interdependence could have pacifying effects on interstate relations, but believe that liberal international economies are structurally unstable so that they have the tendency “to produce periodic collapses of such magnitude as to destabilize the whole pattern of international relations.”²⁶ During these periodic collapses, the probability of war increases, as it is hard to quickly adjust. Due to the division of labor, the structure of the domestic economy increasingly adapts to this division of labor. This adaption means that the patterns of employment, investment, and production are not fit for a self-sufficient economy. In a system of interdependence there is no reason for firms to keep their production in a place where it is inefficient. Therefore, these firms will move to other countries. However, when these firms produce very valuable and vital goods, ceasing free trade is accompanied with the loss of these goods, at least for a short period of time. It is impossible to start up domestic production again, when the domestic economy has adapted to the interdependent system. When trade breaks down, dependent states lose more than self-reliant states. Due to this loss in welfare, the utility of force increases more for dependent than for independent states, as wars may be the only way to survive as a state.²⁷ Independent states are not hurt as much as dependent states. War may be highly necessary for dependent states, as short-run adaption is impossible. Hence, if there is no good alternative for war in the short-run, war becomes a likelier option.

In addition, when state B uses protectionism against state A while no war has occurred, the opportunity cost of war by state A decreases. It therefore is more likely to go to war when this interdependent system breaks down. We will see below in section (3.5.2) and in the model how this opportunity cost affects a state’s decision-making in more detail.

Liberals claim that states do not have to worry about the collapse of an interdependent system if one condition holds. This condition is that there is a hegemonic leader. Such a leader is said to be able to provide the stability of an interdependent system with

²⁴Gilpin, 1981, pp. 130, 134; Gowa, 1986

²⁵Rosecrance, 1986, p. 46

²⁶Buzan, 1984, p. 616

²⁷Buzan, 1984

sustainable free trade. This hegemonic leader has the military strength to force states to open its borders for trade, so that other states are secure in their access to goods from foreign countries.²⁸ However, Buzan (1984) argues that even when such hegemonic leader is present, stability is not certain:

*If we accept that a liberal economic system needs a hegemonic leader to provide its required framework of collective goods, then we arrive at the essence of the problem. Hegemonic leaders do not endure, and when their leadership fails, a high risk is created of major disruption of the pattern of international relations. Such disruption is very likely to increase dramatically the incentives for the use of force.*²⁹

For this reason, realists cannot accept the liberal argument that economic interdependence leads to peace, as interdependent systems must simply break down at some point in time. When this collapse occurs, war is almost inevitable. An independent system with multiple autarkies is said to be more peaceful in that respect, as the collapse of trade does not induce violent behavior. Even when there is minimal trade between ‘autarkies’ (they would be less autarkic in such a case of course), the breakdown of trade is simply followed by domestic production, which is an available alternative in such a situation.

3.4.4 Uncertainty

For realists, states can never be certain about each others’ intentions. As the international system is considered anarchic, realists point out that states will be vigilant, because

*(...) states (...) worry at the extreme that today’s friend may be tomorrow’s enemy in war, and thus states fear that achievements of joint gains that advantage a friend in the present might produce a more dangerous potential foe in the future.*³⁰

Liberals on the other hand, state that economic interdependence increases certainty about each others’ intentions. When economic interdependence is high, relations between states will be friendly, and both parties within the relationship are said to be able to reasonably expect that relations will continue to be friendly in future instances.³¹

The pacifying effect of economic interdependence is contingent on future cooperative behavior of the other state. When states cannot expect that exchanges remain voluntary, the size of the opportunity cost of war decreases. As future trade is not certain, and future peace is not certain—both lead to a decrease in the opportunity cost of war—the pacifying effect of economic interdependence and free trade is absent due to the anarchic nature of the international realm.

According to Copeland (1996) it is precisely the expectations of trade which matter in a state’s decision-making with regard to peace and war. When states expect that trade-relations will remain, then there is no incentive for war, but if they expect that relations will break down in the future, then war becomes a more valuable option. Copeland provides an alternative to realist and liberal theory in this respect, as he does not claim

²⁸See also Kindleberger, 1986

²⁹Buzan, 1984, pp. 619, 620

³⁰Grieco, 1990, p. 29

³¹Keohane and Nye, 1979; Nye, 1988, p. 239

that interdependence *always* leads to peace or war, but rather that its effect is contingent on the future expectations of states. We will provide a more detailed discussion in the model, and in our conclusion.

3.4.5 *Eliminative Wars*

The standard argument that economic interdependence increases the opportunity cost of war does not work when wars are eliminative. Axelrod's (1984) famous experiment of the iterated Prisoners' Dilemma is supposed to show that cooperation is possible under reciprocal conditions, i.e. when players use a 'tit-for-tat'-strategy.³² However, competition between states tends to be eliminative,³³ wherefore any reciprocity is impossible, as a defeat in a war may lead to elimination. As states value the possession of territory, territorial expansion is mostly the main goal of a war.³⁴ In such a case, successful territorial expansion (depending on whether the whole territory or merely a part is captured) leads to the elimination of the former owner/caretaker (the former state) of the territory. There is nothing to cooperate about any longer in that occasion.

For that reason, realists argue that the liberal position is much weaker. States must ultimately survive in order to be able to achieve other goals, and they prefer to remain independent. States are therefore vigilant and are not likely to cooperate if it means that elimination is possible. Entering the division of labor reduces both independence, and it increases the likelihood that when the interdependent system breaks down, elimination becomes a possibility. In sum, the results of Axelrod (1984) cannot be applied to any interactions between states, as their relations are fundamentally different.³⁵ The possibility of elimination is known to be a cause of shorter time horizons. This is true for when elimination is exogenous, but especially when it is endogenously caused by the actions of other states.³⁶

3.5 The Liberal Thesis

The liberal thesis is that economic interdependence leads to peaceful intergovernmental relations due to the acknowledgment of the mutual benefits of trade. In a system of complex interdependence,³⁷ there are many disincentives for states to engage in interstate wars. A system of complex interdependence is contrary to neorealist assumptions characterized by three things: multiple channels connect societies; military security is not always the most important point on a state's agenda; and "military force is not used by governments towards other governments within the region, or on the issues, when complex interdependence prevails" (Keohane and Nye, 1977). We will show below that there

³²"I cooperate with you, if and only if you cooperated with me in the previous period." We explain in section (3.5.2) how this opportunity cost affects the likelihood of war.

³³Waltz, 1979, p. 111: "A self-help situation is one of high risk — of bankruptcy in the economic realm and of war in a world of free states."

³⁴Fearon, 1995, pp. 402, 408

³⁵Grieco, 1990, pp. 38, 39

³⁶Rosecrance (1986, p. 8) points out that 95 percent of the state-units which were present in Europe in the beginning of the sixteenth century no longer exist. However, it may also be the case that elimination in the twentieth century is no longer an issue, looking at the enormous increase in the number of states in the world, and the small number of states that are subdivided and/or obliterated. The problem of elimination may thus be contingent on the specific time and situation which states face.

³⁷On complex interdependence, see Keohane and Nye (1997).

are three main paths by which liberal assumptions explain how and why interdependence leads to peace.

3.5.1 War is Costly; Trade is Not

War and trade do not merely differ in their strategic consequences, they also differ in the amount of costs. War is generally a costly endeavor, whilst trade is mostly a cheap way to achieve material gains. In order to start a war, it is necessary to build and uphold a military force, while the costs of trade are (among other things) made up of transportation costs. These transportation costs are throughout history always lower than the costs of building a military force. For this reason, liberals argue that economic interdependence increases the benefits associated with allowing free trade and joining the division of labor, and lowers the value of war when holding the benefits of war constant. War is not necessary if free trade is a more efficient option.

Rosecrance (1986) shows this by making a distinction between so-called ‘trading-states’ and ‘military-political’ or ‘territorial states’. The former realize that trade is a more valuable option, while the latter believe war is the most efficient means to achieve national ends. The conquest of territory is generally a negative sum game,³⁸ or at best a zero sum game, while the goal of economic welfare of trading-states is mostly a positive sum-game. There is less reason for conflict between states in positive sum-games than negative sum-games, as both can achieve gains from peaceful cooperation with trade. Liberals tend to emphasize that states are ‘trading-states’, which receive benefits from an economic interdependent system. This provides reasons for sustaining peaceful coexistence:

*Trading states recognize that they can do better through internal economic development sustained by a worldwide market for their goods and services than by trying to conquer and assimilate large tracts of land.*³⁹

The liberal peace is said to be based on the liberal internal structure of states. The democratic-peace theory is one of the theories of liberalism which claims that democratic states tend to have peaceful relations with other democratic states. There is a separate peace between liberal states. The same holds for the economic structures of states. When states are liberal in the sense that they allow trade with other states and remove external barriers to trade, then they are said to not engage in wars with other liberal states.⁴⁰

3.5.2 Trade as an Opportunity Cost of War

Allowing bilateral trade is often contingent on whether bilateral relations are friendly. If they are not, states are not willing to help a potential enemy. In a situation of free trade, war often leads to the breakdown of free trade, as a war shows by definition that bilateral relations are no longer friendly. Because free trade brings economic benefits, which increase in the level of economic interdependence, war has an opportunity cost. War may provide some short-run benefits, but liberals state that the long-run costs may

³⁸Nothing is produced, while costs are incurred. The distribution of production is altered, but war is not efficient. Both states would be better if territory would be traded. This is also the argument of Fearon (1995) when he proposes that war is irrational on first sight.

³⁹Rosecrance, 1986, p. 24

⁴⁰Doyle, 1986, p. 1151

override the short-run benefits, so that the likelihood of war decreases along with an increase in economic interdependence.

The international division of labor brings economic advantages to every nation that participates. When the level of economic interdependence increases, free trade becomes a more valuable good in itself:

Each economy is said to be better off than it would have been under autarky; each thus acquires an incentive to avoid policies that would lead the other to break these economic ties. Because keeping open markets rests upon the assumption that the next set of transactions will also be determined by prices rather than coercion, a sense of mutual security is vital to avoid security-motivated searches for economic autarky. Thus, avoiding a challenge to another liberal state's security or even enhancing each others' security by means of alliance naturally follows economic interdependence.⁴¹

When a war has just taken place between two states, the victim of the war (or: the state who was not the aggressor) will stop allowing trade with the other states according to liberalism. It is however unclear which arguments they specifically have. If one takes a rationalist approach, a past event is simply a sunk cost if it does not influence the future anymore. Stopping free trade, even after a war, is also costly for the victim of aggression if interdependence is high. However, it will become more clear in the next section (the model) that disallowing free trade is a threat. When a state wants to stay credible, it must carry out this threat. Otherwise, it can no longer have credible commitments in the future. Therefore it makes sense that, in order to make sure that a potential opponent refrains from using aggression (which is inherently costly for a victim), a threat is introduced, which will be carried out when aggression takes place.

3.5.3 States as Economic Welfare Maximizers

For liberals, governments are highly responsive to domestic political demands for economic welfare. Mere survival is not the only goal for states, nor is it the utmost important one. Due to the fact that economic welfare and economic growth is more important, the loss of trade after a war, and the costs associated with the use of military force lead to a smaller incentive for war. Bilateral relations based on free trade and peace are much more conducive to achieving national goals, so that economic interdependence increases both welfare and the desire for peace. Autarkic national economies are inefficient, whilst economies that participate within the international division of labor are efficient. It is therefore beneficial to avoid wars, and to aim to peacefully coexist with other states in order to reap the benefits associated with the international division of labor.⁴²

Becoming autarkic is therefore not a national goal, as a system of economic interdependence ensures the realization of gains from trade. Although economic interdependence brings about the loss of autonomy, this autonomy loss is valued less than the economic benefits from free trade. For this reason, states have no incentive to change the national economy into a self-sufficient one, and there is also no incentive for territorial expansion to achieve an autarkic position. Economic interdependence is not inherently costly, and thus does not lead to war.⁴³

⁴¹Ibid., p. 1161

⁴²Rosecrance, 1986, p. 24

⁴³Ibid., p. 14; Keohane and Nye, 1987, p. 40

When states become more and more ‘economic’ actors instead of ‘political’ actors, they will care less about political goals relative to economic goals. In such a case, standard economic theory that predicts that individuals maximize economic welfare through the division of labor has more and more explanatory power in predicting a state’s behavior.

3.6 Implications for Bilateral Relations

Both theories have different arguments with regard to economic interdependence and war. This also results in different expectations for the peacefulness of bilateral relations. We have explained that there is a difference between a situation of low symmetrical interdependence and high symmetrical interdependence. The former situation is said to be conflict-inducing according to liberals, as there are no opportunity cost of war, so that economic interdependence has no peaceful effect. Liberals argue that high symmetrical interdependence is much more conducive to peaceful coexistence. Realists take the opposite view, they state that situations of low economic interdependence are to be preferred over high interdependence, as the latter leads to more conflicts.

Table 1: Theoretical Expectations of Liberalism (L) and Realism (R)

Interdependence	Likelihood of War	Explanation
Low	R: Low	Low dependency cost
	L: High	Low opportunity cost
Asymmetrical	R: High	Dependent state initiates war: (avoiding dependency)
	L: High	Independent state initiates war: (low opportunity cost)
High	R: High	High dependency cost
	L: Low	High opportunity cost

The argumentation of both sides also has implications for asymmetrical dependence. In such a situation, one state depends on the other, while the reverse is not the case. Both sides then have differing expectations as to who is more likely to start conflicts. Liberals would argue that a dependent state in such a relationship is likely to prefer to avoid conflict as it does not want to lose the gains from trade. Realists on the other hand would argue that a dependent state is more likely to start conflicts in an attempt to avoid its dependent status.⁴⁴

4 The Model

In this section we contrast liberal and realist theory in order to provide a micro-foundation of their expectations regarding economic interdependence and war. We start with a praxeological analysis⁴⁵ of how economic interdependence could in theory affect a state’s

⁴⁴Copeland, 1996. An empirical investigation of this is interesting, but outside the scope of our thesis.

⁴⁵Praxeology is a term introduced by Ludwig von Mises (1949). It is an *a priori* methodology which starts from the axiom of human action (“man acts”). From this axiom, many other fundamental truths are

decision-making to go to war. We then proceed with the model, we explain the set-up and start with the liberal thesis. Afterwards, we proceed with a realist critique and end with a summary of all results of the model.

4.1 Praxeological Analysis

The relationship between economic interdependence, trade, and war is a complex one. Before we proceed with our model, it is necessary to explain the *a priori* effects of economic interdependence on a state's decision-making with regard to allowing trade and/or using military force. We contrast two states of the world, one of perfect autarky with low economic dependence on foreign economic activities, and one of extremely high dependence on the division of labor. When economic dependence on foreign economic activities is high, this means that the subjective value of those activities is high. If economic dependence is high, foreign goods generate a large amount of benefits. Because of this, a dependent state is willing to incur a relatively high amount of costs to obtain the goods. Economists generally compare two ways of obtaining the goods; domestic production or trade. When a state chooses self-sufficient domestic production, it foregoes the benefits of specialization and the division of labor. Allowing trade is thus a beneficial option, as in equilibrium, goods are produced in the places where it is the most efficient. A high level of economic interdependence thus increases the value of allowing free trade.

This thesis however also analyzes the third option of the use of military force. To investigate the effects of economic interdependence on the use of military force, we assume that a state's choice-set consists of two options; domestic production and military force. Again, economic dependence increases the value of foreign goods vis-à-vis domestic production. Wars are generally costly endeavors for a state, so that when the benefits of foreign goods increase, the likelihood of using aggression to obtain the goods also increases. This line of argumentation already proves that the effects of economic interdependence on peace are not always positive. The point however is, that we have assumed that trade is not a part of the choice-set of a state. When trade also becomes an option, it is obvious that the value of military aggression becomes lower, as a state can also obtain the good by simply trading it for something else. The choice of trade or war is also dependent on their costs, so that when trading becomes less costly, the value of war decreases and vice versa.

The main argument that is brought up to support the positive effects of economic interdependence is mainly built on the costly long-run effects of war. When a state decides whether to uphold friendly or unfriendly relations with another state, the state considers the long-run effects of its short-run actions. Although economic dependence increases the value of war, this increase is only an increase in the short-run. In the long-run, an attacked state no longer allows free trade with the aggressor. We have shown earlier that economic dependence increases the value of free trade. For this reason, a potential aggressor incurs a larger cost when economic dependence is high, and it therefore is less willing to use war to obtain the goods. With this line of argumentation, the effect of economic interdependence on the occurrence of war is ambiguous, as in the short-run the benefits of war increase, but in the long-run the value of war decreases. War thus has a

deduced, and with the help of subsidiary assumptions, application to the solution of problems become possible. A praxeologist can show for example, that man must value a future homogeneous good less than a present homogeneous good. See also Crovelli (2007) for a discussion on praxeology and international relations.

large opportunity cost, which means that peace is more likely to occur. For this line of argumentation to succeed however, it is necessary to assume that the long-run costs have a higher weight than the short-run benefits.

Below, we will use the last argument as our starting point of the model. The notion that war has a long-run opportunity cost is one of the main arguments of liberal theorists. After explaining the liberal position, we will show that this line of argumentation is problematic using predominantly realist arguments.

4.2 Realism, Liberalism, and Game Theory

Game theory is the study of strategic interaction. As our thesis considers the strategic relationship between economic interdependence and war, game theory is a helpful tool in order to understand this relationship. Both neorealism and neoliberalism assume that states are rational, unitary actors. Both theories assume that states are able to make rational calculations about the costs and benefits of certain actions, and that states are able to see the strategic consequences of their actions. Game theory provides interesting insights, as it—like Crusoe economics—simplifies the real world and displays a real world situation as a game.

A model starts with identifying the players, information sets, pay-offs, and set-up. Once this is done, we can draw conclusions about what actions players will take in which situations. Such is also the case when it comes to economic interdependence and war. The liberal idea is primarily based on the fact that economic interdependence increases a long-run opportunity cost of war, as after a war, trade is reduced. Realists believe this is not the only effect of economic interdependence, with the relative gains problem being the most important factor to mitigate the pacifying effect of interdependence.⁴⁶

4.3 Identification of the Pay-offs

Before we proceed with our model, we explain the pay-offs of different choices. First, it must be stressed that some options are more valuable than others. Second, the pay-offs of a given player are dependent on its actions, but also on the actions of the other player.

4.3.1 War and Peace

In the next section, we will assume that states face a Prisoners' Dilemma scenario vis-à-vis each other. This means that the pay-offs of mutual peace are higher for both players than the pay-offs of mutual war. In addition, it means that players have an incentive to deviate from the mutual peaceful outcome as long as the other chooses peace. When such a situation occurs, the aggressor has a relative advantage (we assume that he is better off than mutual peace) while the victim is worse off than the mutual peace-outcome and also worse off than the mutual war-outcome. War thus dominates the option of peace.

It need not be the case that states always face a Prisoners' Dilemma. It can also be the case that war does not dominate peace, and the aggressor does not gain by defecting. Such a situation is however not particularly relevant for our thesis, as economic interdependence cannot have any pacifying effect in that case. We want to show that economic interdependence introduces a long-run cost which may override the short-run benefit of

⁴⁶Grieco, 1990, pp. 28-31

war. When such a short-run benefit of war does not exist, the long-run cost does not matter.

4.3.2 Free Trade and Autarky

The same holds for the decision to allow free trade, or to disallow free trade. The reason why we assume that states also face a Prisoners' Dilemma is that it again is the most applicable scenario to our thesis. We assume that states are better off under conditions of free trade than autarky (although some realists would disagree), but states have an incentive to disallow free trade and impose tariffs to achieve some short-run gain. The intuition is that both states will want to impose tariffs and thus they ultimately face a situation in which all trade is vanished, and both states are autarkic. Naturally, this is quite an extreme position, and it need not hold in the real world, but to reiterate, it makes our model work in a better way. Using an extreme, and simple perspective of bilateral relations, we are more able to show how economic interdependence affects a state's decision-making when it comes to allowing free trade and engaging in an inter-state war.

4.4 Model Set-up

Consider a situation with two players S_i ($i \in \{1, 2\}$). Both players simultaneously choose free trade (F) or autarky (A)⁴⁷ and both players choose peace (P) or war (W).⁴⁸ Pay-offs are consistent with the standard PD pay-offs. Let T be the current period, and t the total number of periods. Choices in period T are made simultaneous and are thus independent of choices by another player in the same period. Let economic dependence for player i be $\epsilon_i \geq 0$.

Table 2: Pay-off Matrix War-Sub-game

		S_2	
		p	w
S_1	P	$x; x$	$z; w + \epsilon_2$
	W	$w + \epsilon_1; z$	$y; y$

$w > x > y > z$

Our goal is to find out whether an equilibrium of (P, p) can be supported. If it can be supported, we will investigate the effect of economic interdependence on the stability of this equilibrium. Of course, several other equilibria exist, but finding these equilibria does not serve our purpose.

⁴⁷In the model, 'autarky' means that a state introduces tariffs, which generate short-run benefits for a state in terms of revenue. When both states would choose 'autarky', trade would decrease, and welfare would be reduced. Therefore an outcome where both choose 'free trade' is Pareto superior to an outcome where both choose 'autarky'.

⁴⁸Pay-offs and choices of player 1 are capitalized, and those of player 2 are in standard form.

Table 3: Pay-off Matrix Trade-Sub-game

		S_2	
		f	a
S_1	F	$b + \epsilon_1; b + \epsilon_2$	$d, a + \epsilon_2$
	A	$a + \epsilon_1, d$	$c; c$

$a + \epsilon > b + \epsilon > c > d$. The pay-off of ϵ_i is only realized maximally once in each period T .
We assume that $e_1 = e_2$.

4.4.1 Static Game

In order to support the peaceful equilibrium, liberals propose that choices in the trade-game are contingent on choices in the war-game. As both games correspond to the PD, it is necessary to use an iterated version of our model. If the model only has one period ($t = 1$), it should be perfectly clear that a peaceful equilibrium cannot be supported.

Proposition 1 *In a static game, both players choose War and Autarky.*

Proof. As both the war-game and the trade-game are PD's, War and Autarky strictly dominate Peace and Free Trade ($w > x, y > z, a > b, c > d$). ■

This corresponds to the classical result of the PD. Even though both players would prefer the Pareto superior outcome, it cannot be an equilibrium, as both players have an incentive to deviate from it. Iteration of the subgames helps our goal to show the pacifying effects of economic interdependence. The proposition above also holds for an iterated version of the game where t is finite, as backward induction becomes the solution concept. Because both players have an incentive to deviate in the last period in both subgames, cooperation cannot occur in the last period. This means that both players also have an incentive to deviate in the second to last period, and so on and so forth until the first period.

4.4.2 Dynamic Game: The One-Stage Deviation Principle

In the dynamic version of the game where $t \rightarrow \infty$,⁴⁹ conditional cooperation becomes a possible equilibrium, as backward induction is no longer the solution concept. Let us first only consider the war-subgame. Let σ_i^T be the strategy of player i in period T , and δ_i ($\delta \in [0, 1]$) be the discount rate of player i . We define conditional cooperation as follows:

Definition 1 Conditional cooperation is a strategy where player i chooses cooperation in period T if player j chose cooperation in period $T - 1$. If player j chose defect in $T - 1$, then player i also chooses defect in period T .

In our model, cooperation consists of both peace in the war-sub-game and free trade in the trade-sub-game. Let us assume that S_2 chooses conditional cooperation in period T and S_1 knows this. From the perspective of S_1 , what is the best action in period T ?

⁴⁹Or when the game ends at a random date.

The answer is that the value of deviation in period T should be lower than the value of conditional cooperation:

$$U_{S_i}(War) = w + \epsilon_i + \frac{\delta y}{1 - \delta} < x + \frac{\delta x}{1 - \delta} = U_{S_i}(Peace). \quad (1)$$

To make the mathematics somewhat easier, we treat the infinitely repeated game as if it were a game with two periods; the present and all future periods. Instead of using δ , we use γ (with values between 0 and a positive, finite number) where a higher γ means that the sum of all the payoffs in periods $T > 1$ becomes more important.⁵⁰ In that case, S_1 chooses to go to war in period 1 if:

$$U_{S_i}(WarBenefits) = w + \epsilon_i - x < \gamma(x - y) = U_{S_i}(WarLosses). \quad (2)$$

The LHS of the equation shows the short-run benefits of deviation in the first period and the RHS shows the discounted long-run cost of deviation. When the LHS < RHS, peace is the equilibrium outcome. In correspondence to our praxeological analysis above, an increase in economic interdependence (ϵ_i), results in an increase in the LHS, which results in a smaller likelihood of peace.

4.4.3 The Trade Sub-Game

Liberals argue that war is not necessary to obtain foreign goods. As trade is an available option, economic interdependence can result in an increase in the likelihood of peace. The argument is that allowing free trade can be made conditional on cooperation of player j in the war sub-game. Again we assume that player $i = 2$ chooses the following conditional cooperative strategy.

Player 2: σ_2^2 = In period $T = 2$ choose f if P and F in period $T = 1$; otherwise choose a .

This strategy means that player 2 is only willing to cooperate if player 1 chose to uphold peaceful relations with free trade in the previous period. For every other combination of choices of player 1, player 2 is not willing to use a cooperative action in the second period.

The immediate implication of this strategy for player 1 is that deviation in the war sub-game becomes less beneficial as player 1 receives a larger punishment than before. This is shown in equation (3):

$$(w - x) + (a - b) > \gamma[(x - y) + (b - c) + \epsilon_1], \quad (3)$$

where the first and second term of the LHS show the deviation gains in the war and trade-sub-game respectively. The RHS describes the punishment losses of ceasing cooperation in period $T = 1$.

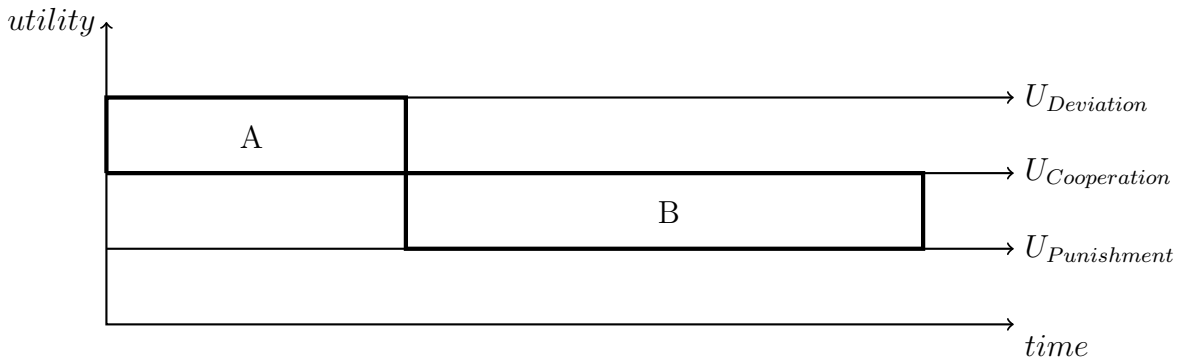
For a war to occur, the short-run gains of deviating in both sub-games (in Figure (2) below these gains are portrayed by block A)⁵¹ have to be higher than the long-run costs of suspended cooperation in both sub-games (those losses are equal to block B of Figure

⁵⁰ γ is equal to $\delta/(1 - \delta)$ of equation (1).

⁵¹Due to the strategy of player 2 (σ_2^2), player 1 knows that cooperation in the trade-sub-game has no long run benefits, as player 2 will end all cooperation in period $T = 2$. Therefore, if player 1 chooses to deviate in the war-sub-game, it is optimal for him to deviate in the trade-sub-game as well.

(2)).⁵² As has been said before, the effect of economic dependence (ϵ_i) is dependent on the valuation of the future. As we have assumed that player 2 chooses a conditional cooperative strategy in period 1 with allowing free trade and choosing peaceful relations, player 1 does not need to start a war to obtain goods produced by player 2. This means that economic dependence (ϵ) does not increase the value of war in the short-run. The only change in value is in the RHS of equation (3). In correspondence to the liberal line of argumentation, economic interdependence leads to peace, as it makes deviation (war) more costly. However, the liberal argument becomes weaker when interdependence is high, but trade is not allowed. In that case, the short-run benefit returns to the equation, and the long-run cost of losing ϵ disappears, as the realization of ϵ_i in the future ($T > 1$) does not depend on whether S_i chooses Peace or War in the present ($T = 1$).

Figure 2: Overview of Pay-Offs in the Iterated PD



4.4.4 More Than Two Players

The effect of ϵ is also contingent on the number of players. If we assume that player i can only deviate against one other player at a time, then it follows that it is possible that ϵ has an additional pacifying effect. If all other players except player S_i suspend cooperation against a deviating player, then ϵ increases the level of punishment. However, we can also reason in another way. The more trading partners a given state has, the more easily it can change from a given trading partner to another. This means that the punishment from a single state (given that other states who are not engaged in the war do not punish the aggressor) is reduced, as trade is simply moved instead of reduced. We will however stay with our model of two players, to make analysis more simple.

4.5 Set of Contingencies

The positive effect of economic interdependence on the likelihood of peace is however contingent on a large set of assumptions, some of which are likely to be violated. The liberal position is severely criticized by realist theorists. We aim to model their points of critique to show that in some occasions, economic interdependence does not lead to peace, or may even increase the likelihood of war.

⁵²This depiction of the short-term and long-term results of deviation in the PD stems from Gibbons (2000, p. 25).

4.5.1 Future Cooperation

In our model above, we have assumed perfect information and certainty about each others' pay-offs and choices in the future. When we formulated the strategy of conditional cooperation, we have assumed that cooperation continues until period $T \rightarrow \infty$. We have assumed that the game is a super-game, where each period the pay-offs of both players remain equal. However, in some periods T , pay-offs might change due to some exogenous reasons, making deviation from the strategy of conditional cooperation more valuable. This means that the future realization of ϵ is not certain, as the other state at some point might want to deviate from allowing trade. Because of this, the pacifying effect of economic dependence is diminished, and war becomes a more likely option. We can show this by extending equation (3). Let $0 \leq \theta \leq 1$ be the likelihood of conditional cooperation in periods $T > 1$, deviation by player S_1 in period $T = 1$ occurs if:

$$(w - x) + (a - b) > \gamma\theta[(x - y + \epsilon_i) + (b - c)] + \gamma(1 - \theta)[(z - y) + (d - c)] \quad (4)$$

From the somewhat long equation, we can observe a few things. If there is a positive probability (θ) that conditional cooperation by player S_j is sustained in future periods, this means that conditional cooperation by player S_i becomes more valuable. The future benefits of peace and free trade by player S_i are increased. In the equation, this can be seen in the RHS (the LHS remains the same). The first term occurs with probability θ , and in that case, the standard future pay-offs are obtained. With probability $(1 - \theta)$, one incurs a cost in the future by cooperating now. If $\theta = 0$, then there are no future benefits of cooperating in the present, and one must always defect in the present period, as this is then better by definition.

4.5.2 Eliminative Wars

Another assumption that might be problematic is that wars are non-eliminative. In our model we show that war is only beneficial in the short-run, and costly in the long-run due to reduction of bilateral trade. Matters become different however, when we introduce the possibility of elimination. When an eliminative war is successful, so that S_1 successfully eliminates S_2 , then there is no future punishment by S_2 and S_1 obtains the territory of S_2 , ensuring a secure and certain stream of ϵ_1 in every period T . No conditional cooperative strategy can be supported as an equilibrium when wars are always successfully eliminative, as there is no punishment after the war has taken place. Let $\rho \in [0, 1]$ be the probability that S_2 is eliminated, then the following equation entails the costs and benefits of war of S_1 :

$$(1 + \gamma\rho)[(w - x) + (a - b)] > \gamma(1 - \rho)[(x - y) + (b - c) + \epsilon_i] \quad (5)$$

We assume that when elimination succeeds, the eliminator obtains a stream of pay-offs of the (war;peace)-outcome. We show that ρ decreases the RHS, so that the effect of economic interdependence on the likelihood of peace is reduced. If $\rho = 1$, then one has no future costs (i.e. the RHS = 0), and a state will always go to war. However, we assume that S_2 uses a conditional cooperative strategy. The likelihood of this decreases with ρ , as deviation from the conditional cooperative strategy becomes more beneficial in period $T = 1$. It also depends on how we formalize the utility function of a state regarding the

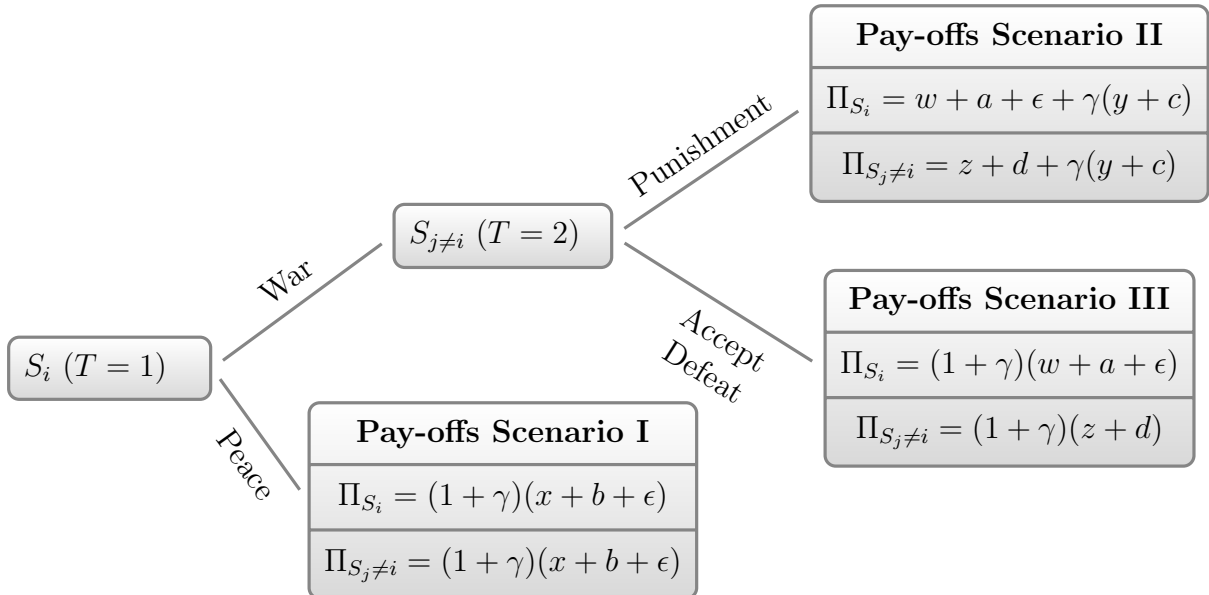
possibility of elimination. If the main goal of a state is survival, and all other goals are merely means towards that goal,⁵³ then the costs of being eliminated approach $-\infty$.⁵⁴ In that case, one does not take the risk of being deviated against in period $T = 1$, as that could have extremely costly consequences in the long-run. When being eliminated becomes more costly, any pacifying effect of economic interdependence is less important.

4.5.3 Time Preference

The pacifying effect of economic interdependence is also dependent on a state's time preference. The higher a state's level of time preference is, the less the state cares about the future, and the less costly deviation becomes. The liberal idea that the future opportunity costs of war reduce the likelihood of war is dependent on sufficiently patient states. If they are not patient, i.e., if the future is heavily discounted, then it follows that the only effect of economic interdependence is a negative one, as it increases the short-run benefits of war.

An additional assumption that is a corollary to time preference is the set-up of the game. As we have seen in the previous section, states are not certain of infinite iterations of the game. At some point, the game may end, so that the long-run costs of any non-cooperative type of action are reduced. We know from standard game theory that cooperation in the PD is dependent on the assumption that the game is infinitely repeated. If it is not, then the results start to resemble the results of the static PD or the finitely iterated PD, where unconditional (defect;defect) is the only possible equilibrium.

Figure 3: Game-Tree: War, Punishment, and Eliminative Wars



The game tree in Figure (3) shows a few things which can illuminate our argumenta-

⁵³This is predominantly a realist way of thinking.

⁵⁴In the standard economic framework, the costs of being deviated against do not affect the stability of the cooperative equilibrium. This however, is caused by the fact that it simply assumed that a player uses a conditional cooperative strategy, rather than trying to explain why a player does so. When the pay-off of being deviated against approaches a very negative number, then unconditional defection may simply be better. If these costs approach $-\infty$, then conditional cooperation can never be better than unconditional defection when unconditional defection provides a finite pay-off.

tion thus far. The figure describes three scenarios. The first scenario is where S_i chooses to uphold peaceful relations. In that case, both players achieve the pay-offs associated with peace and free trade. The second and third scenario occur when S_i chooses to use military aggression against S_j . In that case, S_i achieves some short run gains, but the long run pay-offs are contingent on the aftermath of the war — does S_j punish S_i or does he not? Scenario II describes the pay-offs in case S_j punishes S_i , so that S_i achieves long-run discounted lower pay-offs. In the third scenario, S_i is not punished (caused by the fact that the other player is eliminated or any another reason).⁵⁵ Dependent on the size of the short run benefits; the long run costs; and the valuation of time, the first or second scenario is preferred more by S_i . However, it can also be the case that the victim does not prefer to (or is not able to) punish the aggressor, so that the third scenario is the outcome. In that case, a potential aggressor does not restrain himself, as aggression brings about a short-run *and* a long-run benefit. The interpretation of the game-tree is that a potential aggressor is not sure which scenario will be the case, as there exists uncertainty about the outcome of a war. The more likely it is that a war is won and the other player is eliminated, the more likely it is that scenario 3 is the outcome rather than scenario 2, which means that aggression becomes a more valuable option with respect to keeping peaceful bilateral relations.

4.5.4 The Relative Importance of the Trade-Sub-Game

In addition, classical realists emphasize the difference between *high politics* and *low politics*. Military matters are regarded as the former and economic matters are regarded as the latter. Any effect of economic interdependence is also contingent on how important it is for a state. If economic matters have no importance, then any effect, both positive and negative, of ϵ is reduced to 0. Liberals tend to emphasize the fact that states aim to maximize a utility function which is also based on welfare considerations. In that case, ϵ retains its pacifying effect.

4.5.5 Absolute and Relative Gains

One of the main differences between liberalism and realism is how a state's utility function should be formulated. There is not only a distinction between high and low politics, but also between absolute and relative gains. If we assume that players merely care about absolute gains, then their utility function $U_i = V_i$ is equal to their pay-offs (V_i) which are tabulated in Tables (1) and (2). Realists however emphasize that this utility function is incorrect. States care about what the pay-offs of *other* players are besides their own pay-offs. To be more concrete, realists posit that players positively value the difference between their own pay-offs and those of others. The realist utility function is equal to

$$U_i = V_i + k(V_i - V_{j \neq i}),^{56} \quad (6)$$

⁵⁵In fact, when economic interdependence is high, it is not clear why a victim of aggression should carry out a threat when there is no threat of future aggression. Carrying out a threat is costly for the victim of aggression as well, and the higher economic interdependence, the more costly this is.

⁵⁶It is questionable whether such a utility function really captures the realist argument. The argument is not simply that states want to achieve more gains than the other player, but the main tenet of realism is that states seek survival. The former utility function merely provides a psychological explanation for behavior, while realism is not a psychological theory, but a political/economic one. It is instead true that utility in the present is contingent on power differences in the future. A reformulation of

where $k \geq 0$ is the sensitivity to the pay-off gap between both players. The higher this sensitivity is, the more a state cares about relative gains and losses, and the more important the second term (the pay-off gap) of the equation is.

Table 4: Relative Gains in the Trade-Sub-Game

		S_2
S_1	F	$b + \epsilon_1 + k[(b + \epsilon_1) - (b + \epsilon_2)]; b + \epsilon_2$
	A	$a + \epsilon_1 + k[(a + \epsilon_1) - d], d$
		S_2
S_1	F	$d + k[d - (a + \epsilon_2)], a + \epsilon_2$
	A	$c + k[c - c]; c$

Note: $a + \epsilon > b + \epsilon > c > d$

The difference between absolute gains and relative gains has dramatic effects on the influence of economic interdependence on a state's decision-making. Our model shows that the realist position — the position that relative gains are of importance in a state's utility function — can also explain its position on economic interdependence and war. We propose that the more important relative gains are, the more likely it is that economic interdependence leads to war. This is described in the second proposition.

Proposition 2 An increase in k leads to an increase in the likelihood of war.

Proof. An increase in k has three general effects. First, it increases the benefits of deviating in the short-run by $k[(a + \epsilon_i - d) + (w + \epsilon_i - z) - \epsilon_i]$ ⁵⁷ which is positive by definition and increases with k . The second effect occurs with asymmetrical pay-offs during peace-time and with trade. We assumed that the pay-offs of (F,f) and (P,p) provide symmetrical pay-offs. When we step away from these assumptions (so that $\epsilon_i \neq \epsilon_j$) and player S_i attains relative losses with cooperation in both sub-games, S_i is less likely to cooperate and more likely to deviate. When player S_i attains relative gains with cooperation in both sub-games, then $S_{j \neq i}$ is less likely to cooperate and more likely to deviate. The third effect follows from the second as the long-run punishment is less costly when cooperation is less beneficial. ■

The importance of relative gains does not solely impede cooperative behavior, it also increases the likelihood of war when economic dependence increases. Economic dependence ϵ increases the pay-off gap of deviation. This pay-off however only increases when (A, a) is the outcome in the trade-sub-game, because otherwise the pay-off of ϵ_i is already realized in the trade-sub-game. When there is no free trade, we have already shown above that economic dependence can only lead to more wars, as war is necessary to obtain ϵ_i . In that case, an increase in k leads to an increase in the importance of ϵ_i (i.e. the pay-off gap $k[(w + \epsilon) - z]$ increases in k and ϵ , which leads to an increase of deviation gains.

the utility function does not capture this difference. This means that states do not prefer cooperation with asymmetrical gains in the present, as that endangers the chances of survival of states.

⁵⁷This equation entails the deviation profits in both sub-games. One ϵ is subtracted as the economic gains of ϵ can only be attained once each period maximally.

4.6 Summary

Our model has shown that the difference between realist and liberal theory can be explained with game theory. We have shown that players have a larger incentive to cooperate when dependence is higher when liberal assumptions hold. Defection may be profitable in the short-run, but in the long-run the costs provide a reason for cooperation. The size of these costs increase with the level of economic dependence. The presence of this incentive is however contingent on a range of factors. The first factor is that future cooperation by the other state should be certain. When there exists uncertainty, the pacifying effects of economic interdependence are decreased. Secondly, wars should not lead to the elimination of the other state. If it does, then it follows that there can be no future punishment, so that economic interdependence can only increase the incentive for war. The elimination-argument also holds when not the whole of the opponent's territory is captured, but also if a part is captured. If valuable territory is captured (e.g. oil resources), then the punishment is not as severe as otherwise, as the aggressor got what he wanted. Thirdly, time preference should be sufficiently low (i.e., states should be sufficiently patient) in order for conditional cooperation to be possible. Otherwise, states only look to the present, and the present gains of aggression, rather than looking to the long run costs of aggression. When states only care about the present, economic interdependence may even increase the likelihood of war compared to a situation with low economic interdependence. Fourthly, trade should be sufficiently important for states, otherwise the long-run cost of disallowing trade do not weigh so heavily, so that economic interdependence can have no pacifying effect. The fifth and final factor is the most important, as it is the main point of difference between liberal and realist theory. Economic interdependence increases the level of absolute gains for both parties. However, as realist posit, when states care about their relative gains, economic interdependence increases the likelihood of war, as the pay-off gap increases when economic interdependence is relatively high. When state 1 and 2 depend on each other, then the benefits of aggression are greater, because state 1 receives a higher pay-off, and state 2 a lower pay-off. This change in pay-off due to aggression is higher when economic interdependence is high, as the benefits (costs) of obtaining (losing) much needed goods increase in the level of economic interdependence. In sum, we have shown that under some conditions the liberal expectation holds that economic interdependence leads to peace, while under other conditions, the realist theory holds more ground.

In principle, there is room for synthesis between the two theories. Our literature review shows that researchers find different effects of economic interdependence on the likelihood of war. This could be caused by the fact that different data is researched, or different time periods, but then the question still remains *why* we find different results (other than the possibility that different statistical techniques produce contrasting results), i.e., why does trade lead to war before the Second World War (Barbieri, 1996) while the reverse is generally true after the Second World War? Liberalism and realism have different perspectives and place different weights on the factors described in our model. There could be a synthesis between both theories when theorists find agreement on the application of theory on data. Similar to Copeland's (1996) analysis, we can argue that the effect of economic interdependence on conflict is extremely contingent on the specific situation that states face, and it also depends on a set of assumptions which must hold in order for economic interdependence to have a certain effect.

5 Research Design

To test the validity of our model, and in order to find out which of the two theories has more explanatory power, we use two data-sets to test whether economic interdependence leads to war or peace. As dependence is a latent concept (dependence is the subjective valuation of the service of the other) which cannot be measured, we use trade flows (bilateral and multilateral import and export) as a proxy for economic interdependence. The higher the trade-flows are, the higher economic interdependence is assumed to be. Interdependence exogenously determines trade-flows. The more two nations trade, the more they are said to prefer what the other nation offers over what they currently have, the more dependent they are on what the other offers.

The first data-set takes the world-year as the unit of analysis, containing data from 1870 to 2001. Important data on trade is not available before 1870. We look at aggregated data for the world as a whole, taking the total sum of imports and exports corrected by GDP, yearly amount of wars and MIDs as our main variables of interest. We control for this relationship, by looking at the level of democratization, the number of states and the amount of major powers. We do not add other control variables, as that would dramatically decrease our sample size, as some data is only available after the Second World War. In addition, when we run a regression analysis with our main dependent variable and independent variable (MIDs and trade respectively) we cannot control for everything we want. Therefore, we are cautious with any results we find.

We collect data from several resources. Our main source is Harrison and Wolf's (2012) article which also investigated the effect of trade on inter-state conflict⁵⁸ in a data-set with the world-year as the unit of analysis. Fortunately, their measure on trade ('openness') goes back to 1870, we however have not found older GDP data than 1960 at best. The most recent data on trade stems from the World Development Indicators (Worldbank, 2013). As mentioned before, the world as the unit of analysis is highly aggregated. Therefore, when we find no statistical relationship between our main variables of interest, this does not mean that there is in fact no relationship. Irrespective of our results, we also empirically test our thesis using the dyad-year as the unit of analysis.

The second data-set contains data on a number of dyads. We select dyads which have at least engaged in one inter-state war⁵⁹ after 1945. We start our sampling from a relatively late year, as data becomes less available the further we go back in time. A large problem is the fact that GDP-data is not available for earlier observations, so that we cannot correct bilateral trade data for GDP. We calculate the bilateral trade variable as follows (all data is in current US Dollars):⁶⁰

$$\text{Frac_imps} = \frac{1}{2} \left(\frac{\text{Imports } S_1 \text{ from } S_2}{\text{GDP } S_1} + \frac{\text{Imports } S_2 \text{ from } S_1}{\text{GDP } S_2} \right)$$

⁵⁸We will use a different dependent variable than Harrison and Wolf (2012), which we will explain below.

⁵⁹An interstate war is a war between members of the inter-state system ('states'). Wars must involve "sustained combat, involving organized armed forces, resulting in a minimum of 1,000 battle-related combatant fatalities within a twelve month period." (Sarkees and Wayman, 2010)

⁶⁰Bilateral trade data comes from Barbieri and Keshk (2012) and GDP-data from the World Development Indicators of Worldbank (2013). For older observations not available in the Worldbank's database, data was used from the Penn World Table (PWT). As the PWT does not contain data of GDP in current US Dollars, we calculate the growth rates of GDP using real GDP. We then proceed to apply these growth data to data from the Worldbank, and either we extrapolate our data to older observations, or we interpolate data when observations in the middle of our sample are unavailable.

We exclude inter-state wars with more than two participants from our sample, which also has several reasons. First, wars with more than two participants are strategically different than wars between two states. States may feel that they have to help another for strategical reasons, such as balancing a certain power in a given geographical area. A state may feel it wants to help another to receive a favor in the future. There are more of such reasons possible. If more than two states have engaged in a single war, then the effect of economic interdependence becomes more complex. We have not accounted for this complexity in our theoretical framework, nor in our model. In addition, although adding wars with more than two participants would greatly increase our number of observations, there is a problem with these observations. An assumption of statistical testing is that observations are independent. This assumption is likely to be violated when more dyads engage in the same war. Therefore, we refrain from adding these observations.⁶¹ Taking a maximum of two participants per war ensures that observations are more or less independent. Also, from a statistical point of view, due to the small number of wars relative to the total number of observations, it is not helpful to add all dyads of the world. In any given year we have $\frac{1}{2}n(n-1)$ observations (where n is the number of states),⁶² while the number of yearly inter-state wars is extremely small (only 95 from 1816 to 2007)⁶³ which is approximately half a war per year on average. We find support for this position in King and Zeng (2001), who argue that reducing the number of observations based on their behavior with regard to war and peace is relatively unproblematic.

For this reason, the reduction of our sample to only ‘warring states’ (i.e. states that have shown to be able and willing to fight an inter-state war) seems to be reasonable. We acknowledge that this selection bias removes the external validity of our results. Our empirical findings in the dyadic data-set do not hold for other dyads, as our sampling method is not random. Our main goal is to show the dynamic consequences (i.e. effects over time) of trade on war and vice versa. This also means that it does not matter whether bilateral trade is high or low, but rather whether it is *increasing* or *decreasing*. The same holds for our control variables. We are merely interested in changes in our control variables, not in the static affects. Our main idea is that in some years the utility (and therefore probability) of war is higher than in other years, which is caused by changes with respect to the previous year. This also has the advantage of holding several factors constant. It is impossible to say that, if for one dyad bilateral trade relative to bilateral GDP is 1%, and for another 5%, that the dyad with 5% is more or less likely to go to war than the other dyad. It could well be the case, as we have shown before, that the states in the latter dyad can switch their trading partners more easily, and are therefore more likely to go to war. States make different utility calculations based on the value of economic interdependence and trade, and therefore it also rather makes more sense to look at difference over time than cross-sectional differences at one point in time.

After applying our sampling choice, we reduce our number of dyads to 16. Due to the unavailability of several data-points however, we are forced to reduce our number of dyads to 8.⁶⁴ The other 8 dyads have to be dropped from our sample, as some dyads do not have data on GDP, others do not have sufficient observations before a war, and

⁶¹Signorino, 1999, p. 280

⁶²In 2011 there were 195 states, which means that there were 18,915 dyads. It is close to impossible to find a statistically significant relationship between war and trade if we would use the whole population. Even selecting a subset of these dyads would not be particularly helpful, as the ratio of warring dyads to all dyads will remain extremely small.

⁶³Sarkees and Wayman (2010)

⁶⁴See the appendix for which dyads are selected.

others miss bilateral trade data in the middle of the sample.

An additional advantage of our approach is that we do not have to control for several variables which do not change over time.⁶⁵ Wars are likely to be started between states which are close to each other geographically for example. Due to the fact that this does not change over time, it also does not affect the likelihood of war in any given year. We therefore omit several variables which would be used in other studies that also look at non-warring dyads.⁶⁶

We therefore only look at variables that change over time. Our main variables of interest are war and bilateral trade. In addition, we also look at multilateral trade of both parts of the dyad. Furthermore, to control for the relationship between our two main variables of interest, we collect data for several control variables. However, we ensure that our variables have a high degree of exogeneity. We exclude variables that are likely to be endogenous.⁶⁷ An example of such a variable is whether two states are part of the same alliance. If bilateral relations between two states become more and more unfriendly, then it is likely that they also break with their alliance during the year of the war, or even before that. The same goes for expenditures on military equipment. States that prepare for war are more likely to spend more on the military, leading to a higher military capability ratio,⁶⁸ which leads to the endogeneity bias.

An important control variable is ‘democraticness’, and in particular joint democracy (both states have to be democratic), as most theoretical hypotheses and empirical studies are based on the idea that joint democracy is peace-inducing. If before a war, one or two states from a given dyad stop being a democracy, then war is more likely to happen than it otherwise would be. Another variable of interest is joint communism, as communist states may be less likely to go to war with each other than other states. However, we find that for our sample, there is no variation over time when it comes to communism. Economic growth might also have an effect on the likelihood of war. Countries that have large amounts of economic growth may be less likely to start wars as wars have a dramatic effect on the internal economy of a country, so that growth is reduced. We also look at whether one member of a given dyad has experienced an internal power change. States that are more stable internally are less likely to go to war, as one has a longer time horizon as a state ruler, which decreases the utility of war. An important control variable is the symmetry of trade. As the expectations of realism and liberalism are contingent on the symmetry of trade (i.e., the effect of trade on war is different for asymmetrical trading partners, when compared to symmetrical trading partners) we control for this as well. We use a variable which is constructed in the same way as Barbieri (1996) has done:

$$Symmetry = 1 - \left| \frac{\text{Imports } S_1 \text{ from } S_2}{\text{GDP } S_1} - \frac{\text{Imports } S_2 \text{ from } S_1}{\text{GDP } S_2} \right|,$$

where a higher value corresponds to higher symmetry, with the value of 1 as maximum.

Again, it does not matter how big these difference are in absolute values (for one dyad member 1% bilateral trade may be more valuable than 3% for another), it merely matters that the symmetry changes over time. Symmetry is said to be peace-inducing according to liberals, while asymmetrical relations are relatively likely to fall into war.⁶⁹

⁶⁵Verbeek, 2012, p. 379

⁶⁶Barbieri and Schneider, 1999a, p. 395

⁶⁷Verbeek, 2012, p. 146

⁶⁸Singer, 1987

⁶⁹Copeland, 1996

In the dyadic data-set, we check for two expectations. The first expectation is that pre-war changes in economic interdependence (measured by trade) matter for the likelihood of war. We therefore check for a time trend before a war takes place. We distinguish a short-term, medium term, and long-term trend of 1, 3, and 7 years respectively. For this reason, we create 3 dummy variables to indicate whether a given year is a pre-war year of the short-, medium-, or long-term. If the growth in trade before a war is significantly different from the growth of trade in other years, then it follows that war can be explained by economic interdependence. We make a distinction between individual tests and pooled tests. The former checks whether wars are preceded by increasing or decreasing bilateral trade for individual dyads, while the pooled analysis looks at the trend for all dyads.

We acknowledge however, that this method is not robust. Therefore we also use a logit model—we pool all observations—to check whether wars can be explained by changes in trade. This has the advantage that we can add several control variables. As war is a binary variable, a logit estimation is to be preferred over OLS-regressions. We test whether the first difference (observation in period (t) —observation in period $(t - 1)$) of our independent variables influence the likelihood of war occurring.

The second expectation which we test is about the effect of wars on trade. Both realism and liberalism predict that trade is dramatically reduced after a war, and liberalism strongly relies on this prediction for the pacifying effects of trade. We check whether there is empirical evidence for certain time trends after a war. Again, we distinguish between several punishment lengths using dummy-variables; the short one (1 year); the medium one (3 years); the long one (7 years); and the infinite one.⁷⁰ If post-war levels of trade are lower than trade in other years, then we can conclude that wars decreases trade. An additional method to test whether wars decrease test is using the lagged variable of war to explain our dependent variable of bilateral trade. We run iterated regressions, starting with a one year lagged variable, and we continuously add another lagged variable of a longer period until the effect is no longer significant.

Also, more generally, the empirical part is revolved around time-series analysis in a panel based data-set. In order to correct for the most common problem of the non-stationarity of the time-series, we take the first difference of the variables. This ensures that our time-series are stationary. In addition, we are able to pool the data from our eight dyads only when they are independent of each other. We can however not test whether this is the case, but it is safe to assume that they are. We expect no large problems when it comes to common shocks which are relevant for all dyads, which could subsequently explain the occurrence of wars in a given year.⁷¹

To summarize our research design, we test the effect of trade on war and of war on trade. The expectations of liberalism and realism are the following:

Liberal expectation (1): Decreasing trade-levels increase the likelihood of inter-state wars to occur.

Liberal expectation (2): Wars are followed by low trade-levels.

Liberal expectation (3): More trade leads to less Militarized Interstate Disputes

⁷⁰In the infinitely iterated Prisoners' Dilemma, game theorists have deduced that the optimal punishment length is infinite (Taylor, 1987). We check whether there is evidence for this deduction, or whether we can find evidence for shorter punishments.

⁷¹For information on panel studies, we have used Verbeek (2012, pp. 372-436, especially pp. 376-394)

Realist expectation (1): Increasing trade-levels increase the likelihood of inter-state wars to occur.

Realist expectation (2): Wars are followed by low trade-levels.

Realist expectation (3): More trade leads to more Militarized Interstate Disputes

Expectations (1) and (2) are presented below in Figure (4). In year 0, the war occurs, and one can observe the different trends for years earlier than the war-year (0). Both theories expect trade to be lower after the war.

Figure 4: Theoretical Expectations

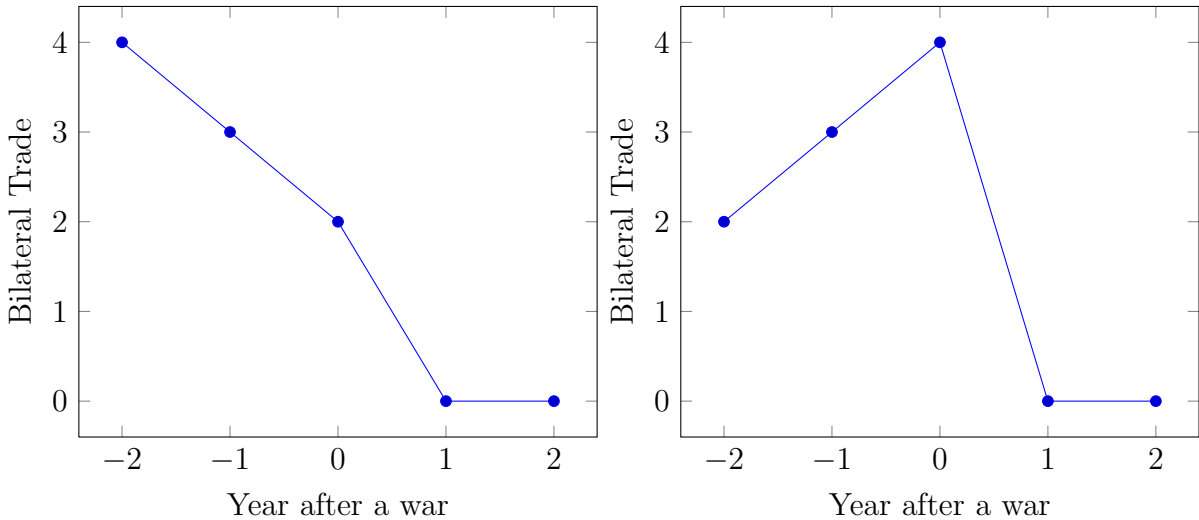


Figure 4.a: Liberal Expectations (1 and 2) **Figure 4.b: Realist Expectations (1 and 2)**

6 Analysis

In this section, we describe the results we have obtained.⁷² We start off with researching whether economic interdependence leads to more or less wars in the first subsection. Here we start off with a description of the different time-series of our eight dyads. We provide graphs to show a possible pattern in bilateral trade around the year that a war occurs. Also, we empirically test for each dyad whether there is a trend before a war. We then proceed to do a pooled analysis, where we look at whether the individual trends combined are significantly different from zero. In the same section, we also run a logistic regression analysis to discover the effect of bilateral trade on war, where we control for several variables. In section (6.3) we do an individual and pooled analysis to check whether wars lead to less trade. Section (6.4) includes an analysis of the relationship between the yearly number of MIDs and yearly trade data for the whole world. We end with a discussion in the final subsection (6.5).

⁷²The time-series are presented below.

6.1 Visual Inspection

Before we run our statistical analyses, we start with a visual inspection of our dyads. As explained in the previous section on the research design, realism and liberalism differ in their expectations with respect to the years before a war, while they agree on the effect of wars on bilateral trade. We therefore try to identify a trend before and after a war.

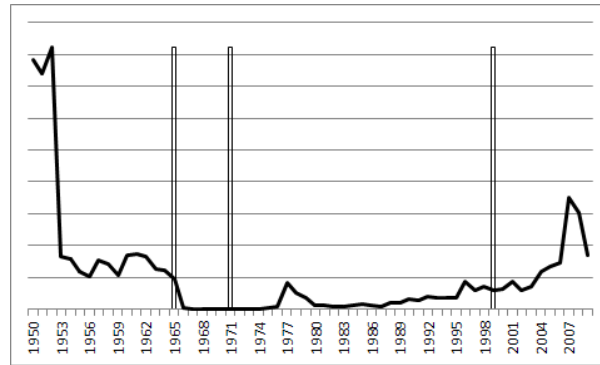


Figure 5: Dyad 1: India - Pakistan (1950-2009)

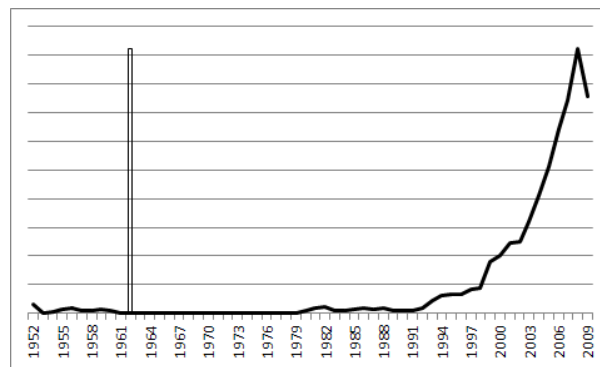


Figure 6: Dyad 2: China - India (1952-2009)

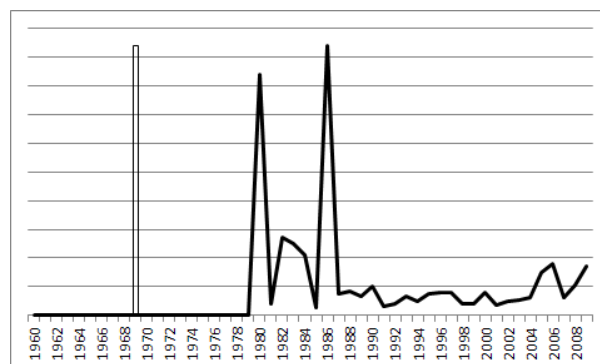


Figure 7: Dyad 3: Egypt - Israel (1960-2009)

For the first dyad (India-Pakistan) we find no clear relationship between war and trade. Before the Second Kashmir War in 1965, there is an indication of a decreasing trend in bilateral trade. After this war, bilateral trade was completely halted for approximately a decade. There is no clear indication of a trend in bilateral trade for the Bangladesh

Liberation War of 1971, but this may be caused by the fact that trade was already at zero due to the previous war. The same holds for the Kargil War of 1999; there seems to be no pre-, nor post-war trend in bilateral trade. The second dyad of China and India also provide no clear indication for any trend whatsoever. Both before and after a war, trade is already extremely low (especially when compared to the levels achieved in the nineties and the twenty-first century), and the data does not show that trade is changing in a different manner than if war did not occur. The same holds for the relation between Egypt and Israel. Trade before and after a war is zero, and it is therefore not possible to infer that changes in trade cause wars, or that a war causes a change in trade.

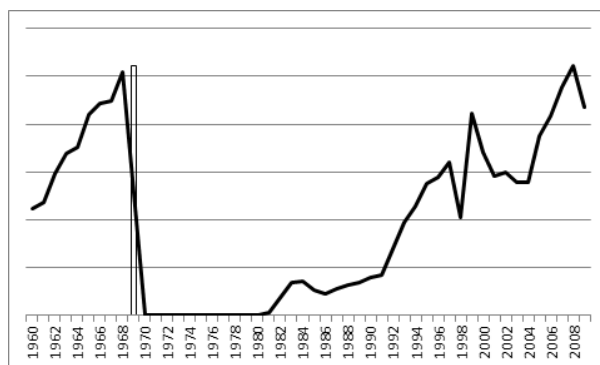


Figure 8: Dyad 4: Honduras - El-Salvador (1960-2009)

There is however an interesting pattern when it comes to the fourth dyad. The relationship between Honduras and El-Salvador shows—as both theories would predict—that bilateral trade is dropped to zero after a war, and this punishment is retained for a number of years. However, there is a clear indication that realist theory may be applicable, as trade is strongly increasing before the 1969 Football War, from 1.1% to approximately 2.5%.⁷³

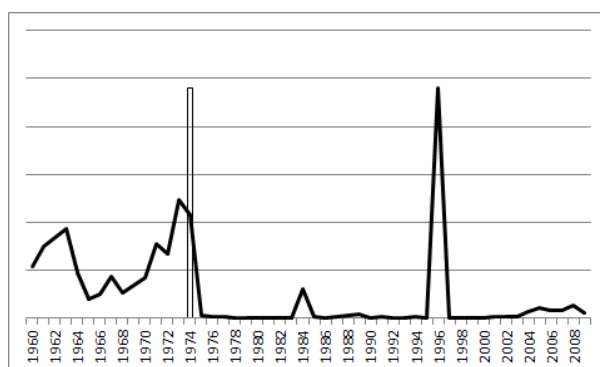


Figure 9: Dyad 5: Cyprus - Turkey (1960-2009)

The same holds for the fifth dyad, where there is also evidence for realist theory. Trade between Turkey and Cyprus tends to be increasing before the Turkish invasion of 1974. In addition, the data shows that trade is reduced to zero after the war, providing evidence for the existence of a punishment. The sixth dyad of Iran and Iraq shows again that bilateral trade is increasing before a war, but here the trade already stopped in the year before the war. There might therefore already be a dispute between the countries in

⁷³These values are calculated using the “fracimps” formula displayed above.

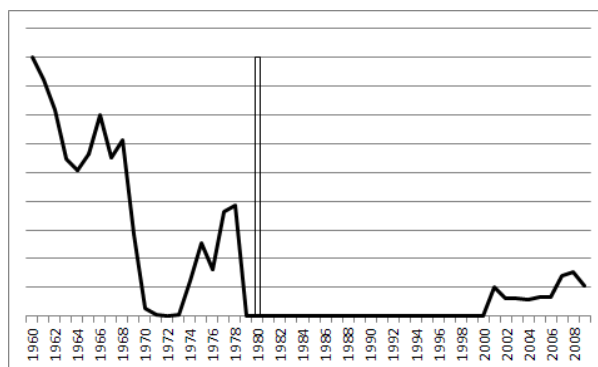


Figure 10: Dyad 6: Iran - Iraq (1960-2009)

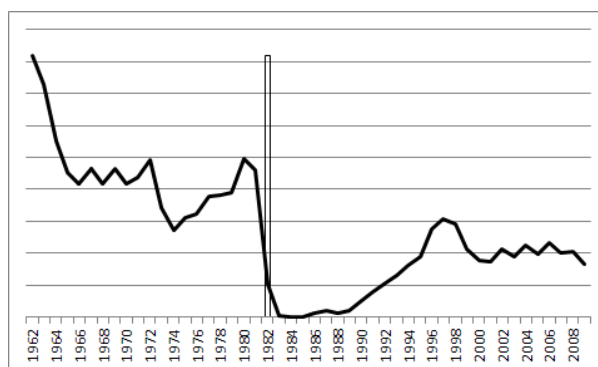


Figure 11: Dyad 7: Argentina - United-Kingdom (1962-2009)

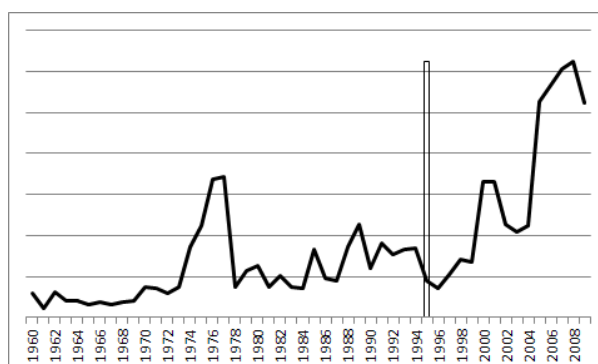


Figure 12: Dyad 8: Ecuador - Peru (1960-2009)

1979 which causes the large decrease in bilateral trade. After the war of 1980, bilateral trade stays non-existent until 20 years later. For Argentina and the UK (dyad 7) there is also an indication that realist theory has explanatory power, in the sense that in the longer period before the 1982 Falkland War trade was increasing over time. However, liberal theory is confirmed when it comes to the year just before the war, where we can already observe a strong decrease in trade, even though the war has not started. For this reason, we do not merely look at the first lag of trade in our statistical analysis, but also at earlier lags. The final dyad of Ecuador and Peru shows no clear evidence for liberalism, nor for realism. Trade has no clear trend before a war, and contrary to both theories, bilateral trade is even increasing after a war.

6.2 Effect of Interdependence on War

The main question of our thesis is about the effects of economic interdependence on the likelihood of war. As explained before, we use bilateral trade as a proxy for economic interdependence. As our dependent variable ‘war’ is a binary variable, we cannot use a normal regression model. Hence, our main options are to use a probit or logit model. Due to the fact that the amount of years with a war are extremely small when compared to our total number of observations, we use a logit model.⁷⁴ We estimate four empirical models, where we test whether bilateral trade has an effect on the probability of war. Our dependent variable war takes a value of $y_{it} = 1$ if there is a war, and $y_{it} = 0$ otherwise.

Table 5: Effect of Trade on War: Summary of Logistic Regression Analysis

Variable	(1)	(2)	(3)	(4)
Intercept	-3.82*** (0.35)	-3.90*** (0.37)	-3.76*** (0.34)	-4.45*** (0.61)
Δ Bilateral Trade	-249.82*** (88.80)	-255.82*** (89.43)		-558.32*** (212.29)
Δ Joint Democracy		-2.10* (1.11)	-2.01* (1.10)	-1.38 (1.09)
Δ Multilateral Trade			-5.46 (10.29)	-8.04 (12.14)
Δ Symmetry				-239.05 (152.96)
Δ Average GDP				0.00 (0.00)
Δ Power Change				1.16 (0.76)

*Dependent variable: war ($y_{it} = 1$). Standard errors appear in parentheses. Coefficients rounded to two decimals. P-values: ***< 0.01, **< 0.05, *< 0.10. Total observations: 408. Number of wars: 10. If we exclude the second dyad (which is non-stationary), our parameter estimates of model (2) change to Intercept= -3.89; Δ Bilateral Trade=-254.05; and Δ Joint Democracy=-2.09. All parameter estimates remain significant.*

As can be seen from Table (5), our first model already shows a significant negative effect of bilateral trade on the likelihood of war on the $p < 0.01$ level. The more bilateral trade grows with the respect to the previous year, the less likely it is that a war takes place in that year. This result is robust even after controlling for joint democracy, which also has a significant pacifying effect on the $p < 0.10$ level. From our logistic regression, we can also observe that multilateral trade has no effect on the likelihood of war. It is rather bilateral trade that matters, rather than trade with partners who are not involved in the conflict within the warring dyad. Even after controlling for other observable variables that may affect the likelihood of war, we observe that bilateral trade holds it negative effect on the likelihood of war.

Our best model is the second one. The other control variables besides joint democracy have no significant effect on the likelihood of war, therefore it makes sense to not add

⁷⁴Verbeek, 2012, pp. 206-219

them to our logistic regression. We see that symmetry does not have an influence on the effect of trade on the probability of war. It is also true that wars are not caused by changes in power in one of the participating states of the dyad. Also, it does not matter whether a given dyad jointly experiences economic growth or a depression, we do not see a significantly different effect than zero. Based on model (2) we conclude that, on average, a decrease in trade by 1% leads to an increase in the probability of war by 4.9% (from 0.02 to 0.069).⁷⁵ We set the initial values of Bilateral Trade and Joint Democracy to zero, indicating that we compare a situation with no changes in trade, and no changes in the value of joint democracy, with the same situation except for a 1% decrease in bilateral trade. We find however that our model cannot explain the occurrence of all wars. Compared to a model predicting that peace will always occur (which will be correct in 97.55 % of the time), our model is correct in 97.66 % of the time, yielding a percentage gain of 4.41%. This is not extremely large, but this is inherent to our data, which has only a few occurrences of a positive value for the dependent variable ‘war.’

This is evidence for the liberal position which states that more trade leads to peace, while less trade decreases the opportunity cost of war, and therefore increases the value of war with respect to peace.

One should however take care with accepting this result. Due to the fact that we only have an observation each year, it may be the case that the pacifying effect is found only because the punishment (the restriction of bilateral trade) already started in the same calendar year as the war takes place. As our main independent variable of bilateral trade is measured in the change of trade with respect to the previous year, the calendar year of the war may already experience post-war effects of the war. This means that we do not measure the pre-war effects of trade on the war, but we also already measure the post-war effect. For example, when a war starts in the first of January of a given year, then the punishment already starts in the second of January, and we may find a negative effect of bilateral trade on the likelihood of war merely because of the punishment.⁷⁶

We therefore look at larger pre-war trends, and we exclude the observation for which the war takes place. This however comes at a cost, because theoretically changes in bilateral trade seven years before a war have a smaller effect than changes one year before a war. The table below shows the result of the investigation of bilateral trade in different periods before a war. We run 27 regression analyses, 3 for each individual dyad to identify pre-war trends with different lengths (short [1 year], medium [3 years], and long [7 years] term length) and three regression analyses with all dyads pooled.

We find that pre-wars years are not significantly different than other years for each dyad individually. Only the sixth dyad shows a short-term effect of bilateral trade. In the seven years before a war in the pooled analysis, we do however find a significant result on the $p < 0.05$ level. In that period, the change in bilateral trade over time is significantly different than yearly changes in other periods. On average, the seven year before a war have 0.03% more growth than other years. This contradicts the earlier finding that an increase in bilateral trade decreases the probability of war. This means that the realist thesis is supported empirically by our data on this occasion. There is thus a difference between the immediate year before the war (there a decrease in trade leads to a higher likelihood of war), and the average trend in the seven years before the war (there an increase in trade precedes wars in the longer term before the war).

⁷⁵ $F(x'i\beta) = e^{x'i\beta} / (1 + e^{x'i\beta}) \approx 0.02$. Marginal effect = $0.02 * (1 - 0.02) * (-0.01) * (-255.8228) \approx 0.049$.

⁷⁶We have tried to account for this by creating a variable that controls for the date, but adding such a variable unfortunately generates an error when we run our regression analysis.

Table 6: Trend Identification: Pre-War Levels of Trade

Dyad	Short-term	Medium-term	Long-term	n*t
1 (IND-PAK)	0.000285	0.0002000	0.000145	59
2 (CHN-IND)	-0.000378	-0.000322	-0.000294	57
3 (EGY-ISR)	-1.77E-05	-1.85E-05	-2.03E-05	49
4 (HON-ELS)	0.002797	0.001334	0.002023	49
5 (CYP-TUR)	0.002304	0.001187	0.000703	49
6 (IRN-IRQ)	-0.000378***	-4.06E-05	1.89E-05	49
7 (ARG-UK)	-9.77E-05	0.000214	0.000242	47
8 (ECU-PER)	-0.000131	-0.000271	4.65E-05	49
1-8 Pooled with Dyad Fixed Effects	0.000497 (0.000318)	0.000270 (0.000180)	0.000329** (0.000160)	408

Dependent variable *fracimps* (bilateral trade). *P*-values: ***< 0.01, **< 0.05, *< 0.10. The pooled analysis is done with cross-section fixed effects (dummy variables). White cross-section standard errors & co-variance (d.f. corrected) are used. The reported coefficients are bivariate correlation coefficients including the intercept. The intercept is however excluded from the table.

6.3 Effect of War on Bilateral Trade

The liberal position that economic interdependence decreases the likelihood of war due to a long-run opportunity cost can only hold when after the war bilateral trade is reduced, at least for a definite period of time. Therefore we test whether wars reduce the amount of bilateral trade flows. We expect that post-war years must be significantly different (significantly lower to be more specific) than other years in order for liberal theory to hold. If not, then the opportunity cost explanation is not of importance in a state's decision-making.

We again differentiate between different term-lengths. As our game theoretical model predicts that trade is reduced after a war, we need to know whether the strong assumption of infinite punishment holds, or whether there is evidence for a shorter punishment. We create dummy-variables for four period-lengths after a war has taken place. The short term indicates a post-war year, the medium term three post-war years, the long-term seven post-war years, and the infinite term is an infinite punishment, where we give the value $x_{it} = 1$ for all years after the first war of a given dyad. Moreover, we run simple regression analyses for each dyad individually, and we also pool the data. In the pooled analyses, we estimate the effect by using dyad-specific fixed effects. This means that we have a different intercept for every dyad, which is logical as the effect of bilateral trade on the propensity to engage in war is likely to be affected by dyad-specific variables.⁷⁷ We do not include period-specific fixed effects, as we do not expect that there are significant effects of common shocks in a certain year that affect all dyads. Also our goal is not to test whether some dyads are more likely to fall into war, as we have excluded non-warring dyads. We rather look at the effects of economic interdependence on the likelihood of war for specific dyads.

⁷⁷Also, when the individuals from the sample are not a random draw, it makes more sense to do a fixed effects estimation, rather than a random effects one. (Verbeek, 2012, pp. 384-385)

Table 7: Effect of War on Trade: Trade-levels after a War

Dyad	Short	Medium	Long	Infinite	n*t
1 (IND-PAK)	-0.001803	-0.001978	-0.001981**	-0.004129***	60
2 (CHN-IND)	-0.002071	-0.002149	-0.002317	0.00239	58
3 (EGY-ISR)	-0.000447	-0.000466	-0.000509	0.000548	50
4 (HON-ELS)	-0.010153	-0.010585**	-0.011569***	-0.009581***	50
5 (CYP-TUR)	-0.000917	-0.000999	-0.001145	-0.002058***	50
6 (IRN-IRQ)	-0.000171	-0.000178	-0.000195*	-0.000330***	50
7 (ARG-UK)	-0.001364	-0.001431***	-0.001520***	-0.001455***	48
8 (ECU-PER)	-0.002053	-0.001428	0.000437	0.004363***	50
1-8 Pooled with Dyad Fixed Effects	-0.002263*** (0.000727)	-0.002327*** (0.000506)	-0.002302*** (0.000462)	-0.001226** (0.000485)	416

*Dependent variable fracimps (bilateral trade). P-values: *** < 0.01, ** < 0.05, * < 0.10. The pooled analysis is done with cross-section fixed effects (dummy variables). White cross-section standard errors & co-variance (d.f. corrected) are used. Standard Errors appear in parentheses. The reported coefficients are bivariate correlation coefficients including the intercept. The intercept is however excluded from the table.*

From the individual dyad analyses we cannot find a significantly negative effect on bilateral trade in the short-run. However, this is probably caused by the limited amount of observations.⁷⁸ On the medium and long-term, we do see a significant effect of the war on trade on the 10% level. It is odd that that some dyads do see long-term punishment but no medium-term punishment according to the regression analyses, but this is likely to be caused by the limited amount of observations. There is a strong indication that war leads to a decrease in trade, which can be observed by looking at the sign of each of the coefficients. In the short, medium, and long-run, almost all signs are negative.

The results of the infinite term should however be taken with a grain of salt, as it is simply a before-after comparison which is not robust. Especially when there is no medium and long-run punishment, it is unlikely that there is an infinite punishment. After using visual inspection on our 8 dyads (see section (6.1)), we cannot find evidence for an infinite punishment, at best there is a punishment for a number of years, but after a while bilateral trade is restored to its normal values again. The punishment-length is also different for each dyad.

The pooled analysis shows that there is a strong indication that trade is reduced after a war. This result is significant in the short-run on the 10% level, and significant in the medium and long-run on the 1% level. This result is confirmed in the appendix (A). There we present a table with iterated multiple regression analyses where we regress

⁷⁸Recall that the number of observations decreases the standard errors. The number of observations for a single dyad may be too low to get statistically significant results, but the pooled analysis by definition has more observations so that the size of this problem is reduced. The standard error decreases in the number of observations, as the standard deviation is divided by the squared number of observations (i.e. $SE_{\bar{x}} = \frac{s}{\sqrt{(n)}}$, where the standard errors are computed by dividing the sample standard deviation (s) by the square root of the number of observations (n)).

bilateral trade on the lags of war for every observation pooled. We add one lag when the previous lag is significant on the 10% level. We find that there is a strong effect of war for four years on the 1% significance level and for 7 years on the 10% level. The table indicates that trade in the first four years after a war is 80% to 85% lower than in other years, and approximately 60% lower than otherwise from the 5th to 7th year after a war.

War thus does have an opportunity cost, and the liberal and realist prediction that trade will end after a war turns out to be correct. This is especially strong evidence for the liberal position that trade leads to peace due to the long-run opportunity cost. However, we find no infinite punishments,⁷⁹ which means that the standard game theoretical prediction is incorrect. We will discuss this in more detail in the final sections.

6.4 Trade, Wars, and MIDs on the Global Level

In this section, we check whether trade leads to peace on the global level. We use data between 1870 and 2001. Our main independent variable is ‘openness’ indicating the number of imports and exports relative to world GDP.⁸⁰ The higher the value this variable gives, the more economically interdependent the world is deemed to be. Our main dependent variable is international military conflict. However, due to the fact that there are very few wars, there is little variation in our dependent variable. Hence we also look at the effect of economic interdependence on conflicts which are not classified as wars. We therefore use the MID-data-set in order to find all events that are characterized by international conflict between states.⁸¹ We exclude MIDs where force was merely displayed or MIDs where states only threatened other states. The reason for this is that our thesis looks at the effect of economic interdependence on conflict, and not on such ‘smaller’ disputes. Economic interdependence is said to be peace-inducing due to a future opportunity cost, however, when force is merely displayed, there is not such a strong incentive for the other state to initiate the so-called punishment of reduced trade. We therefore may find different results than Harrison and Wolf (2012) who find no effect of trade on conflict, as they also look at MIDs where force is merely displayed.

The fact that we use time series data has certain implications for our regression analyses. The error terms are likely to be serially correlated, if that is the case, then we cannot use the variables in their standard form. First it is necessary to check whether our variables are stationary (or integrated of order 0: $I(0)$). For this reason, we perform the Dickey-Fuller test. We find that two of our variables (‘openness’ and the variable which indicates the number of states) are non-stationary⁸² (in our case, they are $I(1)$, meaning that the first difference is in fact stationary). Our dependent variables are however all $I(0)$, which means that we cannot test for co-integration. Our next course of action is to take the first difference of all variables. This has the implication that the interpretation of the results will change, as we check for the effect of changes in our independent variables on changes in the dependent variable.⁸³

Before we run our regression, we must also test whether the assumptions of regression

⁷⁹Although we report significantly different post-war levels of trade for some dyads with the infinite-punishment dummy, our visual inspection has shown that there is never an infinite punishment.

⁸⁰Trade data from Worldbank (2013) and Martin *et al.* (2008).

⁸¹Ghosn *et al.*, 2004. We include MIDs which are coded as a blockade, occupation of territory, seizure, attack, clash, declaration of war, use of CBR weapons, and the begin or joining of an interstate war.

⁸²See Appendix B

⁸³To understand the various issues with time-series analysis, we have used Verbeek (2012, pp. 278-369).

Table 8: Effect of Trade on the Number of Yearly MIDs

	(1)	(2)	(3)	(4)	(5)
Intercept	0.16 (0.40)	0.36 (0.55)	0.49 (0.61)	0.44 (0.57)	0.38 (0.53)
$\Delta \text{MIDs}_{4t-1}$	-0.32** (0.13)	-0.31** (0.13)	-0.32** (0.13)	-0.28** (0.11)	-0.32** (0.13)
$\Delta \text{MIDs}_{4t-2}$	-0.16 (0.09)	-0.16* (0.10)	-0.16* (0.10)	-0.11 (0.13)	-0.16 (0.10)
$\Delta \text{Openness}(x100)_t$		-0.67** (0.31)	-0.68** (0.31)	-0.69** (0.30)	-0.71** (0.32)
$\Delta \text{Openness}(x100)_{t-1}$					(-0.15) (0.36)
ΔStates_t			-0.11 (0.16)	-0.14 (0.17)	
$\Delta \text{Major States}_t$				1.49 (1.30)	
$\Delta \text{Democracy}_t$				1.87 (4.77)	
R^2	0.10	0.13	0.13	0.14	0.13
Adjusted R^2	0.09	0.11	0.10	0.10	0.10

*Dependent variable: ΔMIDs_{4t} . Data between 1870 and 2001. P-values: *** < 0.01, ** < 0.05, * < 0.10. Standard errors appear in parentheses. Coefficients rounded to two decimals. HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 5)*

hold. We check for heteroskedasticity and serial correlation. When the assumptions do not hold, we will correct our standard errors using heteroskedasticity-consistent standard errors (HAC [Newey-West]).⁸⁴ The results of these tests are to be found in the appendix. To solve the problem of serial correlation we use an amount of lags of our dependent variable. We define the optimal amount of lags of the dependent variable by minimizing the Akaike Information Criterion (AIC),⁸⁵ the optimal amount of lags appears to be 2.

We find that the effect of ‘openness’ on the amount of yearly MIDs (where the minimal MID-level is ‘4’) is significant on the 5% level. Differences in trade levels over time have a significant and negative effect on the change in Militarized Interstate Disputes over time. This means that trade decreases the number of yearly MIDs. An increase in ‘openness’ leads to 0.67 less MIDs on average. We find that the optimal model is (2), looking at the adjusted R^2 , which is maximized in model (2). The pacifying effect of trade appears to be robust, even after adding several control variables. Changes in the number of MIDs do not depend on changes in the number of states, the number of major states, or on democracy. This is again a confirmation of the liberal expectation that trade reduces the incentives for engaging in violent conflict with another state.

Based on the results of the global data-set, we can however not say whether trade leads to less MIDs, or MIDs lead to less trade. Model (5) shows that the first lag of

⁸⁴Verbeek, 2012, pp. 125-126

⁸⁵Ibid., p. 310

our main independent variable does not have a significant effect on the amount of MIDs. However, to establish a causal relationship, it is necessary that a cause precedes an effect. We cannot provide absolute certainty that a decrease in trade precedes or comes after interstate disputes. We can however say that they are correlated, and that increases in the number of yearly MIDs are associated with decreasing trade flows. However, it is necessary to know that there are many things which we have not accounted for. We cannot really know whether interdependence changes at the same rate as trade, as we have not accounted for asymmetrical interdependence. There are more of such variables which we have not accounted for, but which are important in order to be able to say something more concrete about economic interdependence rather than trade.

6.5 Discussion

In general, we find that economic interdependence, measured by bilateral trade, decreases the propensity of international conflict, for both interstate wars, and MIDs more broadly. The results presented in this section lead us to believe that the liberal expectation has higher explanatory power, and that the realist arguments against the pacifying effects of economic interdependence do not hold much ground. However, we find in our dyadic analysis that trade does not always follow the same pattern around a war. We mean that trade does not always decrease before a war, and trade does not always go to '0' in every occasion either.⁸⁶ This leads us to believe that the 'contingency'-argument has some explanatory power; under some conditions economic interdependence does increase the propensity to go to war, and in some occasions it decreases or has no effect on the propensity to start a war. We will continue our discussion more broadly in the next section.

7 Conclusion

We have explained how liberalism and realism expect economic interdependence to influence a state's strategy when it comes to war and peace. We have shown that under liberal conditions, economic interdependence will have pacifying influences in the international realm. The liberal expectation that interdependence leads to peace is disputed by several realist authors, who state that liberal conditions do not hold, but the world is rather subject to realist conditions, so that economic interdependence induces states to go to war. We have supported our theoretical framework with a model, in order to show that the basic assumptions of liberalism and realism indeed lead to their corresponding expectations with respect to peace and war. A realist world is characterized by insecurity and a concern for relative gains, while a liberal world is comprised of states more concerned about absolute gains and economic welfare.

After contrasting liberal and realist theory, we have tested their expectations regarding bilateral trade levels before and after wars, and we have tested whether more trade in the world leads to more or less Militarized Interstate Disputes. Although evidence is mixed in the dyadic data-set, we are inclined to say that the evidence for liberalism is stronger than for realism. Both theories are correct when it comes to post-war levels

⁸⁶Also it is important to note that, even though official data will show that trade-flows are '0', this does not mean that they are actually '0'. There exists of course smuggling during periods of war.

of trade (trade is significantly lower after a war than otherwise, with differences of over 60%), but our logistic model shows that wars can be explained by decreasing levels of trade, so that trade is said to be peace-inducing. In addition, after running our regression with the world-year as unit of analysis, we have found that an increase in openness generally leads to less conflict. This also increases the validity of liberal theory.

We answer our initial research question (does economic interdependence lead to less inter-state wars?) in the positive. We are inclined to accept that economic interdependence is a countervailing factor against variables that are likely to increase the propensity to start wars. Most results show clearly that wars are caused by decreasing levels of bilateral trade. Although evidence is mixed (we have shown that on average, in the seven years before a war, trade is significantly more increasing than otherwise),⁸⁷ the evidence for liberalism is stronger. When we closely inspect each individual dyad, we find that neither the liberal nor the realist expectation holds perfectly in every case. This is evidence for the notion that the effect of economic interdependence on war is contingent on several factors. We are however unable to control for these variables. When a state makes an *ex-ante* calculation and maximizes his utility by going to war or keeping peace, his decision is contingent on what each state expects. If a state believes that it will be attacked in a later stage; if it expects that wars are eliminative; and/or if it expects that future trade is not certain, then it follows that it can make a different decision. When we test empirically whether decreases (or increases) in bilateral trade lead to a higher propensity for a given dyad to fall into war, we cannot account for all these *ex ante* subjective valuations. As we have found no reasonable variable to account for all these contingencies, we must rely on regression analyses which have omitted several variables, which are deemed important in our game theoretical analysis.

If our theoretical and empirical research on economic interdependence and war is in fact correct, then this has serious implications for governmental policy. As it is safe to assume that states in general prefer a peaceful world over a unstable world (*ceteris paribus*), then it follows that states must not attempt to stop developments toward economic interdependence. The institution of tariffs, quota's, and export subsidies and taxes hamper the international free market and must lead to a decrease in (or diversion of) trade. Free trade is therefore the policy accompanied with peaceful interstate coexistence, and any deviation from free trade leads to a higher propensity for interstate conflict. If liberal assumptions about the nature of states and the international realm hold, then a process of economic interdependence is accompanied with a process of more peaceful interactions. The division of labor leads to higher total productivity, and when states do not care about relative gains, this can only increase the likelihood of peace. This also has implications for the other contingencies we mentioned in our model. A world of peace and free trade makes extended time horizons of states possible, which is positive for the likelihood of peace. When states can reasonably expect to survive, they can divert their attention to questions of economic welfare rather than considering the possibility that it may be eliminated when it does not carefully consider its security. The pacifying influence then becomes exponentially positive, as free trade is not only beneficial in the short run for economic growth, but also in the long run, as it allows for specialization. As explained before, a situation of peace and free trade allows for a process of decreasing time-preference

⁸⁷Recall that we created a dummy variable to indicate whether a dyad-year observation takes place in the seven years before the war, and we have run a regression analysis to test whether these years are significantly different than other years when it comes to growth or decay in trade. The result was, that there is significantly more growth than otherwise.

rates. Saving and investment lead to lower time preference rates, which subsequently lead to more saving and investment *ad infinitum*. When ‘property’ becomes more secure, saving and investment are accompanied with economic growth, which increase the opportunity cost of war, which leads to a lower propensity for interstate conflict.

It is however more reasonable to expect that the world is continuously changing, which also includes the relevant parameters explained in sections (3) and (4). Therefore it seems more sensible to propose a synthesis between liberal and realist theory. It is unlikely that liberal assumptions *always* hold, and the same is the case for realist assumptions. The ‘contingency’ argument leads us to expect that economic interdependence has a different impact on the propensity to start wars, depending on the time, the parties involved and other parameters. Economic interdependence, so to speak, needs to be divided into smaller pieces, as it by itself does not *always* lead to peace or war.

7.1 Limitations

We acknowledge that there are some limitations to the thesis. The model is not a perfect description of the real world, and it may overly simplify the state’s decision-making process when it comes to questions of war and peace. We have made some assumptions which need not hold in the real world. Specifically, we have assumed that states cannot bargain before they choose to go to war, while other models do work with bargaining.⁸⁸ We have also assumed that states face a Prisoners’ Dilemma, which leads to opportunistic behavior if time horizons are short. This however also does not need to hold in the real world, as states may acknowledge that they cannot win a war, or they may expect that the benefits in the short run do not exceed the costs in the short run. Then war is not an option in the first place, and mutual cooperation will be the equilibrium outcome. Additionally, we have made the odd, but common assumption that a state is a single, unified player with a single utility function (an assumption which is also often made in realist and liberal theories), but the state is instead an organization comprised of multiple individuals. This means that when a decision is made to go to war, this decision is not made by a single individual (especially not in contemporary democracies) but by a group of individuals. This may also have several implications for the question of economic interdependence.

Our thesis suffers from the fact that we have a relatively small sample size. Due to the fact that wars do not occur so often, we cannot add too many dyads, nor can we add many variables as that would severely increase our standard errors. This limits the internal validity of our results. We have however taken this into account by using dyad-specific fixed effects, in order to examine changes over time. We have argued that the question of economic interdependence and war is generally a question which should take into account the dynamics of several relevant variables. The influence of economic interdependence is not a static one, but rather extremely contingent on time.

As has been discussed above, the thesis lacks in external validity when it comes to the dyadic data-set. We have used a non-random sampling method, which implies that we cannot draw conclusions about the effect of economic interdependence on war for other dyads. As there is a trade-off between the possibility of generalizing the results (external validity) and internal validity, we have leaned toward choosing the latter. As the problem at hand does not occur often (i.e., there are few wars relative to the total amount of dyad-

⁸⁸ Fearon, 1995

years), it was rather our choice to discover the dynamic effects of changes in dependencies. As argued before, trade is not a perfect proxy for economic interdependence, so that a dyad experiences more trade than another dyad does not necessarily mean a higher rate of economic interdependence between the two states of the dyad. The level of economic interdependence also depends on a state's outside option. We do not have sufficient data (and we are restricted by time and resources in finding those data) to calculate the 'outside' option of a state (i.e. domestic production or trade with a third country), so that a time series analysis for each dyad individual makes more sense. The pooled analysis has added value—although we can not generalize the results to other dyads—as it shows whether observed patterns for individual dyads are generally identical. If they are not, then factors other than bilateral trade are more important.

7.2 Further Research

We propose that further research is extremely necessary to get a fundamentally deeper understanding of how economic interdependence affects a state's decision-making. Game theory (but also other approaches) may be helpful to understand more clearly how economic interdependence affects the likelihood of war. We have given some answers to this question, but we did not provide a 'full theory' of economic interdependence and war. In particular, theoretical research on the effects of more than two players is relevant, as is research on the post-war dynamics. Does the existence of more than two players lead to different effects of economic interdependence? Is there always a reason to stop trade after an opponent has used aggression? How long should the punishment last? How can we explain that economic interdependence sometimes has an effect, but not always? All these questions are valid, and there is still a lot of room for theoretical analyses.

There is also still room for improvement in empirical research. Although there is a large and developing amount of literature on economic interdependence and war, the relatively high quality studies have been done more recently, with the article of Caselli *et al.* (2013) article being the most recent and most rigorous according to our opinion. It is extremely important that economic interdependence is exogenous to a state's decision-making, otherwise the regression estimates are biased. There is a good case for deeming the finding of oil resources very exogenous (i.e. random) to a state's propensity to start wars. Although we have assumed that economic interdependence (in our thesis measured by dividing bilateral trade by bilateral GDP) is exogenous to going to war, this is likely to be less exogenous to finding an oil resource. From this it follows that, when states expect to go to war, they will already affect trade-flows before a war occurs, while this is almost impossible when it comes to finding oil resources on one's own territory.

Therefore further research which builds on the aforementioned article of Caselli *et al.* (2013) is recommendable. Caselli *et al.* have proposed that further research is necessary, looking at the dynamic consequences of finding (oil) resources, as Caselli *et al.* built a static, and not a dynamic, model and tested their model empirically accordingly. Economic interdependence as conceptualized and measured by this thesis is possibly too aggregated, and it needs to be broken down into smaller pieces, such as dependency on oil or other resources, geographical location of the resources, and so on and so forth. For us, many preferred data were not readily available, so that we had to do the best we could with the available data. When such more dis-aggregated data is available, then the impact of economic interdependence on war can be more robustly measured.

8 Reflection

Although we have given an answer to our research question, both on an empirical and theoretical base, we acknowledge that the model and empirical part of the thesis are based on many assumptions. Some of those assumptions are very strong. It is also true that the more assumptions are made, the less general a theory becomes, and this is a trade-off we have faced. When some assumptions are changed, the theory generates different conclusions. For example, we have made the assumption that choices are binary, i.e., states could choose for peace or war, and free trade or autarky. Such choices are much more nuanced in the real world. There is almost never a dichotomy between peace or war, but there are also other types of actions, such as military threats, which are not peaceful actions, but also not completely the same as military aggression. Moreover, the existence of bargaining was simply ignored in our model, but states are in fact able to communicate and may resolve differences of opinion via communication rather than immediately suspending cooperation. Moreover, theories which do not start from the assumption of perfect rationality may also have some explanatory power, as states will sometimes act contrary to game theoretical predictions.

Also, the assumption that states face a Prisoners' Dilemma constrains the external validity of the model. A model which is based on other models from game theory, such as the game of chicken or a coordination game, will generate different results, which may have different implications for the sign of the effect of interdependence on war. The fact that the Prisoners' Dilemma is best applicable to show the effect of interdependence does not necessarily imply that it is the only correct application to international relations. Another assumption which has simplified our analysis is the aforementioned assumption of single actors. Economic interdependence may have completely different effects when it is assumed that the state is an organization which makes decisions in more complex manners than a single individual. We must simply acknowledge that we cannot exclude the possibility that this is the case, and state that although our model can show how economic interdependence affects a state's decision-making, it is by no means an exhaustive model.

Consider for example the relationship between the Netherlands and Belgium, or Malta and Cyprus. For such dyads, our model does not have a lot of explanatory power, as wars are highly unlikely in the first place. Also, even in the case that both states have some sort of small conflict over economic factors, which happens from time to time, by no means do they even consider war. Other solutions are reached through communication and bargaining, and economic interdependence does not necessarily increase or decrease the likelihood of war. Wars are also very costly due to other reasons than merely the probability of winning the war, such as the existence of norms and rules, interference of the United Nations or the European Union or the interference of other third parties who play a role. The same holds for many other dyads in this era, war is highly unlikely as other solutions are available and are far less costly. For such dyads, another model with different assumptions is much stronger than an iterated Prisoners' Dilemma. If other factors exist that are so strong as to ensure peace with almost absolute certainty, then it logically follows that economic interdependence can have no visible effect. Interdependence then does not make peace or war more likely, it has no effect at all. This also has certain implications for empirical testing of the effect of economic interdependence on war, and the methods that we have used in our thesis may not be applicable.

Our model is however useful to some extent, especially for situations where war at

least has a small probability. We have observed that dyads exist which engage in wars or less extreme military disputes. For those dyads, this model is particularly applicable, as dyads which have some significantly positive probability to engage in war can be influenced by economic interdependence and trade. In some scenarios, states cannot bargain themselves toward agreement, and the aforementioned strong factors are not present, then wars could occur. Economic interdependence is thus an effect on the margin, it can push states into war if realist conditions hold, and it can ensure peace under liberal conditions. Which assumptions and conditions hold will depend strongly on the specific situation and circumstances. This means that an application of the formal model needs to be preceded by a careful examination of the case at hand. We acknowledge that many more variables play a role in determining the likelihood of war, and we have only accounted for some of them. To be able to be more confident of our model, many more assumptions and variables need to be examined both theoretically and empirically. For our data however, the theoretical framework and the model have at least had a certain degree of explanatory power. We have been able to show some of the considerations that need to be made in order to determine the effect of economic interdependence on war.

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10 Appendix A: Dyadic Data-set

Table 9: List of Sampled Dyads

Dyad ID	Countries	Data	Year of Started Wars
1	India - Pakistan	1950 - 2009	1965, 1971, 1999
2	China - India	1952 - 2009	1962
3	Egypt - Israel	1960 - 2009	1969
4	Honduras - El-Salvador	1960 - 2009	1969
5	Cyprus - Turkey	1960 - 2009	1974
6	Iran - Iraq	1960 - 2009	1980
7	Argentina - United Kingdom	1962 - 2009	1982
8	Ecuador - Peru	1960 - 2009	1995
—	China - Taiwan	Insufficient	
—	Hungary - USSR	Insufficient	
—	Vietnam - Cambodia	Insufficient	
—	Azerbaijan - Armenia	Insufficient	
—	Eritrea - Ethiopia	Insufficient	
—	Chad - Libya	Insufficient	
—	Israel - Syria	Insufficient	
—	China - Vietnam	Insufficient	

Note that the first differences of our independent variable (`fracimps`) are all stationary, except for the second one. We cannot reject the null of a unit root for the first difference of `fracimps` of the second dyad. However, when we remove the second dyad from our sample, this does not change our results — we still observe that the first difference of bilateral trade has a significant and negative effect on the likelihood of war in our logit regression.

Table 10: Panel Unit Root Test results of $\Delta\text{Frac_imps}$

Method	Statistic	Prob.	Cross-sections	Obs
Null: Unit root				
Levin, Lin & Chu t^*	-13.67	0.00	8	375
Null: Unit root				
ADF - Fisher Chi Square	231.32	0.00	8	375
PP - Fisher Chi-square	782.09	0.00	8	400

Note: The first test assumes a common unit root process, and the second and third assume a individual unit root process. We can reject all null hypotheses of a unit root, which means that we can pool the data as it is generally stationary.⁸⁹

Table 11: Intermediate Augmented Dickey-Fuller (ADF) test results for $\Delta\text{Bilateral Trade}$. Lag Length Selection based on AIC: 0 to 10.

Dyad	Prob.	Lag	Max Lag	Obs
1	0.00	1	10	57
2	0.77	10	10	46
3	0.00	4	10	44
4	0.00	0	10	48
5	0.00	1	10	47
6	0.00	8	10	40
7	0.00	1	9	45
8	0.00	0	10	48

We reject the null of a unit root for all dyads except for the second one on the 5% level. This means that we cannot say that the second dyad is stationary.

Table 12: Effect of War on Trade

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Intercept	0.26*** (0.03)	0.26*** (0.03)	0.26*** (0.03)	0.26*** (0.03)	0.27*** (0.03)	0.27*** (0.03)	0.27*** (0.03)	0.27*** (0.03)
War _{t-1}	-0.22*** (0.07)	-0.22*** (0.07)	-0.22*** (0.08)	-0.22*** (0.07)	-0.22*** (0.08)	-0.23*** (0.07)	-0.22*** (0.07)	-0.22*** (0.07)
War _{t-2}		-0.21*** (0.08)	-0.21*** (0.08)	-0.21*** (0.08)	-0.21*** (0.08)	-0.22*** (0.08)	-0.22*** (0.07)	-0.21*** (0.07)
War _{t-3}			-0.20*** (0.08)	-0.21*** (0.08)	-0.21*** (0.08)	-0.22*** (0.08)	-0.22*** (0.07)	-0.22*** (0.07)
War _{t-4}				-0.21*** (0.08)	-0.21*** (0.08)	-0.22*** (0.08)	-0.22*** (0.07)	-0.22*** (0.07)
War _{t-5}					-0.16* (0.09)	-0.16* (0.09)	-0.17* (0.09)	-0.17* (0.09)
War _{t-6}						-0.15 (0.09)	-0.15 (0.09)	-0.15* (0.09)
War _{t-7}							-0.15* (0.09)	-0.15* (0.09)
War _{t-8}								-0.12 (0.10)
Obs.	408	400	392	384	376	368	360	352

Dependent variable: Bilateral Trade_t. P-values: *** < 0.01, ** < 0.05, * < 0.10. Standard errors appear in parentheses.

Table 13: Auxiliary Regression of War on Trade

Variable	Coefficient
Intercept	-0.000140
Bilateral trade _{<i>t</i>-1}	0.895878***
@Trend	1.72E-05**
War _{<i>t</i>}	-0.001631**
War _{<i>t</i>-1}	-0.001994**
Joint Democracy _{<i>t</i>}	-0.000226
Joint Democracy _{<i>t</i>-1}	6.61E-05
R ²	0.87

Dependent variable: Bilateral trade. Dyad-specific fixed effects. P-values: *** < 0.01, ** < 0.05, * < 0.10. The table checks for model (2) of section (6.3). After adding a time trend and a lag of the dependent variable, the effect of war on trade is still both negative and significant.

11 Appendix B: Global Data-set

Table 14: AIC for Different Lags of Δ MIDs4

Number of Lags	Akaike Information Criterion
1	6.252447
2	6.236738
3	6.247727
4	6.261102

Table 15: Dickey-Fuller Test Results

Variable	t-Statistic	Critical Value (5% level)
Openness	-0.68	-3.44
Δ Openness	-11.23	-1.94
MIDs4	-6.47	-3.43
Democracy	-1.28	-1.94
Δ Democracy	-6.02	-1.94
States	-0.89	-3.43
Δ States	-5.87	-1.94
Majors	-2.17	-2.88
Δ Majors	-14.54	-1.94

If the null-hypothesis is rejected, it means that we reject the null of a unit root. If we do not reject the null, we must take the first difference of the variable. We repeat this process until we have a stationary series. We take the first difference of all variables in our regression analysis.

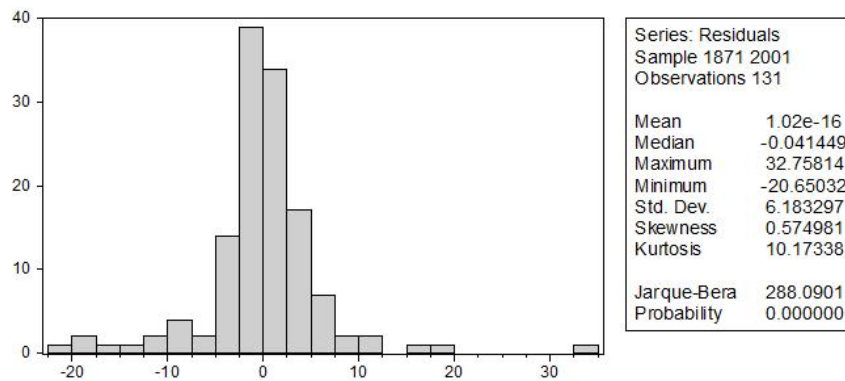
Table 16: Breusch Godfrey Serial Correlation LM Test

F-statistic	0.347602	Prob. F(2,125)	0.7071
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We do not reject the null hypothesis of no serial correlation.

Table 17: Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	0.707586	Prob. F(3,127)	0.5492
We do not reject the null hypothesis of homoskedasticity.			

Figure 13: Distribution of the Residuals

The residuals are not normally distributed. We reject the null of a normal distribution of the error term.