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SOSYAL BİLİMLER ENSTİTÜSÜ

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THE EFFECT OF DEFENSE R&D EXPENDITURES ON THE ARMS EXPORT IN TOP ARMS EXPORTING NATO COUNTRIES

MA Thesis

Yhlas Orazkuliyev

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TEZ ONAY BELGESİ

İKTİSAT (İNGİLİZCE) Anabilim Dalı İKTİSAT (İNGİLİZCE) Bilim Dalı TEZLİ YÜKSEK LİSANS öğrencisi Yhlas Orazkulıyev'nın THE EFFECT OF DEFENSE R&D EXPENDITURES ON THE ARMS EXPORT IN TOP ARMS EXPORTING NATO COUNTRIES adlı tez çalışması, Enstitümüz Yönetim Kurulunun 15.06.2015 tarih ve 2015-21/21 sayılı kararıyla oluşturulan jüri tarafından oy birliği / ~~oy çokluğu~~ ile Yüksek Lisans Tezi olarak kabul edilmiştir.

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ABSTRACT

The Effect of Defense R&D Expenditures on the Arms Export in Top NATO Countries

After the end of Cold-War period, the global situation has changed politically and economically. Most of the countries have cut their military spending and more funds devoted to the civil sector of an economy. These changes mostly affected the defense industries of arms exporting countries. In line with this changes European countries and USA had started restructuring their defense industries, in order to become more competitive in conventional arms export market and less dependent from public budgets. The study examines the effect of defense R&D expenditures on the conventional arms export in the nine top arms exporting NATO member countries. In this study, we employed a panel data model for the period 1981-2011. The results of our study reveal that export of those countries still depends on the political and security environment situations in the world.

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Anahtar Kelimler : Konvansiyonel Silah İhracatı; Savunma Ar-Ge; Panel Data Model; NATO.

ÖZET

AR-GE SAVUNMA HARCAMALARININ EN FAZLA SİLAH İHRACATI YAPAN NATO ÜLKELERİN SİLAH İHRACATI ÜZERİDEKİ ETKİSİ

Soğuk Savaş dönemi sona erdikten sonra dünyada siyasi ve ekonomik durum değişti. Ülkelerin çoğu askeri harcamalarını kısarak kaynaklarını daha fazla ekonominin sivil sektörlerine ayırmaya başladılar. Bu değişiklikler silah ihracatı yapan ülkelerin daha çok savunma sanayiilerini etkiledi. Bu değişiklikler doğrultusunda Avrupa ülkeleri ve ABD savunma sanayilerini, konvansiyonel silah ihracat pazarında daha rekabetçi ve kamu bütçelerine daha az bağımlı olabilmesi için yeniden yapılandırmaya başladılar. Çalışma savunma Ar-Ge harcamalarının konvansiyonel silah ihracatı üzerindeki etkisini en fazla silah ihracatı yapan 9 NATO ülkesinde araştırmaktadır. Bu çalışmada 1981-2011 dönemi için panel veri yöntemi kullandık. Çalışmamızın sonuçları, bu ülkelerin ihracatların hala dünyadaki siyasi ve güvenlik ortamlarına bağlı olduğunu ortaya çıkardı.

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LIST OF ABBREVIATION

3SLS: Three Stage Least Squares

ADF: Augmented Dickey-Fuller

CADF: Cross-sectional augmented Dickey-Fuller

CIPS: Cross-sectional augmented IPS test

EUROSTAT: Statistical Office of the European Communities

FGLS: Feasible Generalized Least Squares

GDP: Gross Domestic Products

GMM: Generalized Method of Moments

GNP: Gross National Products

GBAORD: Government Budget Appropriations or Outlays on R&D

IPC: Levin, Lin and Chu, 2002 unit root test

LLC: Im, Pesaran and Shin, 2003 unit root test

LM: Lagrange multipliers

MIC: Military Industrial Complex

N: number of cross-section

NATO: North Atlantic Treaty Organization

OECD: Organization for Economic Co-operation and Development

OLS: Ordinary Least Squares

PCSE: Panel Corrected Standard Errors

PPP: Purchasing Power Parity

R&D: Research and Development

RMA: Revolution in Military Affairs

S&T: Science and Technology

SEM: Simultaneous Equation Model

SIPRI: Stockholm International Peace Research Institute

SKIN: Simulating Knowledge Dynamics in Innovation Networks

T: number of time-series

TIV: Trend-Indicator Value

WDI: World Development Indicators

UK: United Kingdom

USA: United States of America

USSR: Union of Soviet Socialist Republics

1. INTRODUCTION

The total world conventional arms export and military expenditures have decreased from its peak in the mid-1980s, till to its minimum in 2002 according to Stockholm International Peace Research Institute (SIPRI) database (Figure 1). It was expected that after the end of Cold-War, the decreasing trends of military spending will remain and it was the case for the many countries, except the countries that were involved in the regional conflicts or had high threat in the regions (Elveren and Hsu, 2015; Dunne, Birdi and Saal, 2000). The most western countries' policies have changed and mainly European countries have decreased their military expenditure. From the military spending cuts, no doubts, that it has mostly affected the defense industries of producing countries.

In line with a new global environment, European countries and USA had started to restructure their defense industries, as those industries have faced with military budget cuts globally and had entered into hard periods. These restructuring procedure have done in order to be less dependent on public budget and maintain competitive advantage in the export market for defense companies. The European companies experienced strategic alliances, joint ventures and collaborative projects, while USA companies were tending to move towards the acquisitions and mergers (Neal and Taylor, 2001). Although having new global political and security environment, the export of conventional arms form 2000s have started to increase and maintained its increasing trend till to 2011 (Figure 1).

In line with these global changes and implemented restructuring policies, we tried to answer connected two questions: first, do the defense R&D expenditures affect the export performance of defense industries? Second question, do the defense industries become more export oriented after the restructuring policies implemented in the defense sector?

The objective of our study is examining the effect of defense R&D expenditures on the conventional arms export of the nine top arms exporting NATO member countries. Considering the global arms export market changes and restructuring policies that were implemented after the Cold-War, our analysis tried to capture the effect of defense R&D

expenditures on their export performances. In the analysis we use panel data model, and regression is implemented by the fixed effect regression model with Driscoll-Kraay standard errors, for the period between 1981 and 2011. The main contribution of our study is that to reveal the relationship between the defense R&D expenditure and conventional arms export, and for the period, without any missing time period, between 1981 and 2011 years and for the nine countries or in the panel model.

The results reveal mainly two important conclusions about the defense R&D expenditures for the selected countries. First, in the defense industries, national security objective has still maintained its priority and, creation and production processes are maintained accordingly. However, the export market orientation is still a secondary objective. Second, the main reason for the demand of conventional arms is due to the political and security environment in the world (regional conflicts).

Next section provides theoretical approaches that are used in the military economy and discusses empirical works. The section 3 introduces the empirical models as well as selection of variables and data-sets. The sub-sections of 3 present the pre-test and regression results of empirical models. Section 4 provides a conclusion of the study and suggestions for the future studies.

2. LITERATURE

In this section we present literature reviews of military economics, which we have divided into two sub-sections: the first is theoretical foundation and the second is empirical works. In the first sub-section we have discussed about theoretical approaches and their deficiencies that were developed and used in this field. In the final sub-section we present empirical works that are contributed to our study.

2.1 Theoretical Foundation

In the first period of 1990s, the Cold-War ended and resulted in the hegemony of USA (Dunne and Coulomb, 2008). This brought some important changes in the considerations of national security concept besides the substantial changes in political and economic environments. The change of strategic environment has presented an opportunity to reduce world's total military spending. The most of Western industrialized countries have decreased their military spending and it has been faced with decreasing trends in their military spending in developing world as well. Only exception is the regions in which some countries have been kept high levels of military expenditures due to their security environment (Dunne, 1996).

The most of the defense industries have faced with new environment where the tendency was to cut the military expenditure and to provide optimization of defense funds. Accordingly, by the end of Cold-War many economies, particularly European countries, have started to reconstruct their defense industries in accordance with the new world environment (Neal et al. 2001). These trends have spread to other countries in different forms.

The change of world military and political environment has affected the works developed by policy makers and academic environment as well. In the period of Cold-War the most of the studies were associated with the effects of military spending on growth or development of country economies. With the end of the Cold-War period, direction of the studies has dramatically changed, as the result of what the researchers have mostly devoted their attention into conventional arms export market and its further effects on other parts of the economies. The reason for such a change in the directions of studies is that conventional arms markets stopped decrease and started to increase and sustained the increasing trends for the last years, as shown in the Figure 1.

In the military economics literature, mainly four theoretical positions have been adopted in order to assess the economic effects of military spending, which are used both for the developed and developing nations. However, Dunne (1996) states that for the research on economic effects of military expenditure is complicated, because many economic theories do not have an explicit role for military spending as a distinctive economic activity. Besides, he also notes that it has not been preventing to the development of those theoretical approaches. These theoretical approaches are Neoclassical, Keynesian, Institutionalist and Marxist approaches.

The Neoclassical approach based on maximization of well-defined national interest reflected in a social welfare function, by seeing the government as rational actor which balances the opportunity costs and security benefits of defense expenditure (Dunne, 1996). Then military spending can be treated as a pure public and the economic effects of it are determined by its opportunity cost with trade-off between civil and military spending (d'Agostino, Dunne and Pieroni, 2010). These models based on supply-side model of growth and defense spending relations and referred as Feder-Ram model (Halicioğlu, 2004). Dunne, Smith and Willenbockel (2005) state that the supply-side growth model originally was developed by Feder (1986). This model analyses the impact of the export sector on economic growth in developing countries and popularity of it lies in the appearance of direct link from theoretical model to econometric specification (Dunne et al., 2005).

However, neoclassical approach was criticized for being always able to justify observed actions, not concerning historical development, concentrating on the supply-side, ignoring of internal role of military and military interest, implying a national consensus, requiring extreme knowledge and for the unrealistic computation abilities of rational actors

(Dunne, 1996). In analysis of models of military expenditures and growth Dunne et al. (2005) conclude that Feder-Ram model suffer severe econometric problems, particularly simultaneity bias, lack of dynamics and it provides too narrow a list of possible influences on growth. They also critically evaluate two alternative theoretical approaches, the Augmented Solow and the Barro growth models, suggesting that they provide a more promising avenue for future research than Feder-Ram model.

Keynesian military spending approach was based on Keynes' theory of multiplier effect (Custers, 2010). It sees government as pursuing active policies or proactive actor in the economy, which uses military expenditure as one part of government spending. By increasing of military expenditures, it should increase total output through multiplier effects in the presence of ineffective aggregate demand or deficient demand (Dunne, 1996). As total output increases, this leads to increase in the capacity utilization and higher profits, which results in enhancing to increase in the investment and growth (ibid).

The critiques towards Keynesian approach were due to the lack of theoretical sophistication and it was presumed that it could apply only within context, where the budget spending was closely correlated to the purchases of arms and to military spending in general (Custers, 2010). There exists the possibility that governments do not rely on military spending as their primary leverage for regulation business cycles (Custers, 2010). Moreover it has been criticized for its failure to consider supply-side issues by only concentrating on demand-led effects,[1] which leads many researchers to include explicit production functions in their Keynesian models (Dunne, 1996).

Institutionalist approach as defined by Dunne (1996) is usually having radical liberal approach, which combined with radical Keynesian perspectives. They have focused their works towards the way, in which large amounts of military spending can lead to the industrial inefficiencies and to the creation and development of powerful and unified interest groups. These interest groups consist from different groups of society, institutional linkages, military personals and politicians. By institutional linkages they referred as military industrial complex (MIC). Dunne and Sköns (2009) stated that MIC has become a self-generating structure in which groups compete for the resources. It leads to the internal

[1] For the further information, see Tiwary and Tiwary (2012).

pressures (lobbying in the US Congress;[2]) for the high military spending and proving for justification the external threats and; even when there is no threat to justify such expenditures. They also noted that the MICs imposes burden on the rest of society and crowding out civilian resources.

Adam and Adam (1972) stated that the reason for MICs is the military market structure which is characterized as monopolistic and oligopolistic; and the best empirical indicators for the structural economic powers (in our situation MICs) are the presence of economic profit and technological inefficiency. They also summarized as best explanation of poor (inefficient) performance in the MIC is the uncertainty emanating from inadequate technological information and monopsony-oligopoly configuration it promotes. Elveren et al. (2015) stated that although MICs were the important explanation for the high military spending during the Cold-War period, many aspects of MICs have remained even after the Cold-War period.

Marxist approach is not different from others in a manner of providing a general Marxist theory of militarism, rather Marxist scholars provided specific linkages between military expenditure and the profit rates (Elveren and Hsu, 2015). The role of military spending seen as an important aspect of the capitalistic developments and at the same time having contradictions to it. It means that militarism bears within itself the contradiction or destruction, by which competition among groups forces them to spend more resources each period on military spending which leads to the financial collapse. Dunne and Uye (2009) also stated that in the literature a number of strands to the Marxist approach which differ in their treatments of crisis and the role of MICs in class struggle, where MICs are constrained by the laws of motion of the capitalistic system. They also pointed out that the only Marxist theory in which military spending is both important in itself and an integral component of the theoretical analysis, the underconsumptionist approach.

The theory of underconsumption was introduced by Rosa Luxemburg (1913) and later taken up by Baran and Sweezy (1966) interpreted under the “monopoly capitalism” theory.[3] In this approach military spending under the monopoly capitalistic condition,

[2] For the further information, see Neal et al. (2001).
[3] For the further information, see Zeitlin (1974) and Dunne (2011).

which means existence of MICs, plays an important role in the economy. It helps in preventing realization crises (stagnation or crises caused by difficulties in selling outputs due to deficient demand meaning that profits cannot be realized), through absorption of economic surplus without raising wages (so maintaining the profits) or capital and no other government agencies could do this (Dunne, 2011). According to this approach the MICs provides valuable service to maintaining capitalism. Again when capital economies have tendencies of overproduction then according to same theory military spending is wasteful and the allocation of resources into MICs prevents overheating by playing positive role (Sköns et al., 2009).

Besides previous four theoretical approaches, within neoclassical framework, there was developed "arm race" models for determination of military spending in countries. One of the most influential models of the arms race is based on mathematical model of an "arms race" in the seminal study presented by Lewis F. Richardson in 1960 and; later arm race models are the variants of Richardson arm race model (Hou, 2009). According to this model two opposing countries determines their military expenditures in an action-reaction framework and rival's military spending are main determinants of a countries' military expenditure (Dunne et al., 2008). The problems associated with Richardson model revealed as not including of decision-making process, explicit objectives, explicit economic constraints and strategic considerations (Hou, 2009). But although having problems of models, Dunne, Nikolaidou and Smith (2003) stated that during the Cold-War period arm race between the USA and USSR was the focus of much concern and since end of Cold-War period the focus has been shifted to regional conflicts and these are still analyzed using arms race models which developed during the early period.

2.2 Empirical Works

Before starting the discussion about empirical works, we note that, the most of the research works are deviated from theoretical grounds. Dunne (2011) also points out that most of them do not use specific model, and vary in the length of the time-series and coverage. No doubt that all works that was done in this field are contributed in development of military economy, and each of them reveals new perspectives to it.

J. Paul Dunne is one of the researchers who has contributed the most of his researches to military economy fields. The most of his works mainly was analyzing impacts of military spending on different aspects of economies, particularly with growth. His contribution was not only limited with empirical works, but he also contributed in assessing theoretical foundation and models for all approaches that we mentioned in the previous section. He also concluded that survey of the empirical analyses, mainly within Keynesian framework, suggests that military expenditure has at best no effect on growth but is likely to have a negative impact and certainly there is no evidence of a positive effect (Dunne, 1996).

Dunne, et al. (2005) reviewed some theoretical and econometric issues involved in estimating growth models that include military spending. They pointed out that mainstream growth literature has not found military expenditure to be a significant determinant of growth, many of the defense economic literature has found significant effects, and they argued that it is largely the product of the particular specification, the Feder-Ram model, which has been used in the defense economic literature but not in the mainstream literature. They, (Dunne, et al., 2005), critically evaluate this model, detailing the Feder-Ram model problems, limitations and suggest that it should be avoided. They also critically evaluated two alternative theoretical approaches, the Augmented Solow and the Barro models, suggesting that they provide more promising avenue. However, the same researches in their previous work in 2001 for the same problems developed an Augmented Solow growth model with Harrod-neutral technical progress. They also surveyed the econometric issues involved in estimating these models and used a panel of 28 countries study for the period 1960 and 1997. The estimates were made of both the Feder-Ram and new alternative growth model using one and two way fixed effects models and a Swamy random coefficient estimator.[4] Empirical works produced poor results for the Feder Ram model, but much more promising results for the Augmented Solow growth model with Harrod-neutral technical progress.

[4] The Swamy random coefficient estimator is presented an efficient method of estimating the mean and the variance-covariance matrix in random panel data models by Swamy (1970).

Within the Neoclassical approach Dunne et al. (2000) investigated the relationship between growth and military spending of South Africa's manufacturing industries using modification of the Feder-Ram model (neoclassical approach) that have widely used for developing countries. The dataset was used in the analyses is in the form of panel data model and regressed with random effects model. The estimations were carried out for the period 1973-1993 and for the 45 industries. Their analysis showed that government procurement had a significant and positive effect on industrial growth.

A different methodology, but for the same country, for the empirical analysis was implemented by Dunne, Nikolaidou and Roux (2000). They defined a simultaneous equation model (SEM) consisting of four equations: a growth equation, a savings equation, a trade balance equation and an equation of the demand of military expenditures. Unlike previous work, in this analysis they used the Keynesian supply and demand model for the period of 1961-1997. They estimated results by using 3SLS model and revealed that military burden has a negative impact on growth and significant. It also revealed that military burden does not have significant effects on savings. Finally they concluded that there is certainly no evidence of any positive impact, suggesting that cuts in military spending do present an opportunity for improved macroeconomic performance.

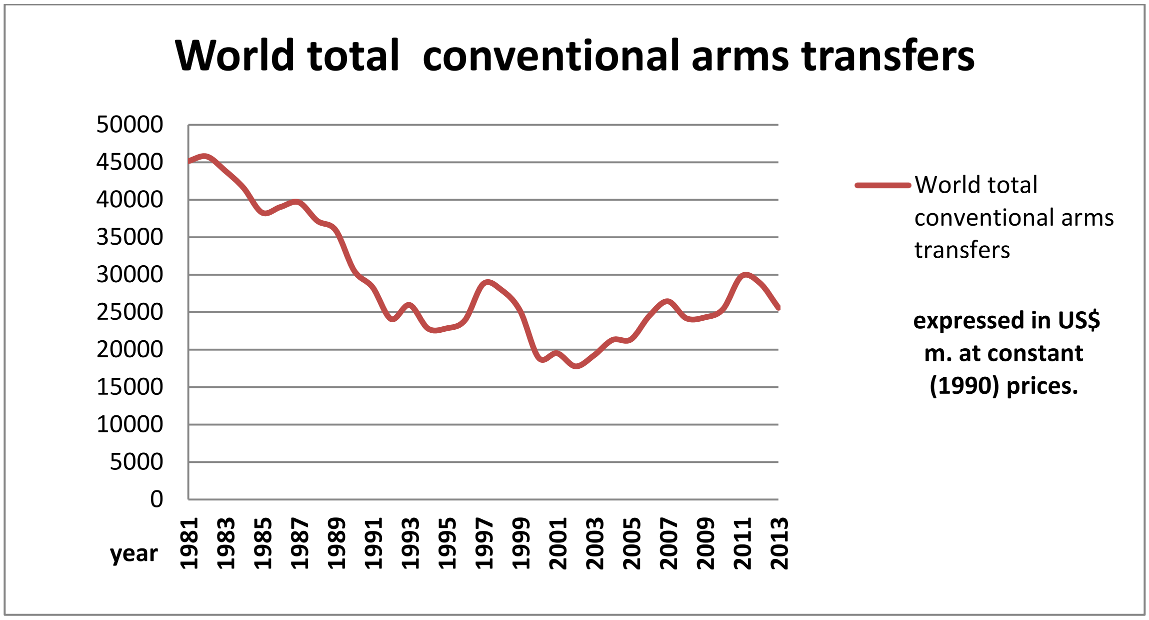
Within the Institutional and Marxist approaches Sköns et al. (2009) reviewed the origin and theoretical foundation of the concept MIC and explained the key issues involved in the literature on the MIC in the Cold-War context and post-Cold War period changes. They pointed out that the concept of the MIC was developed in the USA and is most readily applied there. While with the end of the Cold-War there were significant cuts in demand for arms, which leads to the reduction of power of the MIC in many countries. In the USA, however, there were developments that went against the trend, with military spending starting to grow again in 1999 and increase rapidly in 2001, with the 'war on terror'. There were also changes in the nature of the demand in the arms market. The changes in the demand side of the arms market, with the Revolution in Military Affairs (RMA) making communication and control technologies increasingly important in the theatre of military operations. Concluding that, there still remarkable degree of continuity within the MIC in the post-Cold War period.

Dunne et al. (2003) contributed to the arms race models, which was developed aside the mainstream theoretical approaches. They reconsidered the estimation issues with Richardson's action-reaction model, which was used in some recent developments in time-series econometrics and illustrated the issues with estimates for Greece and Turkey and India and Pakistan. The time period for Greece and Turkey and India and Pakistan models in the analysis was between 1961 and 1996. They showed that in one case it takes the classical Richardson form and in the other it does not. However, there is little evidence for a Richardson type arms race for Greece and Turkey, India and Pakistan show a stable interaction with a well determined equilibrium. They explained the differences for cases by security environment and different political decision taking policies. Although being explained by arm race models of determination of military spending, Dunne (2011) highlighted that best strategic explanation, are rooted in war and the communist threat, rather economic justification. Another perspective for determination of military spending is stated by Freeman, Cooper, Ismail, Sköns and Solmirano (2011) that, economic growth rates, security threats and power seeking in global and regional status.

Besides Dunne, Frederiksen and Looney (1983) re-examined seminal works of Benoit (1972) and developed a model of defense and economic growth that explicitly incorporates resource constraints. They argued that previous works produced mixed results instead of the same for the all developing countries, mostly insignificant results. The reason for the mixed results, they pointed out due to the relative financial resource constraints faced by individual countries. Therfore, they sorted, 37 out of 44 developing countries which was in Benoit's original work, in to four groups, where grouped from most resource abundant countries to the resource scarce ones. Then they used in the analysis the same methodology, data and time frame (1950-1965) as in Benoit (1972) work. The results of the analysis conformed their hypothesis, and showed that the relationship between the growth and defense will be positive and statistically significant for the countries that are relatively resource unconstrained, while the opposite will be true for the resource constrained countries.

By the time of the ending of the Cold War period, the empirical researches also deviate their analysis from classical defense-growth frameworks towards other field of economy. As seen in the Figure 1, the conventional arms trade market in the post-Cold War period decreased, but after the 1990s the volume of export in the marked increased again.

Figure 1: World total conventional arms transfer



Source: author's calculations based on SIPRI Arms Transfers Database

Thus, as the post-Cold War situation changed in conventional arms market from policy oriented concerns towards economic concerns, especially for European countries, many researches are concentrated their works on assessment of arms production and their effects. Brzoska (1999) analyzed economic factors shaping arms production in less industrialized countries in considering new environment they faced. He pointed out that the most important reason for less industrialized countries have got involved in domestic production, is that they received substantial pushes from arms embargoes (mainly from political reasons) declared by the major arms exporters. Sislin (1994) analyzed arms exports of USA as manipulating tool and used logit analysis for the period 1950-1992. His empirical woks supported the arguments of Brzoska, and showed that USA had successful influence when it used promises or rewards, focused on altering the receipt's foreign policy.

The second and most important conclusion, Brzoska (1999) revealed in his analysis, important determinants for the production of arms in less industrialized countries are the civil industrial capacity and capability of producing different types of products and strong political supports by their governments. Similar analysis was done by Brauer (1998) about arms industry in the developing nations. He also pointed out that developing nations could graduate to higher levels of arms production sophistication as the civilian industry capabilities increases and as they become more integrated into the transnationalization of arms production efforts.

A similar econometric work was done by Kinsella (2000), he examined a relative importance of civilian industry capabilities by analyzing time-series cross-section (panel) data for the twelve leading third world arms producers from 1968 to 1990. He revealed similar results which supports Brzoska's (1999) and Brauer's (1998) works that arms production depends on the state's industrial capacity and by the closeness of political and governmental institutions, and thus the military's potential influence in the allocation of resources. On the top of them he also stated that states are motivated to pursue military industrialization programs by their involvement in regional conflict and the level of regional militarization.

Yakovlev (2007) examined the growth effects of military expenditure and tried to incorporate arms trade and their interaction in a balanced panel of 28 countries during 1965–2000. Further, he investigated a nonlinear interaction in the context of the Solow and Barro growth models recommended by Dunne et al. (2005) (which is mentioned in previous section) and used fixed effects, random effects, and Arellano–Bond GMM estimators. He concluded that Augmented Solow growth model specified in Dunne et al. (2005) yields more robust estimates than the reformulated Barro model. He also found that higher military spending and net arms exports separately lead to lower economic growth. However, higher military spending is less detrimental to growth when a country is a net arms exporter.

Beside the production of arms, recent years' trends research works concentrated on conventional arms export and its determinants. Elveren and Hsu (2015) analyzed within Marxian model of the circuit of capital to specify the role of military expenditures on the rate of profits and provided the evidence for 24 OECD countries for the period of 1963-2008 by employing the panel autoregressive distributed lag model for the first time. Their findings showed that while for the whole period there is a positive linkage between military expenditures and profit rates, in the post-1980 era, the impact of military expenditures is negative. Furthermore Elveren and Hsu (2015) suggest that there is no strong evidence to underscore the assertion for arms exporting countries and there is a positive linkage between military expenditures and profit rates, and negative linkage for non-arms-exporter countries.

ZhengQi and SiQi (2014) analyzed effects of strategic and economic factors on the conventional arms export after the Cold-War period. They used the fixed effect panel data model for the most exporting seven countries, for the period of 1992-2011. They used only two explanatory variables because of data availability issues due to the defense sector secrecy. The first explanatory variable they used is the military expenditures that represent the equipment purchases and the defense R&D expenditures. The second explanatory variable is the total world conventional arms demand, which represent the supply capacity and security environment indicators. The empirical results showed that USA, UK, and Germany have negative relationships between arms export and military spendings. They concluded that those countries developed into the stage of expanding arms export to promote saving on military expenses. For the Russia and China, they also concluded that both countries rationalized (optimized) their military expenditure and arms exports.

Castellacci and Fevolden (2014) also examined conventional arms export but at the firm level relations within Norway defense companies. They made use of two complementary methodologies: the first is based on econometric firm level panel data (100 firms) analysis for the whole population of defense companies, and the second one is based on qualitative case study research on the three most important defense export products (weapon stations, ammunition and electronics). Their empirical results highlighted the importance of four major success factors for exporting firms: the first is the participation in offset agreements; the second is the ability to focus on their set of core competencies; the third is their R&D activities and interactions with the public S&T system; and the last one is demand opportunities and, relatedly, user-producer interactions. Their findings were also supported by the empirical results of ZhengQi et al. (2014) works. In their firm level analysis, they also revealed that there is a negative relationship between the defense R&D expenditure and arms export for the period 2006-2009. They concluded that it was due to the short period.

Simulation methods were also used in assessing arms export performance in the firm level by Blom, Castellacci, and Fevolden (2012). They used SKIN model (Simulating Knowledge Dynamics in Innovation Networks). The SKIN is an agent-based model that provides an accurate analysis of private firms' interactions and knowledge dynamics in high-tech (or knowledge intensive) industries. The aim of their analysis was to forecast future scenarios of openness and liberalization (restructuring policies) in the defense sector. The simulation analysis pointed out that European defense firms will progressively become more efficient, less dependent on public procurement and innovation policy support, and more prone to knowledge sharing and inter-firm collaborations. It also highlighted the importance of firm-specific capabilities of innovation and increasing productivity.

Finally, mentioning about production and innovation capability of any industry or sector, the main attention will naturally concentrate on the Research and Development (R&D) processes and its affects. In the defense sector there is a few empirical works about defense R&D effects, mainly because of the data availability problems and missing periods (Middleton, Bowns, Hartley and Reid 2006). Although difficulties with dataset there are empirical works and mainly their discussions about crowding out and spin-off effects hypothesis of defense R&D spending.

Before crowding out and spin-off hypothesis, in the literature mainly from military and engineering academicians, analysis were done between defense R&D and military equipment quality and military capabilities of countries. Middleton et al., (2006) developed a quantitative model, which investigates the relationship between defense R&D and equipment capability. They used open data source and they evaluated military equipment quality of the ten nations from 1971 to 2005 and analyzed time-dependent correlation with defense R&D investment back to 1951. They found that the nations mostly "got for what they paid" and the defense R&D expenditures are positively correlated with equipment capability. They also revealed that observed variability in equipment quality was most highly correlated with the defense R&D which is spent 10–25 years earlier.

Okur (2013) assessed the effect of the defense R&D expenditures on the military capability and technological spillover. He analyzed 137 countries for the period 2009-2012. His study revealed that there is a highly positive correlation between the defense R&D expenditure and military capability, as well as between the defense R&D expenditure and technological spillover index. In his study, he also introduced new measures of military capability, a new estimation method for the defense R&D expenditures, and the new method to measure technological spillover effect from defense R&D expenditures.

Morales-Ramos (2002) analyzed the crowding out hypothesis by applying three types of models for the UK case: supply, demand, and demand–supply models for the period 1966-1996. The main argument for crowding-out hypothesis is that most part of defense is financed by government budget that may be used for other fields. The results for the UK reveals that the effects of defense R&D expenditure was non-significant and he concluded it due to the relatively small compared to whole economy. Further he applied demand–supply models for the France, Germany, Japan and USA; for the period 1971-1997. He reached to the same results, which indicates insignificance of defense R&D effects to the growth of those countries.

3. MODEL AND RESULTS

In this section, we first present variables, reasons for choosing them and expected effects from the analysis. In the first subsection we present empirical models and data-sets. Finally in continuing sub-sections test and estimation results are presented.

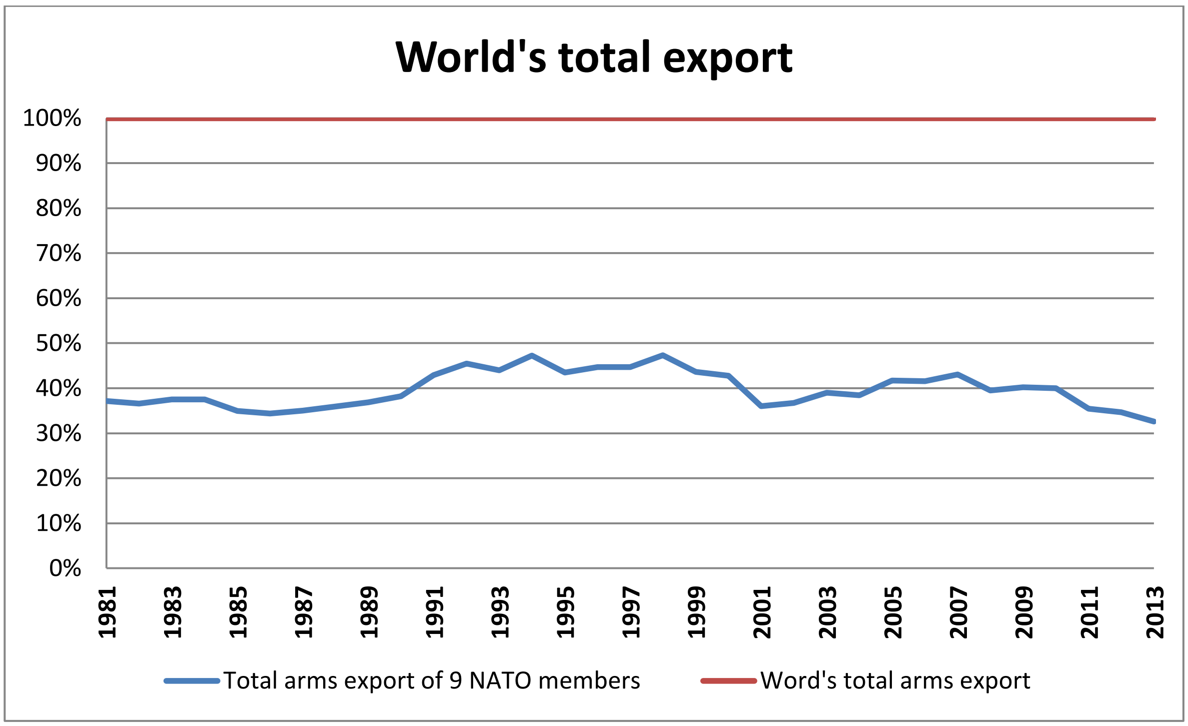
3.1 Model and Data:

In the light of contributions in the literature, this paper attempts to investigate the effects of defense Research and Development (R&D) expenditure of the governments, on their conventional arms exports. Due to the nature of the military sector, involved high secrecy, we limit our analysis with selected countries. In selecting these countries, we considered several reasons. The first reason is that countries that involved in the analysis are all members of North Atlantic Treaty Organization (NATO), which requires standardization of equipment among all members. This standardization means that all producer countries are subject to the same regulations (standards) in the production of arms. The second reason is that these countries are the leading exporting countries of conventional arms. Their total export volume constitutes 35-48 percent of world's total conventional exports, according to Stockholm International Peace Research Institute (SIPRI), as shown in the Figure 2 bellow. The last reason is the data availability of these countries without any missing periods.

The Figure 2, bellow, illustrates the conventional arms export in percentage of those nine countries in the world total conventional arms export for the period 1981-2013. In Figure 2 we can see the change in the variation of percentage that occurred after the end of Cold-War. During the Cold-War period (till to 1991), there is a quite stable percentage line, which variates between 35 and 38. However with the end of the Cold-War, the upper bound of variation frequency of total percentage line has increased till to 48. The changes in frequency of variations for those countries clearly show that after the Cold-War period the conditions in the export market of conventional arms have been changed as well.

The Figure 2 also shows that our analysis tried to investigate nearly about the half of the variations in the conventional arms exports.

Figure 2: World's total export of conventional arms in percentage



Source: author's calculations based on SIPRI Arms Transfers Database

Before proceeding to variable explanations first we defined the main concepts of our analysis, which are conventional arms and the defense R&D expenditures. Defining the main concepts enabled us to get easily the statistics and avoiding problems,[5] which inherent to the defense sector.[6]

First, by conventional arms we refer to the conventional weapon systems, which are defined and covered by the SIPRI Arms Transfers Database.[7] The Arms Transfers Database of SIPRI is differs from the government official dataset. Holtom, Bromley and Simmel, (2012) pointed out that SIPRI uses a unique pricing system in order to measure the volume of deliveries of major conventional weapons and, which is called the trend-indicator value (TIV). The SIPRI TIV measures transfers of military capability rather than the financial value of arms transfers. It means that high volume of export also indicates in some sense the quality of conventional weapons besides indicating exports in numbers.

Second, by defense and civil R&D expenditures we refer to the scope and standards of the Organization for Economic Co-operation and Development's (OECD's) methodology for R&D, which are based on Frascati Manual classification. The Frascati Manual defines the general R&D as: "creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications" (OECD, 2002, p. 30). They separate the defense R&D from civil R&D by means of objective perspectives, which are primarily for the defense reasons, regardless of their content or whether they have secondary civil applications. The objective of defense R&D is defined as: "the creation or enhancement of techniques or equipment for use by national, overseas or multinational armed forces" (OECD, 2002, p. 87).

Next, we defined the methods that are developed by the OECD and used to measure R&D expenditures. We extracted the datasets for the defense and civil R&D expenditures, from the GBAORD statistics calculated in accordance with socio-economic objectives. There are mainly two reasons for choosing the GBAORD statistics. First reason is that it provides internationally comparable information about the characterization of the

[5] The defense R&D expenditure of Italy and military expenditure of Spain have missing periods. Then statistics for the missing period are collected from other sources and calculated by author and calculation method is explained in Appendix 5.1.

[6] For further information, see Keith (2006).

[7] For further information, see SIPRI, Arms Transfers Database – Methodology http://www.sipri.org/databases/armstransfers/background/coverage/

government support for R&D activities.[8] The next reason is that it covers government financed R&D performed abroad (OECD, 2013). Finally after defining and mentioning about used measurements for the main variables for our study, we proceed to the explanations and reasons for selecting variables.

3.1.1 Variables

First explanatory variable is *Defense R&D spending of government* measured in million US dollars and at constant PPP with the base year 2005, which is this study's primary explanatory variable. The reason for choosing the defense R&D expenditure as an explanatory variable is to capture the economic effectiveness and rationalization military funds after the Cold-War period doctrine (Dunne et al., 2008; Birdi et al., 2000). Especially after the Cold-War period, the most European countries and USA have started to support cooperation and the liberalization of military industry firms in order to maintain competitive advantage in the export market (Neal et al., 2001). Hence, we expect to have a positive effect of *Defense R&D spending of government* on conventional arms export through the increasing capability of weapons that leads the latter to become more competitive in the export markets. However, increasing the defense R&D expenditure may lead to increasing the price of conventional arms, which in return will have negative effects on the export performance. Besides, the defense R&D has specific characteristics that lead to the market failures by means of public good, high risk and uncertainty, national security. The defense R&D also creates two types of externalities: negative (crowding-out), and positive (spin-off) (Morales-Ramos, 2002), which are out of our scope of this analysis.

An important point in the data availability of the defense R&D expenditure is that all datasets are government-funded defense R&D spendings. Beside to the data availability, the reason for taking only government-funded defense R&D expenditures datasets is that the most and even all parts of the defense R&D expenditures are funded by the

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[8] For further information, see OECD, Directorate for Science, Technology and Innovation http://www.oecd.org/sti/2013_1_documentation_e.pdf

governments (Castellacci et al, 2014; Brzoska, 1999; James, 2004). There are differences between the USA and European countries in the mode of funding the defense R&D. As James (2004) points out that USA contractors are more in advantageous positions than Europeans one because USA government typically funds the full cost of private defense R&D cost, whereas European countries fund the not full of private defense R&D costs.

Second explanatory variable is *Civil R&D spending of government* measured in million US dollars and at constant PPP with the base year 2005. The civil R&D expenditure is supposed to capture industrial capability (production capability) of a country. It is an important variable to capture industrial capability of producing the variety types of products. By industrial capability we refer to the degree of scientific, technology and engineering technology embodied in industrial production capacity.[9] Hence, analysis includes not only defense industry sector but civil industry contributions as well. Beside to defense technology, civil technology is used in military equipment too which leads to difficulty in distinction between non-military and military R&D expenditures (Keith, 2006). By including the civil R&D expenditure into analysis we tried to reveal the effect of total R&D expenditures on arms export. Accordingly, we expect that civil R&D expenditures will have a positive effect on conventional arms export of a country as the defense R&D expenditures.

Third explanatory variable is *World total conventional arms import* measured in million US dollars and at constant prices with the base year 1990. By taking world total conventional arms import into analysis we incorporated the total demand level that affected by the security environment (ZengQi et al., 2014). Also, the demand for conventional arms is not affected by the price and exchange rate, which are the short-run economic situations (ibid). Hence, the world total conventional arms import is assumed to reflect the global political situation and security issues. As the political situations worsen or destabilize, and threaten patterns on national security of any country increases, then, demand for conventional arms increases. In other words we expect to have a positive relationship of world total conventional arms import with conventional arms export.

[9] For further information, see Brauer (1998) and Brzoska (1999).

Fourth explanatory variable is *Military Expenditure of NATO member Allies* measured in million US dollars and at constant prices with the base year 2011, excluding observed country's military expenditure.[10] We expect that military expenditure of allies to have a positive relationship with conventional arms export because the NATO has standards for the military equipment obligated for all member countries.[11] Given that these selected nine countries produce under the NATO standards then, a further demand for those countries is to be generated. Further, NATO member countries are usually involved in the process of a collaborative development and production of weapons under the same export control rules (ZengQi et al., 2014). Especially after the Cold-War period the NATO has expanded to Western-Europe countries, and newcomers adopted new military equipment under NATO standards ensuring equipment interoperability (Neal at al. 2001). Besides to the newcomers, every renewed arms or new accepted military technology also create additional demand for those who produce the weapons.

The Figure 3 illustrates world military expenditure trends measured in million US dollars and at constant prices with base year 2011. In the Figure 3, there are two lines that represent Total NATO and Total World military expenditure for the period between 1981 and 2011. From the Figure 3, we can observe four main trends in the military expenditures:

-First, there is a sharp decline in the world military expenditure when the Cold-War periods ended. It may be mainly due to decrease in Russian (USSR) military expenditure.

-Second, after the mid-1990s, total world military expenditure has started to increase and even left behind the amount that was before the end of Cold-War period. The total NATO military expenditure has also declined, but, it has nearly smoothing shape, which means that there was a steady decrease in the military expenditure rather than a sharp decline as in the rest of the world.

-Third, total world military expenditure mimicked the total NATO military expenditure for the period 1993-2005. It means that in the rest of the world, other than NATO, military expenditure in total had stayed constant.

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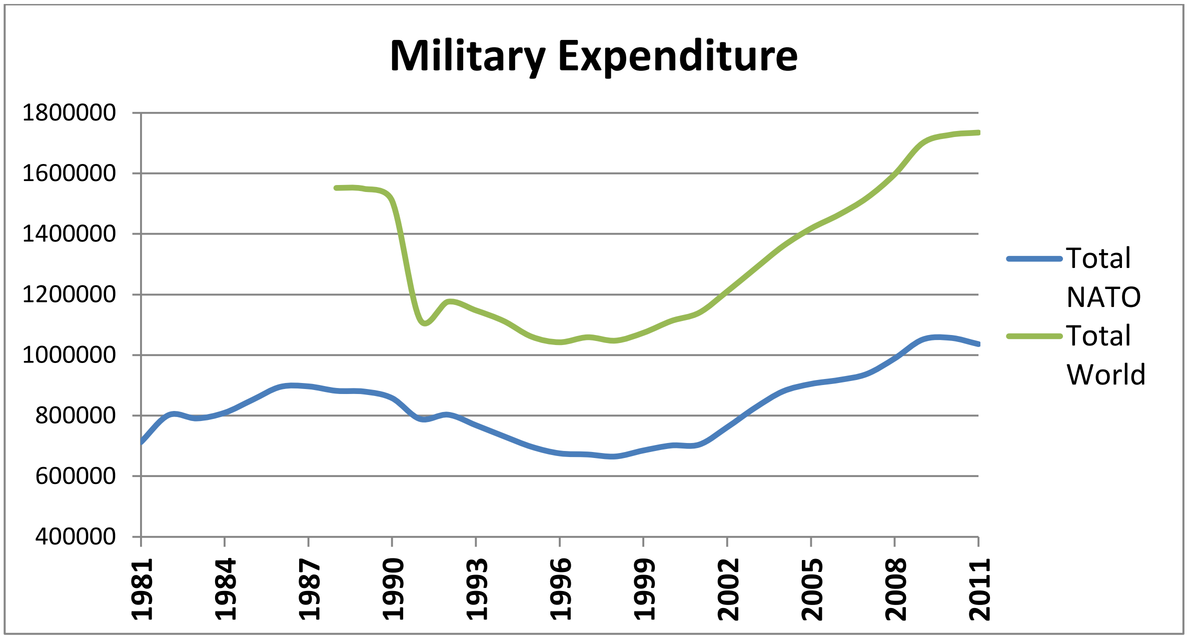
[10] Total NATO member countries military expenditure minus observed country's military expenditure.
[11] For further information, see NATO Standardization Agreement (STANAG) in 1998 and AEDP-2 (2005).

-Fourth, after 2005 total world military expenditure has increased more than total NATO military expenditure, which indicates that the countries outside the NATO have also started to increase their military expenditures especially Russia and China (Freeman et al., 2011).

Figure 3: World Military Expenditure



Source: author's calculations based on SIPRI Arms Transfers Database

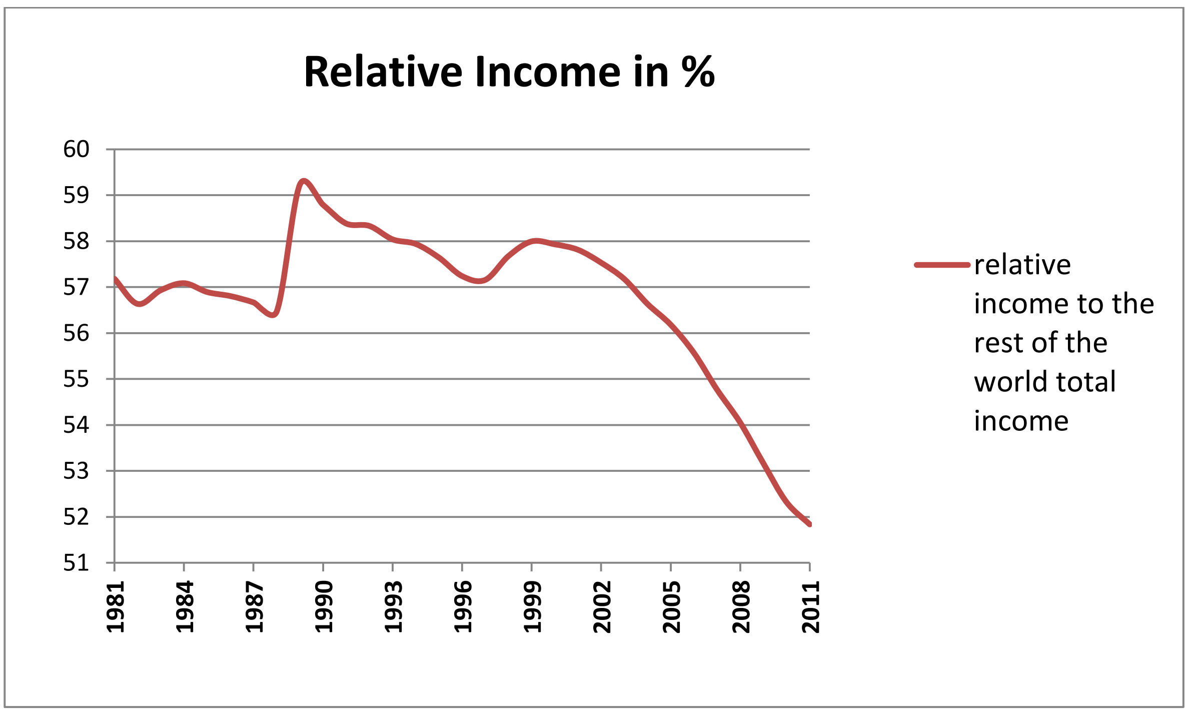
Fifth explanatory variable is *Relative Income of nine countries*. Its calculation is shown below:

$$\text{Relative income} = \frac{(\text{total GDP of nine countries who are in analysis})}{\text{World's total GDP} - \text{total GDP of nine countries who are in analysis}}$$

All GDPs are measured at constant US dollars prices at base year of 2005. The analysis employed relative income in order to capture the effect of income level on the conventional arms demands in developing countries. In the report for US Congress, Grimmett and Kerr (2012) reported that during years 2004-2011, about 68.6% of all exported conventional arms were sold to developing countries. They also point out that this trend is due to the increasing trends of incomes (GNP or GDPs) of developing countries which create more funds for military spending and on conventional arms demand. That military expenditure of many countries increases proportional to their GDPs is also pointed out by Freeman et al. (2011). We expect to have negative relationship of relative income with conventional arms exports, which means that as relative income increases, the demand for conventional arms increases as well.

We presented in the Figure 4, the graphical form of our fifth explanatory variable which is the *Relative Income of nine countries*. Figure 4 clearly shows that relative income of those nine countries have been decreasing relatively to the rest of world total income for the last decades.

Figure 4: Relative income in percentage



Source: author's calculations based on World Bank Database.

Last explanatory variable is *Cold-War period*. We have incorporated it into our analysis as dummy variable labeling as "one" for the period of Cold-War and "zero" for post-Cold-War period. The period for Cold-War includes the years between 1981 and 1991 and the post-Cold-War period covers the years from 1991 to 2011. The reason for incorporating this independent variable is to capture the trend effects in time dimension. After the Cold-War period, most countries around the world entered into decreasing trend of military expenditures (Dunne, 1996), which can be seen in the Figure 3 too, as a sharp decline in the world total military expenditure. Besides, leading exporting countries changed their policies towards their defense industries and have pursued restructuring of their defense industries, involving concentration, retrenchment and globalization. However there are still some governments, wedding to the maintenance of domestic military industrial bases (Birdi et al., 2000). Then between 1981 and 2011 we have two types of trends followed by the most countries in our analysis: first period between 1981 and 1911 and second period between 1992 and 2013. Finally we expect it to have positive effect on conventional arms export.

3.1.2 Models

Before introducing our models we assert that in this study, we incorporated two models that are Model A and Model B. The Model A is an initial form of the main function in which all variables are in level form, whereas a Model B is a transformed version of the Model A into the growth form, except the dummy variable. The reason for transformed version of the Model A is for avoiding from the stationarity problem, which is revealed by the unit root tests for the Model A in related sections.

In our analysis the general model for the Model A is constructed as follows:

Conventional Arms Exports (*Export*) = **f [**internal determinants (*Defense R&D* and *Civil R&D*); external determinants (*Import; Allies exp.* and *Income*); and global policy changes (*Cold-WAR*)**]**

Export*= *Conventional arms export (US$ million at constant (1990) prices).

Defense R&D* = *Defense R&D spending of government (US$ million at constant PPP 2005 prices).

Civil R&D* = *Civil R&D spending of government (US$ million at constant PPP 2005 prices).

Import* = *Total World Import of Conventional Arms (US$ million at constant (1990) prices).

Allies exp.* = *Military Expenditure of NATO member Allies (US$ million at constant 2011 prices).

Income* = *Relative Income of nine countries (all GDP calculated at constant US dollars at 2005 prices).

***Cold War* =** *Cold-War* as dummy variable.

Second general model in our analysis is a model B and it is constructed as follows:

Conventional Arms Exports (GrExport) = **f [**internal determinants (GrDefense *R&D* and GrCivil *R&D*); external determinants (Gr*Import;* GrAllies and GrIncome); and global policy changes (*Cold WAR*)**]**

Gr*Export*= Growth form of *Conventional arms export* (US$ million at constant (1990) prices).

Gr*Defense R&D* = Growth form of *Defense R&D spending of government* (US$ million at constant PPP 2005 prices).

Gr*Civil R&D* = Growth form of *Civil R&D spending of government* (US$ million at constant PPP 2005 prices).

Gr*Import* = Growth form of *Total World Import of Conventional Arms* (US$ million at constant (1990) prices).

Gr*Allies* = Growth form of *Military Expenditure of NATO member Allies* (US$ million at constant 2011 prices).

Gr*Income* = Growth form of *Relative Income of nine countries* (all GDP calculated at constant US dollars at 2005 prices).

***Cold WAR* =** *Cold-War* as dummy variable.

Besides, all variables are measured in constant prices that exclude the effect of currency volatilities and nominal changes, for the both models.

3.2 Empirical Model.

We used five different sources in collecting the datasets. Datasets for the military spending, conventional arms exports and imports obtained from to Stockholm International Peace Research Institute (SIPRI Arms Transfers Database, 2015). In military spending datasets there were missing periods for Spain and conventional arms export missing period for Norway, which are obtained and recalculated by author from the report "World Military expenditure and arms transfers 1986" for the U.S. Arms Control and Disarmament Agency in 1987. The hardest data to obtain was the statistics for the defense R&D expenditures of governments, due to the scarcity and inherit secrecy involved. It is obtained from OECD database statistics and missing periods for Italy are obtained from EUROSTAT statistical pocketbooks and recalculated by author.[12] GDPs of countries are obtained from the World Bank (World Development Indicators (WDI)).

The countries involved in the analysis are all the leading exporting countries of the conventional arms, according to the SIPRI for the periods 2009-2014, which are: Canada, Germany, France, Italy, Netherlands, Norway, Spain, United Kingdom and United States.

In our study, we obtained all datasets for all countries and time period without any missing periods. It means that, we have strongly balanced panel data model with 9 cross-section and 31 time-series dimensions. We firstly proceeded to the pre-test analysis before implementing regression in order to deal with all problems, which may lead to biased and spurious relationship results.

3.2.1 Tests for the Model A:

In this section we implemented first and second generation unit root tests, cointegration and cross-sectional dependency tests for the Model A. Then we discussed the reasons for selecting those particular tests and their results.

3.2.1.1 First Generation Unit Root Tests for the Model A:

At the first step in our study, we started with stationarity tests of the first and second generation unit root tests. These tests are implemented in order to avoid biased results by means of suffering from previous periods. The second generation unit root tests take into consideration cross-sectional common factors due to the cross-sectional characteristics of panel models.

[12] The missing data recalculation and sources are presented in Appendix 5.1.

We started the first test with the first generation unit root tests. LLC (Levin, Lin and Chu, 2002) test based on the pooled panel dataset and IPC (Im, Pesaran and Shin, 2003) based on the mean of individual unit root statistics, and both tests are applicable for our datasets. Both tests are more powerful when the datasets are satisfying; when *N* relatively smaller or bigger to a *T*, and requires the datasets varying between *N*: 10-250 and *T*: 5-250. LLC test is more generally applicable, because it allows individual specific effects, dynamic heterogeneity and serial correlation.[13] The IPS test also allows for dynamic heterogeneity and serial correlation. They both have a same null hypothesis of existence of a unit root but have different alternative hypothesis. The LLC's test alternative hypothesis concludes that in all variables there isn't any common unit root, while in the IPS's test it may have in some variable individual unit root. Because of these flexibilities of those tests, they are more appropriate to detect the unit root when we testing the unit root in the first stage of our study. Besides, Westerlund and Breitung (2009) showed that LLC test is more powerful than IPS test. We implemented both tests due to the differences in their alternative hypothesis. By doing so, we incorporated the possibility of a unit root in some of the variables.

In the Table 1, we tested for both with constant & trend and with only constant cases. According to these results we conclude that only dependent *Export* variable is strongly stationary (at 1% significance level) for both cases and tests. The *Civil R&D* rejects null hypothesis in both tests only for the constant & trend case at 1% significance level. However, the independent *Import* variable rejects the null hypothesis only in the IPS test for both cases at 10% and 5% significance level respectively. Besides, in the LLC test it rejects the null hypothesis only for the constant case at 1% significance level. Finally, generalizing these results, we conclude that only dependent *Export* variable has not unit root in both tests and cases.

[13] For further information, see Levin, Lin, and Chu, (2002).

Table 1: Unit root results (First generation):

Variables	**LLC prob.**		**IPS prob.**	
	constant & trend	***constant***	***constant & trend***	***constant***
Export	-5.37552* (0.0000)	-4.35690* (0.0000)	-4.11524* (0.0000)	-4.06488* (0.0000)
Defense R&D	-0.57291 (0.2834)	0.21784 (0.5862)	-1.88615 (0.0296)	0.84392 (0.8006)
Civil R&D	-3.89700* (0.0000)	1.93565 (0.9735)	-6.94920* (0.0000)	2.37359 (0.9912)
Import	-0.30559 (0.3800)	-3.47284* (0.0003)	-1.31344*** (0.0945)	-1.73467** (0.0414)
Allies exp.	1.89943 (0.9712)	2.52996 (0.9943)	6.31491 (1.0000)	2.20847 (0.9864)
Income	1.86609 (0.9690)	- 11.2924 (1.0000)	1.97498 (0.9759)	10.1132 (1.0000)

Note: 1) the null hypothesis for LLC is Unit root (assumes common unit root process). 2) The null hypothesis for IPS is Unit root (assumes individual unit root process). The numbers in the brackets are ***p****-values for the tests. (*) and (**) denotes the rejection of null hypothesis of unit root at 1% and 5% significance level respectively.*

Before proceeding to the second generation unit root tests, we tested our data for cross-sectional dependence test. We tested it in order to reveal the affecting common factors. We chose the Breusch-Pagan (1980) cross-sectional dependency test for our study. The Breusch-Pagan (1980) cross-sectional dependency test is appropriate for our study, because our dataset has relatively bigger time-series dimension than cross-section dimension ($N<T$).[14] This test is enough to reveal the presence of affecting common factors in this stage of our analysis.

[14] For further information, see Baum, (2001).

In the Table 2, results of Breusch-Pagan (1980) cross-sectional dependency test indicate that there is a cross-sectional dependence, or, in other words, there are common factors affecting the cross-sectional units. Thus, we finally proceeded to the second generation unit root tests.

Table 2: Breusch-Pagan cross-sectional dependency test Results:

	Breusch-Pagan
Test Summary	154.001
Probability	0.0000

Note: Under the cross-sectional dependency null hypothesis test assume that there is no cross-sectional dependence and alternative hypothesis assumes that there is a cross-sectional dependence.

3.2.1.2 Second Generation Unit Root Tests for the Model A:

The main disadvantage or restrictive properties of the first generation unit root tests are that they both assume cross-sectional independence among panel units except for a common time effect (Hurlin and Mignon, 2007). Hence, we implemented the Pesaran (2007) and Moon & Perron (2004) second generation unit root tests, because the second generation unit root tests are supposed to handle cross-sectional common factor problems.

Moon & Perron (2004) test proposed two modified test statistics (t_a* and t_b*), which are based on pooled estimation of the first-order serial correlation coefficient of the data. The limiting distributions of Moon & Perron (2004) test statics are normal, because there is no need for the special table to compute *p*-values. The proposed estimation and testing procedure in Moon & Perron (2004) unit root test are based on de-factored observations and suggest estimating the factor loading by the principal component method (Pesaran, 2007). The *k* in the test represents the cross-sectional common factors. Under the null hypothesis of test assumes asymptotic distribution and diverge under alternative one. The tests are likely to be valid, only when the dataset has large time-series than cross-sectional observations (*T*>*N*).

Pesaran (2007) unit root test also proposes two tests for testing unit root in the presence of cross-sectional dependency. The first test is the Cross-sectional Augmented Dickey-Fuller (CADF) statistics, which is the standard Augmented Dickey-Fuller (ADF) regression augmented with the cross-sectional average of lagged levels and first differences of the individual series. The second test is the cross-sectional augmented IPS (CIPS) test, which is the simple average of the individual CADF tests. Gengenbach (2004) pointed out that polled CIPS test has better power properties than individual specific CADF tests, accordingly we chose CIPS test for our dataset analysis. The Pesaran unit root tests are assumed to have an unobserved one-common-factor structure whereas Moon & Perron unit root tests allow multiple cross-section common factors (Gengenbach, Palm, and Urbain, 2009). The null hypothesis of Pesaran unit root tests is the existence of unit root. The last, unlike the Moon & Perron unit root test, Pesaran unit root test is applicable when datasets have time-series observations smaller or bigger than cross-sectional observations (*T*<*N* or *T*>*N*).

The Table 2 shows results of Moon & Perron unit root tests that consider the cross-section common factors. The two test statistics are calculated (t_a* and t_b*) for the three cases where common factors (*k*) are respectively 1, 4 and 6. Hence, with implementing Moon & Perron unit root test, we consider the multiple affecting cross-section common factors. However, with the Pesaran unit root test we consider only one cross-section common factor case.

From the empirical findings of Table 3, results indicate that the only dependent *Export* variable rejects the null hypothesis of existence of a unit root in all test statistic tests and cases. It indicates that the dependent *Export* variable exhibits stationary characteristics at 5% significance level. Next, the independent *Defense R&D* variable rejects the null hypothesis in the t_b* test statistics, only for the case of constant with no trend. However, for the same case, but for the t_a* test statistics it could not reject the null hypothesis. Further the independent *Defense R&D* variable in the case of constant with trend in both test statistics it could not reject the null hypothesis. Then, in general, we conclude that the *Defense R&D* variable does not exhibit stationary characteristics. Other remaining variables, both in t_a*

and t_b* test statistics and in all cases, could not reject the null hypothesis of existence unit root.

Table 3: Moon & Perron unit root test results (Second generation):

Variables	Moon and Perron Tests (with constant)			
		k=1	*k=4*	*k=6*
Export	t_a*	-2.314*	-2.314*	-2.314*
	t_b*	-2.314*	-2.134*	-2.134*
Defense R&D	t_a*	-1.212	-1.212	-1.212
	t_b*	-1.666*	-1.666*	-1.666*
Civil R&D	t_a*	0.288	0.288	0.288
	t_b*	0.955	0.955	0.955
Allies exp.	t_a*	-0.073	-0.073	-0.073
	t_b*	-0.386	-0.386	-0.386
Variables	**Moon and Perron Tests (with constant & trend)**			
		k=1	*k=4*	*k=6*
Export	t_a*	-3.071*	-3.071*	-3.071*
	t_b*	-2.994*	-2.994*	-2.994*
Defense R&D	t_a*	0.769	0.769	0.769
	t_b*	0.767	0.767	0.767
Civil R&D	t_a*	-0.832	-0.832	-0.832
	t_b*	-0.706	-0.706	-0.706
Allies exp.	t_a*	1.103	1.103	1.103
	t_b*	0.846	0.846	0.846

Note: Under the unit root hypothesis the Moon–Perron statistics are standard normal. (*) denote the rejection of the null of unit root at 5% level, critical values are from normal t-statistics table which is corresponds to 1.645.

The Table 4 shows results of Pesaran unit root tests, which consider a single cross-section common factor. Unit root tests are implemented for the two cases: constant and constant & trend. The *p*-values are order of the time-series augmentation.

From empirical findings of the Table 4, results indicate that the dependent *Export* variable rejects the null hypothesis of unit root only in the case of constant and 1nd order of the time series augmentation at 5% significance level. However, in the other cases, the dependent *Export* variable could not reject the null hypothesis of unit root. Then these results lead us to conclude, in general, that the dependent *Export* variable does not exhibiting stationary characteristics. Next, the independent *Civil R&D* variable rejects the null hypothesis of unit root only in the case of constant and for the 1st and 2nd order of the time series augmentations at 5% and 10% significance level respectively. However, in the other cases, the independent *Civil R&D* variable could not reject the null hypothesis of unit root. Besides, in the Moon and Perron unit root test results the independent *Civil R&D* variable *Civil R&D* variable does not exhibiting the stationary characteristics. Then considering both test results we concluded that the independent *Civil R&D* variable does not exhibiting the stationary characteristics. Other remaining variables in both cases could not reject the null hypothesis of existence unit root.

Considering both Table 3 and Table 4 results, there is an important contradiction among Pesaran and Moon & Perron unit root test results. For the dependent *Export* variable the Pesaran CIPS unit root results could not reject the presence of unit root in both cases, whereas the Moon & Perron test results strongly reject the null hypothesis of unit root in all cases. Other remaining variables, both in the Pesaran CIPS and Moon & Perron unit root test statistic results support the same results. Finally, considering both unit root tests results, we conclude that all variables do not exhibit stationary characteristics.

Table 4: Unit root results Pesaran CIPS Tests (Second generation):

Variables		constant	constant & trend
Export	P:1	-2.296*	-2.610
	P:2	-1.974	-2.027
Defense R&D	P:1	-0.667	-2.385
	P:2	-0.637	-2.284
Civil R&D	P:1	-2.287*	-2.655
	P:2	-2.231**	-2.269
Allies exp	P:1	-1.488	-2.396
	P:2	-1.469	-2.588

Note: Under the unit root hypothesis the Pesaran statistics are standard normal. The (*) and (**) denotes are the rejections of the null of unit root at 5% and 10% significance levels, respectively. The critical values are calculated by Pesaran (2007) and provided in Appendix 5.4.

3.2.1.3 Cointegration Tests for the Model A:

As the results of unit root tests, we conclude that all variables are non-stationary but stationary at *I(1)*, we chose to implement Westerlund (2007) test cointegration. Cointegration tests are implemented in order to test the presence of long-run relationship between integrated variables.

The Westerlund (2007) cointegration tests are applicable for balanced and unbalanced panel data models. Furthermore, Westerlund cointegration tests are based on structural dynamics rather than residual dynamics. Therefore they do not have common factor restrictions. The tests are also good to capture short term dynamics and bootstrapped versions of tests developed in order to handle test with cross-sectional dependence[15].

[15] For the further information, see Burret, Feld, and Koehler (2014).

In the Westerlund (2007) cointegration test there are four tests with same null hypothesis of non-existence cointegration. However, they have different alternative hypothesis. The first two tests', G_t and G_a, alternative hypothesis indicate that the panel is cointegrated as a whole. The other two tests', P_t and P_a, alternative hypothesis are indicating that there is at least one individual is cointegrated.

In Table 4, almost all tests in *constant with no trend* and *constant with trend* cases could not reject the null hypothesis, except P_t test. The P_t test rejects the null hypothesis and accepts the alternative hypothesis only in *constant with no trend* case. However, the P_t test in *constant with trend* version could not reject the null hypothesis. Finally, both in group (G_t and G_a) and individual (P_t and P_a) cointegration tests and in both cases, the results could not reject the null hypothesis indicating that there is no cointegration.

Table 5: Westerlund cointegration test results:

	Constant				***Contatant & trend***		
Statistic	**Value**	**Z-value**	**P-value**		**Value**	**Z-value**	**P-value**
$\mathbf{G_t}$	-2.283	1.145	0.874		-2.579	1.420	0.922
$\mathbf{G_a}$	-2.817	4.425	1.000		-1.884	5.659	1.000
$\mathbf{P_t}$	-9.303*	-2.020	0.022		-8.843	-0.488	0.313
$\mathbf{P_a}$	-1.908	3.387	1.000		-1.706	4.647	1.000

Note: In the test the lag, leads and the kernel width have taken as one. (*) and (**) denote the 5% and 10% significance levels, respectively.

Then, we proceeded to the bootstrapped version of Westerlund (2007) cointegration test in order to take into account the cross-sectional dependency. Before interpreting the results, we note that we took the kernel width as one, because Damiaan and Westerlund (2008) suggest taking smaller values than Bartlett kernel window width which is calculates for our case $4(T/100)^{2/9} \approx 3$. They explained that in small data sets the results may be sensitive to the specific choice of parameters such as lag, lead and kernel width.

The Table 6 results, show that results did not change (looking into robust P-values), even when we took into account cross-sectional dependences, the tests still reject the null hypothesis accept the P_t test. Only the P_t test reject the null hypothesis, which states that at least one individual is cointegrated, in *constant with no trend* case. Finally, we conclude that both group and individual test could not reject the null hypothesis, indicating that there is no cointegration.

Table 6: Westerlund bootstrapped cointegration test results:

	Constant			
Statistic	**Value**	**Z-value**	**P-value**	**Robust P-value**
G_t	-2.283	1.145	0.874	0.247
G_a	-2.817	4.425	1.000	0.732
P_t	-9.303*	-2.020	0.022	0.035
P_a	-1.908	3.387	1.000	0.757
	Constant & trend			
Statistic	**Value**	**Z-value**	**P-value**	**Robust P-value**
G_t	-2.579	1.420	0.922	0.282
G_a	-1.884	5.659	1.000	0.958
P_t	-8.843	-0.488	0.313	0.119
P_a	-1.706	4.647	1.000	0.817

Note: In the test the lag, leads and the kernel width have taken as one. In bootstrapped version of the test was bootstrapped to 1000 times. (*) and (**) denote the 5% and 10% significance levels, respectively.

3.2.2 Tests for the Model B:

In this section of a study, we implemented first and second generation unit root tests, cointegration and cross-sectional dependency tests for the Model B. Next, we proceeded to Hausman specification test for choosing right regression model. Then we implemented the heteroskedasticity, cross-sectional and serial correlation tests in order to select right robust estimation methods. Finally, we implemented the fixed effect regression model and discussed estimation results, on top of it we also discussed reasons for selecting those particular tests and test results.

3.2.2.1 First Generation Unit Root Tests for the Model B:

After the failure of concluding that variables are cointegrated, we had to deal with stationary problem. The frequently used ways in dealing with unit root is differencing or detrending the variables. But in practice it often difficult to know whether series should be detrended or differenced or using both (Mahadeva and Robinson, 2004). Due to these reasons, we took the growth form of variables in order to minimize loss of observation rather taking difference. By taking growth form we lost only one time period for every cross-section rather half time period, if we have chosen the case with differenced form of variables.

From the Table 7 results, we conclude that all variables strongly rejecting the null hypothesis of unit root, for both tests and cases, and they are all strongly stationary at 1% significance level. After passing first generation unit root tests, we proceeded to the next test analyses of the second generation unit root tests, which take into account the cross-section common factors.

Table 7: Unit root results (First generation):

Variables	LLC prob.		IPS prob.	
	constant & trend	***constant***	***coefficient & trend***	***constant***
Gr*Export*	-12.6684* (0.0000)	-15.6011* (0.0000)	-12.8589* (0.0000)	-15.0091* (0.0000)
Gr*Defense R&D*	-8.89826* (0.0000)	-9.98643* (0.0000)	-9.51113* (0.0000)	-10.6774* (0.0000)
Gr*Civil R&D*	-6.14329* (0.0000)	-7.48683* (0.0000)	-7.74097* (0.0000)	-9.31317* (0.0000)
Gr*Import*	-11.5829* (0.0000)	-10.1419* (0.0003)	-9.09553* (0.0000)	-8.86119** (0.0414)
Gr*Allies*	-6.11944* (0.0000)	-6.16534* (0.0000)	-6.88402* (0.0000)	-7.82116* (0.0000)
Gr*Income*	-7.46488* (0.0000)	-3.06139* (0.0011)	-5.22792* (0.0000)	-2.46710* (0.0068)

Note: 1) the null hypothesis for LLC is Unit root (assumes common unit root process). 2) The null hypothesis for IPS is Unit root (assumes individual unit root process). The number in the brackets is p-values for the

3.2.2.2 Second Generation Unit Root Tests for the Model B:

The Table 8 shows the results of Moon & Perron unit root test results for the Model B. The results indicate that all variables are rejecting the null hypothesis of unit root at 5% significance level for the all cases.

Table 8: Unit root results (Second generation):

Variables	Moon and Perron Tests (with constant)			
		k=1	*k=4*	*k=6*
Gr*Export*	t_a*	-27.285*	-27.285*	-27.285*
	t_b*	-6.896*	-6.896*	-6.896*
Gr*Defense R&D*	t_a*	-65.164*	-65.164*	-65.164*
	t_b*	-8.092*	-8.092*	-8.092*
Gr*Civil R&D*	t_a*	-36.210*	-36.210*	-36.210*
	t_b*	-11.793*	-11.793*	-11.793*
Gr*Allies*	t_a*	-13.227*	-13.227*	-13.227*
	t_b*	-4.174*	-4.174*	-4.174*
Variables	**Moon and Perron Tests (with constant & trend)**			
		k=1	*k=4*	*k=6*
Gr*Export*	t_a*	-16.937*	-16.937*	-16.937*
	t_b*	-13.641*	-13.641*	-13.641*
Gr*Defense R&D*	t_a*	-4.894*	-4.894*	-4.894*
	t_b*	-1.955*	-1.955*	-1.955*
Gr*Civil R&D*	t_a*	-16.996*	-16.996*	-16.996*
	t_b*	-13.676*	-13.676*	-13.676*
Gr*Allies*	t_a*	-5.134*	-5.134*	-5.134*
	t_b*	-4.402*	-4.402*	-4.402*

Note: Under the unit root hypothesis the Moon & Perron statistics are standard normal. (*) denote the rejection of the null of unit root at 5% level, critical values are from normal t-statistics table which is corresponds to 1.645.

The results of the Table 9, which shows Pesaran unit root test results, indicate that the Gr*Export* and Gr*Civil R&D* variables reject the null hypothesis of a unit root in all cases at

5% significance level. The only independent Gr*Civil R&D* variable rejects the null hypothesis at 10% significance level. The independent Gr*Defense R&D* variable also rejects the null hypothesis of the unit root in all cases except for the *constant & trend* case, at different significance levels. However, in general we conclude that the Gr*Defense R&D* variable exhibiting the stationary characteristics. Finally, the independent Gr*Defense R&D* and Gr*Allies* variables also reject the null hypothesis of the unit root in all cases except for the *constant & trend* case, at different significance levels. However, in general we conclude that both variables exhibiting the stationary characteristics.

In general the growth form of all variables rejected the null hypothesis of unit root both for the 1st generation and 2nd generation unit root tests. There is not any contradiction between Moon & Perron tests and Pesaran CIPS test results, as it was the case in the level form of variables. Taking into consideration Moon & Perron tests and Pesaran CIPS test results test results, we concluded that all variables in growth form are exhibit stationary characteristics and we proceeded to the regression analysis process.

Table 9: Unit root results Pesaran CIPS Tests (Second generation):

Variables		Constant	Constant & trend
Gr*Export*	P:1	-4.371*	-4.307*
	P:2	-3.514*	-3.447*
Gr*Defense R&D*	P:1	-3.105 *	-3.388*
	P:2	-2.411**	-2.713
Gr*Civil R&D*	P:1	-4.228*	-4.267*
	P:2	-3.012*	-3.073**
Gr*Allies*	P:1	-2.860*	-2.958**
	P:2	-2.140**	-2.337

Note: Under the unit root hypothesis the Pesaran statistics are standard normal. The (*) and (**) denotes are the rejections of the null of unit root at 5% and 10% significance levels, respectively. The critical values are calculated by Pesaran (2007) and provided in Appendix 5.4.

3.2.2.3 Hausman Test for the Model B and its lagged version models

After passing stationary tests we proceeded to next tests, in order to choose an appropriate model for the regression, whereas we have random-effect and fixed-effect regression models. In deciding between random-effect and fixed-effect regression models, we implemented the Hausman (1978) specification test.

Before implementing the Hausman specification test, we introduced four versions of the Model B. The introduced four of Model B are the lagged form of independent Gr*Defense R&D* and Gr*Civil R&D* explanatory variables, starting with no lags till to 3 year lag. In practice, the military R&D takes on average 5 or 7 years or even more years to accomplish and shows the effects.[16] However, due to the short time dimension we lagged it up to 3 years. Besides, both variables are in the growth form, meaning that they contain information about previous periods and it reveals that we have 3 years lags but 4 years' affects. Then we labelled as Model B1, where Gr*Defense R&D* and Gr*Civil R&D* are lagged for one year; Model B2 where the Gr*Defense R&D* and Gr*Civil R&D* are lagged for two years; and Model B2 where Gr*Defense R&D* and Gr*Civil R&D* are lagged for three years. Note that in Model B1, B2 and B3, all other explanatory variables are the same, meaning that no lags as in the initial Model B.

After introducing lagged versions of Model B, we proceeded with the Hausman specification test. The Hausman specification test is designed to detect violation of random-effect modelling assumption that the explanatory variables are not correlated with individual effect (Greene, 2003). In case there is no correlation between independent variables and the unit effect, then estimates of β in the fixed-effect model should be similar to the estimates of β in the random-effect model.[17] If there is a correlation between independent variables and the unit effect then the null hypothesis will be rejected.

The results of the Table 10, in all cases, reject the null hypothesis, which means that the appropriate model for our regression is the fixed effect model. These results, for all versions of the Model B, justify our dataset selections. It means that all nine countries are the member of NATO and have similar (NATO standards) standards in the production.

[16] For further information, see Middleton et al., (2006).
[17] For further information, see Clark, and Linzer, (2015).

Table 10: Hausman Specification Test Results:

	Model B	Model B1	Model B2	Model B3
Test Summary	10.99	20.12	20.13	10.81
Probability	(0.0887)	(0.0026)	(0.0026)	(0.0944)

Note: Under the null hypothesis the Hausman Specification test assumes that there is no correlation between explanatory and individual effect and alternative hypothesis assumes that there is correlation between explanatory and individual effect.

3.2.2.4 Heteroskedasticity, Serial Correlation and Cross-Sectional Dependence Tests for the Model B:

Before implementing regression analyses, we tested for serial correlation, heteroskedasticity and cross-sectional dependency, as well. These tests are implemented in order to choose an appropriate robust estimation method, which leads to the efficient and unbiased results.

The first test we implemented is for groupwise heteroskedasticity. The reason for testing for groupwise heteroskedasticity is that the error process may be homoscedastic within cross-sectional units, but their variance may differ across units (Baum, 2001). As we dealing with panel data model, the classical assumption of homoscedasticity in the relationship may reasonably hold within each group. However, it will not hold between groups because of cross-sectional dimension characteristics of a panel dataset model. Then it is more reasonably to take into account groupwise heteroskedasticity, when we are dealing with panel model dataset where every country may differ and have different industries (Baum, 2006). Hence, the Hausman test results, for our case, revealed that the appropriate model is the fixed-effect regression model, we implemented the modified Wald statistics which are proposed by Greene (2003). He points out that in the standard Wald test statistics, some statistics are sensitive to the assumption of normality of the errors, whereas proposed modified Wald statistic calculates the groupwise heteroskedasticity in the residuals even under the violation of normality assumptions.[18]

In the Table 11, the null hypothesis of modified Wald test for groupwise heteroskedasticity decisively rejects. It means that the errors exhibit groupwise heteroskedasticity under fixed-effect regression model.

Table 11: Modified Wald Test for groupwise heteroskedasticity Results:

Test Summary	15197.57
Probability	(0.0000)

Note: Under the groupwise heteroskedasticity null hypothesis the Modified Wald test assumes that there is no groupwise heteroskedasticity and alternative hypothesis assumes that there is groupwise heteroskedasticity.

The next test we implemented is for the serial correlation problem. The reason for testing our dataset for the serial correlation is to indicate if there is any serial correlation, then our standard errors and test statistics are not valid and even asymptotically (Wooldridge, 2012). For this reason, we implemented a new Wooldridge (2002) serial correlation test to reveal a serial correlation. Drukker (2003) states that although in comparison of new Wooldridge serial correlation test with Baltagi and Wu (1999) serial correlation tests, it has less power, but, due to the fewer assumptions, it is more robust and easier to implement. Besides, regarding our previous test results showed that our dataset is violating heteroskedasticity assumptions, indicating that the Wooldridge's (2002) serial correlation test is more appropriate to implement.

The Table 12 shows the results of Wooldridge autocorrelation test results. The results failed to reject the null hypothesis, which means that there is no serial correlation.

[18] For further information, see Baum, (2001).

Table 12: Wooldridge autocorrelation Test Results:

Test Summary	0.647
Probability	(0.4446)

Note: Under serial correlation null hypothesis the Wooldridge test assumes that there is no autocorrelation and alternative hypothesis assumes that there is an autocorrelation.

We implemented the final test is for the cross-sectional dependency problems. The cross-sectional dependency may arise due to the presence of common shocks, which are unobserved and they are uncorrelated with included regressors or in other words identically distributed errors may arise in the context of contemporaneous correlation of errors across cross-sectional units (Baum, 2001). Then the fixed-effects and random-effects may have estimators that are consistent, but may not be efficient and standard errors are biased (De Hayos and Sarafidis 2006). We chose and implemented Breusch-Pagan (1980) cross-sectional dependence test. The Breusch-Pagan (1980) test is applicable and appropriate for our case due to our panel data has $N<T$. Alternative tests for cross-sectional dependence are Pesaran's (2004), Friedman's (1937) and Free' (1995) tests applicable when the case is N>T. Therefore we implemented only Breusch-Pagan test.

The *correlation matrix of residuals*, in the Table 13, shows the correlation among residuals of cross-sectional dimensions, in our case they are countries.

In Table 13, the results of Breusch-Pagan LM test of independence test strongly reject the null hypothesis, meaning that all models exhibit cross-sectional dependence. In other words, there is a cross-sectional dependence or there is a common factor affecting the cross-sectional units even in growth form of variables.

Finally we, considering Heteroskedasticity, Serial Correlation and Cross-Sectional Dependence test results, conclude that our dataset suffers from groupwise heteroskedasticity and cross-sectional dependency problems.

Table 13: Breusch-Pagan cross-sectional dependency test Results:

Correlation matrix of residuals									
Countries	*Canada*	*Germany*	*France*	*Italy*	*Netherlands*	*Norway*	*Spain*	*UK*	*USA*
Canada	1.0000								
Germany	-0.1352	1.0000							
France	0.1266	-0.1877	1.0000						
Italy	-0.0660	-0.2290	0.0614	1.0000					
Netherlands	0.1050	-0.2107	0.5640	0.3246	1.0000				
Norway	-0.0037	0.1126	-0.3410	-0.1244	-0.2902	1.0000			
Spain	-0.1715	-0.0435	-0.1391	-0.1873	0.2754	-0.1750	1.0000		
UK	0.0454	-0.0037	0.0568	0.1219	-0.0720	-0.0507	-0.4548	1.0000	
USA	0.2887	-0.0059	0.4667	0.0807	0.2270	-0.3366	-0.3450	0.4746	1.000
						Test Summary		***Probability***	
Breusch-Pagan LM test of independence						62.443		0.0041	

Note: Under the cross-sectional dependency null hypothesis test assume that there is no cross-sectional dependency and alternative hypothesis assumes that there is a cross-sectional dependency.

3.2.3 Regression Results:

For dealing with heteroskedasticity and cross-sectional dependency problems, the FGLS (feasible generalized least squares) estimator method is proposed by Parks (1967) and Kmenta (1986). However, Beck and Katz (1995) pointed out the two deficiencies of Park-Kmenta methods and proposed their own the PCSE (panel corrected standard errors) method. The first deficiency of the FGLS method is that it is infeasible when the panel's time dimension is smaller than the cross-section dimension or $N>T$. The second deficiency tends to produce small standard errors. For dealing with this problems Beck and Katz suggest relying on OLS coefficient estimates with corrected standard errors. However, even their methods perform poorly when the panel's time dimension is smaller than the cross-section dimension or $N>T$ (Hoechle, 2007). For our fixed-effect regression models the appropriate robust is Driscoll-Kraay estimator, because the PCSE estimator method based on the pooled OLS, whereas in our case the regression model is fixed-effect. Although using the fixed-effect regression model we applied Beck-Katz estimator with pooled OLS regression model too and results are showed in Appendix 5.3.

In our specific case we used the fixed-effects regression with Driscoll-Kraay standard errors with zero lag, meaning that there is no serial correlation.[19] However, for the case with serial correlations, it calculates by the Newey and West’s (1994) plug-in estimators, which deliver optimum number of lags.[20]

The results of Table 14 indicate that the only significant explanatory variable in all cases is Gr*Import*. As expected it positively related with Gr*Export* and has stronger parameter effects between 2.39 and 2.57 in all cases, and also stronger significance level of 1% in all cases. This means, when we increase 1% in Gr*Import* it leads to increase between 2.39% and 2.57% in Gr*Export* of these countries. In other words they are benefiting more from the world arms export or more competitive in arms market.

Another variable that significantly affects the Gr*Export* dependent variable is the Gr*Defense R&D* independent variable, but only it has effect in the case where the lagged period of 3 years and with 1% significance level. It affects the Gr*Export* dependent variable negatively that contradicts to our expectations, but supported by empirical works of Castellacci et al. (2014). Besides, it has a weaker effect than the Gr*Import* explanatory variable. The sign of Gr*Defense R&D* independent variable changed in every case but they are insignificant. ZengQi et al. (2014) explained the negative sign by the reflection of those countries’ strong defense industrial base and advanced weapon R&D and production technology. [21] They concluded that those countries developed into stage of expanding arms export to promote saving on, in our case, defense R&D expenditure.[22] But, we could think

[19] For further information, see Zhong, Huang, and Scott, (2014).
[20] For further information, see Hoechle, (2007).
[21] In ZengQi et al. (2014) empirical work results revealed the negative results were between military expenditure and conventional arms export they concluded for mainly USA, UK and Germany.

[22] ZengQi et al. (2014) explained it that during the post-Cold War the USA, UK and Germany gained huge amounts of profits through arms exporting. On the one hand economize production cost of arms, and on the other hand financing the high-tech defense R&D, which finally resulting to alleviation the pressure of military expenditure.

about negative relationship due to the priority objective of the defense R&D expenditure, which is military capability of a country.

Other independent variables in all cases are insignificant but have different affecting parameters. The first one is the Gr*Civil R&D* explanatory variable have positive effect in the first case and negative effects in others. The power of parameters also changes with every cases and all of them are insignificant. The second is the Gr*Allies* explanatory variable, the direction of relationship has negative in the first case and positive for other cases, which is the same with our expectation. But, it has failed to show econometrically significant effect on GrExport of allied producer countries. The third one is the Gr*Income* explanatory variable, which has positive effect on the dependent variable. This result is one of the strongest parameters in the regressions. But, besides, it has higher standard errors. Therefore, in order to decrease the standard errors, we multiplied the Gr*Income* by 1000 instead 100 when we transform the variable into growth form. We repeated the same analysis for the fixed-effects regression with Driscoll-Kraay standard errors with zero lag and indicated in Appendix 5.2. Multiplying the variable by 1000 does not make any effects on the test results. And, this does not affect any parameter or significancy. It means that, it has failed to show econometrically significant effects of increasing relative income of the rest countries in the world. The last one is the *Cold WAR* explanatory variable that has negative effect in the first two cases and positive relationship in the last two cases. In the regression results those parameters have the strongest effects but at the same time they are insignificant. Finally, we concluded that the effect of Cold-War did not show its effects even with 2 and 3 years of lags.

Table 14: Fixed-effect regression with Driscoll-Kraay standard errors Results:

	Model B	**Model B1**	**Model B2**	**Model B3**
Gr*Defense R&D*	0.0636907 (0.1345035)	-0.1296647 (0.1320672)	0.1127947 (0.1610946)	-0.2613188* (0.0608497)
Gr*Civil R&D*	1.531054 (1.848318)	-0.6010046 (0.7400798)	-2.848574 (1.925681)	-0.3491671 (0.9102633)
Gr*Import*	2.556741* (0.5572383)	2.39435* (0.5126446)	2.412458* (0.491877)	2.56844* (0.5033267)
Gr*Allies*	-0.0571714 (1.147794)	1.073527 (1.32971)	1.214278 (1.539547)	1.070596 (1.23545)
Gr*Income*	2.443059 (8.555734)	2.12601 (8.924072)	1.214278 (1.539547)	4.742751 (9.936189)
Cold WAR	-9.259529 (9.98326)	-1.858073 (10.37729)	3.721397 (11.27912)	5.38018 (9.303595)
Observations	270	261	252	243

Note: (*), (**) and (***) denote the rejection of the null at 1%, 5% and 10% significance levels, respectively.

4. CONCLUSION:

In our analysis we tried to answer connected two questions: first, do defense R&D expenditures affect the export performance of defense industries? Second, do the defense industries become more export oriented after the restructuring policies implemented in the defense sector?

In order to answer to those questions, we have implemented the fixed-effect regression model with Driscoll-Kraay standard errors for the four cases starting with no lagged effect until to 3 year lagged effect of *Growth of Defense R&D expenditure* and *Growth of Civil R&D expenditure* independent variables. Our primary aim is to reveal the effect of defense R&D expenditure on conventional arms export with the means of econometric tools. The analysis examines the top nine conventional arms exporter and NATO member countries, for the period 1981-2011. As we mentioned before, our study also try to capture effect of implemented restructuring policies on defense industries of those countries.

The results of analysis showed that the primary affecting variable to Conventional Arms Export of those countries is the world import of conventional Arms. Within the scope of this analysis these results indicate that regional and political situations are the primary reasons for exporting of the Conventional Arms for the selected countries. It means that the export of conventional arms depends on the regional and global political situations rather than economic reasons. Although this argument is supported by works of Sislin (1994) where conventional arms export is analysed as a tool for perusing political ambitions.

The second conclusion is that defense R&D expenditure of countries econometrically showed that their primarily objective is military capability of a domestic country rather exports market. The reason for primarily orientation to the national security may be due to financing the most part of projects by public funds. Third one is the effect of defense R&D expenditure showed their effects with at least 3 years lagged period of a time.

For the further research studies we suggest to include more cross-sectional observations like other exporting countries like Russia, China, Israel and Ukraine in order to cover the most part of conventional arms export. Next, in analysing affecting factors to the conventional arms markets, financial payment supports can be included, which are provided mostly by exporting countries and import to the importing countries.

5. APPENDIX:

5.1 Appendix:

Description of recalculation of missing periods:

The first 2002-2004 defense R&D expenditure of Italy is missing in OECD database statistics and the missing data set obtained from EUROSTAT publication “Science and technology in Europe pocketbooks” of a year between 2002 and 2006. The scope, coverage and measurement units are the same as in OECD’s but the data is in the ratio form to total R&D expenditure of government. We calculated it simply by multiplying the ratio of defense R&D expenditure with total R&D expenditure of Italy.

The second missing data is for the Norwegian conventional arms export for the year 1984. The missing data obtained from the report “World Military expenditure and Arms transfers 1986” for U.S. Arms Control and Disarmament Agency in 1987. The scope and coverage of classifications are the same but the base year is different. In the report it takes 1983 as the base year and SIPRI database statistics takes 1990 as the base year. We calculated as follows:

$$\frac{\text{data for 1983 at base year of 1990 of SIPRI statistics}}{\text{data for 1983 year of the report os 1987}}$$
$$\times \text{ data for 1984 from the report of 1987, which is missing year in SIPRI statistics}$$

It gives us the missing period for the Norwegian conventional arms export at the base year of 1990 and we also added it to the total demand, which is in our analysis total world import of conventional arms.

The third missing data periods are for Span’s military spending for the period of 1981-1983. The missing data obtained from the report “World Military expenditure and

Arms transfers 1986" for U.S. Arms Control and Disarmament Agency in 1987. The scope and coverage of classifications are the same but the base year is different. In the report it takes 1983 as the base year and SIPRI database statistics takes 2011 as the base year. We calculated as follows:

$$\frac{\text{data for 1983 at base year of 2011 of SIPRI statistics}}{\text{data for 1983 year of the report of 1987}} \times \text{data for the 1981,}$$
$$\text{1982 and 1983 years from the report of 1987, which is missing year in SIPRI statistics}$$

This gives us the missing datasets for the military expenditure of Spain at base year 2011.

5.2 Appendix:

The Table 15 shows the regression analysis implemented after the correction was done, in order to decrease standard errors of Growth of Relative income explanatory variable. Note that corrections do not change any test parameter coefficients and significances.

Table 15: Fixed-effect regression with Driscoll-Kraay standard errors Results:

	Model B	**Model B1**	**Model B2**	**Model B3**
Gr*Defense R&D*	0.0636667 (0.1345019)	-0.1296925 (0.1320578)	0.1127835 (0.1610964)	-0.2612752* (0.0608527)
Gr*Civil R&D*	0.0636667 (0.1345019)	-0.6005334 (0.7402338)	-2.848309 (1.92578)	-0.3490052 (0.9101942)
Gr*Import*	2.557595* (0.5570966)	2.395475* (0.5124625)	2.413391* (0.4916788)	2.569116* (0.5032957)
Gr*Allies*	-0.0560271 (1.147356)	1.07519 (1.32924)	1.215515 (1.539371)	1.071057 (1.234934)
Gr*Income*	0.2473692 (0.8564998)	0.2167353 (0.8930196)	0.2430405 (1.01746439)	0.4762735 (0.9943665)
Cold WAR	-9.262682 (9.983498)	-1.863843 (10.37827)	3.72005 (11.278)	5.381867 (9.303333)
Observations	270	261	252	243

Note: (*), (**) and (***) denote the rejection of the null at 1%, 5% and 10% significance levels, respectively.

When we can compare the Table 14 and Table 15 results, it does not make any significant changes only standard errors of Gr*Income* decreased.

5.3 Appendix:

We also implemented regression analysis for the Beck-Katz estimator with the pooled OLS regression model.

In the pooled OLS regression model with Beck-Katz estimator gives us different results from the fixed-effect model with Driscoll-Kraay estimator results. There is no difference in the effects, relationship and significance level of parameters of the Gr*Import* explanatory variable on the GrExport of those countries. But, the divergence from the fixed-effect model results reveal that the Gr*Civil R&D* explanatory variable also have, as expected, positive and strong effects on the GrExport with no lag case at 5% significance level. It means that the capability of countries have the positive effects within the period.

Finally, the other advantage of the pooled OLS than the fixed-effect model is that it can calculate unobserved effects that affect our dependent variable. In our results, the unobserved effects have the strongest and significant effect for the all cases.

Table 16: Pooled OLS regression with Beck-Katz standard errors Results:

	Model B	**Model B1**	**Model B2**	**Model B3**
Gr*Defense R&D*	0.0502981 (0.1030806)	-0.1366403 (0.1072225)	0.1011374 (0.1039694)	-0.2601437 (0.1049127)
Gr*Civil R&D*	2.543588** (1.217768)	0.7262029 (1.286666)	-1.278037 (1.340985)	1.070011 1.358303)
Gr*Import*	2.679667* (0.5868866)	2.505909* (0.6306366)	2.474287* (0.648861)	2.644306* (0.632748)
Gr*Allies*	-.1407241 (1.265606)	0.9032559 (1.582107)	0.9333441 (1.652201)	.9922581 (1.583278)
Gr*Income*	0.2861283 (0.8420693)	0.375124 (0.9291433)	0.3628818 (0.9936651)	0.6062971 (0.9939942)
Cold WAR	-10.97621 (11.20712)	-4.893661 (13.22759)	0.7318444 (14.23176)	3.478945 (14.39221)
Constant	23.47088* (7.402478)	26.03844* (8.224008)	29.38555* (8.658741)	26.69308* (8.398595)
Observations	270	261	252	243

Note: (*), (**) and (***) denote the rejection of the null at 1%, 5% and 10% significance levels, respectively.

5.4 Appendix:

Table 17: Critical values for Pesaran (2007) unit root test:

Significance level	**constant**	**constant & trend**
5%	-2.25	-2.94
10%	-2.12	-2.76

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