DEFENCE PROCUREMENT IN GREECE: A COST-BENEFIT ANALYSIS OF FIGHTERS FOR THE HELLENIC AIR FORCE

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1. Introduction

This paper provides a framework of defence procurement in Greece. The methodology used is a cost-benefit analysis and its application is made for the new fighters of the Hellenic Air Force. Whereas previous research is concentrated on the effects of defence spending on the economy this study provides an economic analysis framework for defence procurement. This is the main intellectual contribution of the current paper compared to those that already tackle the issues of defence economics in Greece.

2. Literature Review

The first author, who has analysed the defence economics of Greece, was Andonakis (1985, 1989, 1990, 1995) who proves that military spending has a negative effect on the economy. Andonakis (1996) concludes that Offsets / Benefits could “contribute to the promotion of co-production programmes and exports as well as the creation of job opportunities in the Greek defence industry”. Andonakis (1997, 1999, 2001) conclusions are similar.

In his early work, [Kollias and Kollias et. al. (1991,1993,1994,1995, 1996a)] he analysed the defence expenditure of Greece and Turkey. Later [Kollias (1996b 1997, 1998, 2000, 2001a, 2001b)] he provides a general analysis about defence economics and he tackles the issue of cost-benefit analysis of a certain procurement program relating both these elements to time duration. Defence spending has negative effects on the level of savings and investments, however the effects on consumption are positive. Also R & D expenditure in the long run promotes the growth rate of the economy.

Georgiou (1990), Georgiou et. al. (1996) tries to answer the question of the potential existence of an arms race between Greece and Turkey. Georgiou (1990), points that both countries increase proportionally their spending following one the other. However, using data from the 1960-1990 later research Georgiou et. al. (1996) does not prove the hypothesis of an arms race between the two countries. This outcome contradicts that of Kollias (1996) who pointed out that level of Greek defence spending is related with that of Turkey and not with that of other NATO countries and the Hellenic spending does not follow the pattern of the alliance.

Liousis (1997, 2000) has concentrated in the developments of the 1980s and the 1990s, almost exclusively in the arms race aspect of defence policy. Stavrinos [Balfoussias-Stavrinos (1996), Stavrinos (1997)] initial findings point out that defence spending had a favourable effect in the economy by reducing unemployment. These results partially co-inside with those of Kollias (1994, 1995), and oppose those of Andonakis (1995, 1997a, 1997b). In a later work his main conclusion is that Greece has to increase its defence spending in order to balance the expenditures of Turkey. He points out, that due to the high public debt, and the budget deficit the Greek economy is unable to sustain a long term arms race with Turkey. For Turkey he concludes that the huge investments in the military sector practically grounded out the civil sector of the economy and created a high inflation, high debt situation. These results co-inside with those of Andonakis (1995).

The work of Nikolaidou (2000), [Nikolaidou et. al (2001,2002,2003)] is analysing the relationship between defence spending and economic growth. Her results point out that for Greece the major determinant for its defence spending is political (i.e. threat of war) rather than economic. Also for the Greek economy, defence spending has a harmful effect. (Dunne & Nikolaidou 2001). For the case of Turkey evidence for the 1960-1996 period demonstrates that there is a negative impact on growth from defence spending as well. (Dunne & Nikolaidou & Vougas 2001).

3. The Cost-Benefit Methodology: Theory and application in the case of defence industry

The above literature, does not take into consideration the cost / benefit anaysis of defence articles (aeroplanes, tanks etc) in both countries. The fulfilment of this gap in the literature is the intellectual aspiration of this paper. The cost-benefit analysis is a useful methodology developed in economics for evaluation of various investment projects. In the defence sector the above methodology is used extensively for the evaluation of defence projects. A typical application of this methodology can be found in the writings of Hartley & Hooper (1993), and Hartley (2000).

In theory, every country who is engaged in defence procurement or purchases has the following four policy options: 1) Engagement in a national project exclusively. This solution allows the country to have a free hand in the type of the equipment which will be produced, the quality of the product and the number of produced units. The absence of participants secures the access of the single producer to confidential designing and technology. However, this policy is associated with high R&D expenditure and high risk. 2) Collaboration with one or more countries. This is especially important for the case of defence industry since it allows the reduction of high R&D costs, and also minimises the risk of wasting financial resources in similar activities across countries of the same alliance.3) Licensing, co-production, or subcontracting. Here production cost can be reduced since certain elements of the defence equipment are produced in another country and thus a cost-focus strategy is achieved. 4) The final option refers to the case that one country will simply buy it from the international market. This transaction (arms trade) will have two potential dimensions. The first refers to "off the shelf trade", that is equipment purchased without any offsets for the buyer. The second option refers to arms trade with offsets for the buyer. Nowadays most nations which are third tyre defence producers follow the "trade with offsets" strategy but the extent of these offsets is not always clear and is not always publicly available information. When the authorities of a state decide on the type of policy that they will follow then the next step will be the determination of the benefits that will occur from the production, joint production, or simply purchase of a specific type of defence equipment. These potential benefits are of two main types: 1) Military and Strategic Benefits, 2) Economic/ Social Benefits. In the first category the acquisition of one specific defence article and its introduction to the local armed forces will have implications for the fighting power of the local forces. In the case of military aircrafts the benefits for the local air-force which will use the new aircraft include elements like aircraft capability (i.e. time and flights required per day), range (ability to flight longer distances without using intermediate airfields), size and weight of equipment (more heavily armed than the existing aircrafts), airfield facilities including smaller airfields with smaller runways and smaller times for preparation as well as smaller numbers of ground support personnel, survivability in an intensive battlefield (ability to meet multiple threats from SAM systems, BVR systems, etc.), maintenance and life cycle traits including support in remote airfields, standardisation of equipment with existing aircraft and other systems (telecommunications, radar systems, ammunition, fuel etc). The military benefits may include broader co-operation in the defence sector. Thus the same company may provide not only airplanes but also other equipment (radars, missiles, etc).

TABLE 1: A Cost-Benefit Analysis-Policy Options and Frameworks for evaluation of industrial projects and procurement policies.

Policy Options	**Benefits (Military Strategic Factors)**	**Benefits (Economic Factors)**	**Costs**
1. National Project (independence)	**1**. Performance of the specific Defence Article	**1**. Technology transfer (this may have dual purpose)	**1**. Acquisition price
2. Collaborative Project (two or more nations)	**2**. Number of defence articles to be produced or purchased	**2**. Employment creation (Jobs)	**2**. Total nominal cost (acquisition price multiplied by the total number of units purchased or produced)
3. Licensed or co-production	**3**. Delivery Schedu- le, time duration	**3**. Balance of Payments Effect **3a**. initial capital inflow, **3b**. import substitu-tion effect, **3c**. export creation	**3**. Life cycle per unit cost
4. Imported Equipment	**4**. Standardisation	**4**. Growth (GNP effect) **4a**. Total payments for factors of production **4b**. Return (after tax profit) **4c**. Taxes to the local government **4d**. Opportunity cost of local factors of production **4e**. Positive and Negative broader social externalities including defence/ security policy	**4**. Total life cycle cost
4a. "Off the shelf" (i.e. equipment purchased without offsets)	**5**. Other military/ strategic factors (support for Defence-Industrial Base, political support, broader defence co-operation)		**5**. Broader economic costs (capital outflow, imports, etc)
4b. Imports with offsets			

Sources: Modified version originally adopted from Hartley & Hooper (1993), Hartley (2000). Most of the economic benefits refer to FDI in the defence industry from first to third tyre producers.

The economic benefits will vary according to the type of agreement between the two sides. These benefits however encompass a variety of economic activities such as job creation, technology transfer which may include transfer in the defence sector or transfer in the civil sector. In the case of FDI thus creation of a joint venture between the companies of the two states the benefits for the local economy will include initial use of factors of production (capital, labour, land), import substitution effects (since the specific defence equipment is now produced locally) and possibility of export increases since the third-tyre producer country has the ability to export the product to other countries. Other economic effects refer to growth rate, profit which will be re-invested in the domestic economy as well as taxed, broader positive externalities (like the creation of skilled labour force), minus any negative externalities (such as the opportunity cost of factors of production, industrial espionage etc). Finally the costs refer to nominal costs as well as life-time costs. The nominal cost refers to per unit cost, as well as, the overall cost of the project. Life time costs refer to the total operational cost for the time period which the system will be in service (this for the case of Greece and Turkey is around 25-30 years) plus the cost of service and maintenance as well as middle-life upgrading. Broader economic costs may occur due to various outflows of capital for a variety of reasons (payment of foreign suppliers, payments for imported equipment etc.). The following table provides an overview of the various elements which are (or should be) included in a cost-benefit methodology. However, for the defence industry adequate information for all the data is not always possible.

4. A Cost-Benefit Analysis for fighter aircraft: The case of the Hellenic Air-Force

This section presents the application of cost-benefit analysis for fighter aircraft. The purpose of the study was to construct a comparable set of Efficiency - Cost Indicators for eight types of fighter aircraft (i.e. EF-2000, Su-27/30 MK, Mirage-2000-5, F-15E, F-16 / 50+, F-16/52+, F-22A and Rafale B). The indicators would take into consideration technical characteristics for Efficiency and cost characteristics for Cost.

The basic Efficiency-Cost Indicator (ECI) is then a number for each type of fighter, and it goes without saying that the one with the highest ECI is the best choice. In a second more advanced stage of evaluation the basic ECI is “enlarged” in order to take into consideration some additional factors.

The Efficiency part of the analysis is based firstly, on the technical characteristics and secondly on the choice of appropriate weights of the various characteristics.[1] Since fighters are very complex weapon systems, the analyst has to make a choice as to the number of characteristics that he / she will consider. The more characteristics considered, the more detailed, but also, more complex, the study is expected to become.

In this particular study a "middle way approach" was chosen with the selection of fifteen main characteristics, some with sub-categories, as given in the Tables in the Appendix.

Even more difficult than the choice of the number of separate technical characteristics to be considered, is the choice of weighting-evaluation. Here, a certain degree of subjectivity cannot be avoided. The analyst thus, has to be careful and explain his choices. Table 1 provides our choice for weights for technical characteristics. To illustrate, let us examine in more detail some of the choices. We provide a weight of 5 (out of a range 1-10) to "maximum speed", because we estimate that this characteristic is important for modern fighters, but not essential. Therefore, a maximum speed difference of 0.5 mach between F-15E (2,5 mach) and Mirage-2000 (2 mach) does not play an important role in modern air combat.

On the other hand, we give a weight of 10 to "maximum range", because of the particular configuration of the Hellenic Air Force needs. (This kind of classification may differ from one air-force to another). Greece's main potential military threat comes from Turkey. One of the main tasks of the Hellenic Air-Force is first effective deterrence, the capacity to be able to strike at all targets of the potential adversary (air force bases, other strategic objectives located deep inside the enemy, at distances of more than 1,000 km from the Hellenic's Air Force bases).

The second task due to the existence of the Joint Defence Doctrine between Greece and Cyprus is the defence of Cypriot air space (Cyprus has no air force of its own, with the exception of some helicopters). Thus, HAF aircraft have to be able to reach and stay long enough under combat conditions over Cyprus. The distance, between the nearest Hellenic Air Force base on the island of Crete, to Cyprus is, about 700 Km. Under the above geographical impediment, "range" is one of the most important traits for the HAF. This might not be the case for a country with different defensive needs and far less extensive geographical area to cover.

To illustrate our views further, let us consider the two sub-elements of point 9, air-combat. We rank using number 10 of the scale the "Beyond Visual Range (BVR)" characteristics and we give only 5 out of 10 for the "dogfights" characteristic. This has to do with our estimates as to future air combat. Estimates from the American, and other air forces, as well as, historical data gathered from recent conflicts [Kinzey (1992), Ripley (1992), Chant (2001)], expect that in future most air-combats-interceptions will be fought "beyond the visible horizon" (BVR). Thus, fewer of the older close "dogfights" style operations will occur.

This evolution necessitates aircraft that have strong radar systems, good electronics (i.e. links with airborne radar systems) and as many as possible BVR missiles. (i.e. AIM-120 or MICA). On the other hand, “dogfight” characteristics, like manoeuvrability become less important. Still it must be stressed once again that the discussion regarding weights is open to constant critical assessment according to new developments and experience.

For the same reasons, as expressed above, we considered the capacity of an aircraft to carry cruise missiles very important and gave to this sub-point a weight of 10.[2] Once the weights have been chosen, a scale of points, for each efficiency characteristic, must be chosen. We have selected a scale of 1-200, which gives greater scope for differentiation than a smaller scale. It must be stressed here again, that the results are not invariant to the choice of scale as to the definite ranking of fighters. A smaller (i.e. 1-100 point scale) gives lesser differences in the total efficiency score for each aircraft. Although the efficiency raking would not change, i.e. the “best” fighter in the 1-100 scale would still be the best in the 1-200 scale, the ECI may change, since the ECI is constructed as:

$$\mathrm{ECI} = \frac{\mathrm{Efficiency\,Score}}{\mathrm{Cost}}$$

Let us consider an example, to illustrate this: Assume that fighter A, scores, 1,200 points in a 1-100 scale and costs \$50m, while fighter B scores 1,000 and costs \$30m. The ECI’s are 24 for A, and 33 for B, i.e. the most cost-efficient choice would be fighter B (which is technically somewhat inferior to A, but much cheaper).

Assume now that we change to a 1-200 scale, and fighter A now scores 2,500 points while B scores 1,400, the costs being unchanged. The two ECI’s would now be 50 for A and 47 for B, i.e. now A would be the most cost-efficient choice. We provide this example, in order to illustrate, the difficulties encountered by the analyst in the choice of weights and the scale of score for technical characteristics. According to our best knowledge, there is as yet no objective method to overcome these difficulties. The best the analyst can do, is to make clear, his preferences. (The actual weights and scale chosen and Efficiency scores for the particular study are presented in the Appendix, Tables 2, 3).

Concerning cost, two elements have to be considered: “fixed” and “operational” cost over the expected lifetime of the weapon system. “Fixed cost”, is relatively straightforward, since, it is provided by the producers (i.e. companies), when they make their offers. “Operational cost” is more difficult to calculate, since the analyst has first to estimate the lifetime of the fighter, which in our study is considered to be

25 years. Then, the additional elements of operational cost have to be estimated, as they include the following:

1) Spares of all kinds, at base and depot level, including labour cost and overhead charges. For aircraft in use, like the third generation fighters, historical costs are published (for example the "AFI 65-503 Document" of the USAF Cost and Planning Factors dated July 28th 1998, was used for the cases of F-16/50+ and F-15E). For fourth generation fighters, these estimates are very difficult to obtain, because historical costs do not exist and the only available sources are the data provided by the manufacturers themselves, which for obvious reasons may underestimate the cost of the aircraft. For the case of the F-16/52+ no data were provided, however since this aircraft is a more advanced version of the previous F-16/50+ model indicators were constructed taking into consideration the differences between the two models. These are as follows: 1) Slightly higher speed, 2) greater range to 560 nautical miles (1,037.8 km), which can be increased up to 780 nautical miles (1,445.5 km), 3) better radar system [APG-68(V)9] which allows the pilot to achieve Multi-Target Situation awareness (MTS) for four targets simultaneously compared to two targets in the case of the F-16/50+, 4) better GPS system, 5) coloured screens in the cockpit with night visual capabilities, 6) better fuel capacity, 7) better avionics and electronic equipment (these include the Joint Helmet-Mounted Cueing System (JHMCS) and the Advanced Self Protection Integrated Suite (ASPIS) system, which is comprised by the ALR-93(V)1 radar warning receiver, the ALE-47(V) countermeasures dispensers and the ALQ-187 Jammer, with Digital Radio-Frequency Memory (DRFM).

2) General depot maintenance. This, requires, periodic overhauls, for repair and overhead.

3) Personnel and various items, such as training, clothing etc.

4) Energy (fuel costs). This element of cost depends on the "flying attitudes" of the various Air Forces. All air-forces, use, often afterburners which increase fuel consumption dramatically. Personnel cost depends on the number of pilots (two or one) needed for every airplane, and the rate of crew to aircraft. (For example in the USAF case, 1,25 crew is needed for each F-15E, i.e. 2,5 pilots per plane, or 45 crew members for a squadron of 18 aircraft).[3] Further, support personnel, has to be attributed to the aircraft. Again in the case of USAF, the support personnel for an F-15E squadron of 18 aircraft, is 170 organic and 128 intermediate level persons.[4]

From our study, we concluded, that -in general- the third generation aircraft are cheaper to acquire than those of the fourth generation. However, fourth generation aircraft are cheaper to maintain. To illustrate, we mention that the ratio of "direct unscheduled maintenance" versus "main hours per flight hours" is, according to French sources: 15 for the case of F-15E, 12 for the case of F-22A and only 10 for the case of Rafale.[5] The "mean time" for engine change was reported as 235,6 hours for Rafale. Furthermore, the "mean engine change time" was reported as 147 minutes for the F-15E, 90 minutes for the F-22A and only 60 minutes for Rafale.

The above examples illustrate the practical complexities of collecting, evaluating and comparing the necessary data. In our study we have been unable to collect even approximate operational cost estimates for F-22A, Su-27 and EF-2000. Thus, we had to follow the second best solution, of constructing the indicators for the above airplanes, using just the acquisition cost, with all the caveats that this entails.
Tables 4 and 5 contain the acquisition price (flyaway), according to the estimates, which were provided by the manufacturers.[6] Once again we must stress, that Tables and the ECI's illustrate the researcher's subjective preferences, and so are always open to criticism if other researchers apply different subjective evaluation criteria. In other words, cost-benefit analyses as these are not to be taken as indisputable assessments. However, they are useful, because they serve to illustrate and quantify a great number of technical, cost, tactical, and preference elements, and so they can serve, as a clear basis, of reference and discussion. We believe also, that according to the brief – earlier discussion of operational cost, the inclusion of this element of cost would change the simple ECI's more in favour of four generation fighters, i.e. Rafale, F-22A and EF-200.

The basic ECI can be extended in order to include more elements. In our case, we considered enlarged ECI's which include the following: 1) Time preference, 2) Safety of delivery and support, 3) General economic effects, 4) Political considerations, 5) Comparative Developments between the Hellenic and the Turkish Air-forces.

1. Time preference. This may be an important element in the decision – making process, since defensive needs are not time independent. One weapon – system may be absolutely superior in all respects compared to others, but if it will be delivered, say after six years, it may be too late if the need to be covered is immediate. The basic ECI can be modified according to the following formula to take time preference into consideration:

$$\mathrm{ECI(e)}_t = \frac{1}{(1+i)^t} \cdot \mathrm{ECI}$$

i.e., the basic ECI is discounted in "present value" according to the discounting factor i. (subjectively taken again, at 0.05 rate) and the time horizon of delivery, t being the year of first delivery. Assuming 1999 as basis year, t equals 3 for fighters to be delivered in 2002 and 7 for fighters to be delivered in 2008. It is clear, that the ECI's as formulated above, favour deliveries that are made sooner, rather than later.

2. Safety of source and support. This, may be important, in particular over the life-time of the weapon – system, the good functioning of which depends on the problem of free delivery of spares etc. If for any reason the parent company ceases to exist, or does not produce the required spare parts, the weapon system may become un-operational. Political considerations play also a role. In some cases, the manufacturer, or more likely, the country of origin of the manufacturer, may want to exercise pressure to the country, which has acquired the weapon system by either with holding or delaying spare part deliveries.

So, the ECI may be expanded, by including a risk-safety factor attributed to each manufacturer country combination. The researcher will have to express, again, subjective evaluations of this element, by giving a higher factor (say 1) to "safe" combinations, and lower ones (say 0.8 or 0.5) to riskier ones.

3. General economic effects. Apart, from being generally expensive, modern weapon – systems embody high technology and know how which is important for the economy of the acquiring country at large. Countries, like Greece, have recognized this and require companies to include in their offers an offset program. This, usually, requires 100% compensation over a time period of the initial contact, in the form of direct investment, know-how transfer, creation of joint ventures, sub-contractor contracts, etc., from the company into Greece. The basic ECI can be further modified in order to include this element, i.e. by giving a certain rank to each offset proposal. This can again take the form of a factor (say between 1-0) why which the basic and modified ECI will be multiplied.

4. Political considerations: Since the issue of acquisition of modern weapon systems is not politically neutral, the basic ECI can be further extended using the same methodology in order to try to illustrate political influence and preference. It must be accepted that huge military contracts are a bargaining element between countries wishing to gain also economic and political advantage. Again, this can be taken into consideration by multiplying the basic ECI with an appropriate factor, which gives the political importance for the acquiring country for each of the manufacturer's country of origin.

The methodology as presented can be further extended to include other elements that influence choice. The problem is, of course, that the more additional elements are included, the more the basic ECI's (based on technical efficiency and cost) are diluted, and the last choice may have little in common with the original ECI in its basic, elementary form.

However, experience demonstrates that this is something, which does happen in real choices of weapon systems. Therefore, the quantification of such additional factors, even in the very simple form presented above, helps to bring the hidden preferences of decision-makers and researchers into the open, and so at least, stimulates intellectual discussion of this sort.

5. Conclusion

In this paper we attempted to develop a Cost – Benefit Analysis Model as a strategy for the evaluation of weapon – systems, giving as a particular real case study, the ECI's, constructed to facilitate choice of fighter aircraft for the Hellenic Air-Force, by using a modified version of Hartley & Hooper (1993) methodology. Thus, we departed from the current framework of analysis.

We have tried to illustrate the advantages but also the inherent difficulties and uncertainties of such an analysis, which always carries with it a high degree of subjectivity. This approach, certainly departs from the existing literature on the issue, since it is focused on the evaluation of specific defence article(s) (in this case aircraft), rather than, the already, well developed issues of arms races and general macroeconomic effects.

We found that the US fighters have a marginal qualitative superiority over the Western European and Russian ones. Furthermore, we have demonstrated that the decision of the HAF to include two main fighters, compared to that of the THK for one fighter, does not create any essential (strategic) advantage in the Greek-Turkish arms race. The proposed methodology, in spite of its subjective character, stimulates further intellectual discussion in the field.

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APPENDIX

TABLE 1: WEIGHTING OF TECHNICAL CHARACTERISTICS

Technical Characteristic	Weight
1. Speed	5
2. Range	10
3. Ceiling	3
4. Radar	
4a. Range of radar	10
4b. Simultaneous tracks ability of radar	10
4c. Dual use of radar	
5. Self protection	8
6. Systems	
6a. Targeting systems	6
6b. Navigation systems	6
7. Number of Anti-Aircraft Missiles	
7a BVR (Beyond Visual Range) ability	10
7b. WVR ability	3
8. Missile capabilities	
8a. BVR	10
8b. WVR	10
9. Air-to-Air Battle	
9a. BVR	10
9b. Close contact (Dogfight)	5
10. Air-to-Ground Battle (combination of missions and range)	10
10a. Weapon Load	10
10b. Stand-off missiles	9
10c. Hit Accuracy	10
11. Survivability	9
12. Life Duration	7
13. Stealth characteristics	6
14. Helmet targeting system	5
15. Self escort	10

TABLE 2: EFFICIENCY SCORES FOR US FIGHTERS (1-200 Range)

Technical Characteristics	F-16/50+	F-16/52+	F-15E	F-22A
1. Speed	70	90	100	100
2. Range	150	200	200	200
3. Ceiling	30	35	40	60
4. Radar				
4a. Range of radar	120	150	180	200
4b. Simultaneous tracks ability of radar	80	160	150	200
4c. Dual use of radar	0	0	0	200
5. Self protection	70	80	100	160
6. Systems				
6a. Targeting systems	120	140	120	160
6b. Navigation systems	120	140	120	160
7. Number of Anti-Aircraft Missiles				
7a BVR (Beyond Visual Range) ability	150	170	150	180
7b. WVR ability	90	110	150	90
8. Missile capabilities				
8a. BVR	200	200	200	200
8b. WVR	200	200	200	200
9. Air-to-Air Battle				
9a. BVR	100	130	150	200
9b. Close contact (Dogfight)	80	100	40	100
10. Air-to-Ground Battle				

(combination of missions and range)				
10a. Weapon Load	**70**	**100**	**180**	**100**
10b. Stand-off missiles	**100**	**120**	**100**	**100**
10c. Hit Accuracy	**150**	**170**	**150**	**200**
11. Survivability	**80**	**100**	**120**	**140**
12. Life Duration	**80**	**100**	**120**	**140**
13. Stealth characteristics	**0**	**0**	**0**	**100**
14. Helmet targeting system	**0**	**50**	**0**	**100**
15. Self escort	**60**	**80**	**160**	**160**
TOTAL	**2,120**	**2,625**	**2,730**	**3,450**

TABLE 3: EFFICIENCY SCORES FOR EUROPEAN FIGHTERS (1-200 Range)

Technical Characteristics	**Rafale B (France)**	**Mirage-2000-5 (France)**	**EF-2000 (European)**	**Su-27/30MK (Russian)**
1. Speed	**70**	**70**	**70**	**80**
2. Range	**150**	**60**	**100**	**200**
3. Ceiling	**40**	**40**	**50**	**40**
4. Radar				
4a. Range of radar	**180**	**140**	**180**	**200**
4b. Simultaneous tracks ability of radar	**50**	**80**	**150**	**130**
4c. Dual use of radar	**150**	**0**	**0**	**0**
5. Self protection	**100**	**70**		**70**
6. Systems			**100**	
6a. Targeting	**140**	**60**	**120**	**70**

systems				
6b. Navigation systems	**140**	**60**	**120**	**70**
7. Number of Anti-Aircraft Missiles				
7a BVR (Beyond Visual Range) ability	**150**	**90**	**200**	**200**
7b. WVR ability	**90**	**90**	**160**	**160**
8. Missile capabilities				
8a. BVR	**200**	**200**	**200**	**150**
8b. WVR	**200**	**200**	**200**	**150**
9. Air-to-Air Battle				
9a. BVR	**140**	**100**	**180**	**120**
9b. Close contact (Dogfight)	**70**	**50**	**90**	**90**
10. Air-to-Ground Battle (combination of missions and range)				
10a. Weapon Load	**140**	**50**	**120**	**100**
10b. Stand-off missiles	**200**	**100**	**200**	**100**
10c. Hit Accuracy	**150**	**100**	**150**	**100**
11. Survivability	**120**	**80**	**150**	**140**
12. Life Duration	**120**	**80**	**120**	**120**
13. Stealth characteristics	**100**	**0**	**100**	**0**
14. Helmet targeting system	**100**	**0**	**100**	**0**
15. Self escort	**100**	**60**	**100**	**160**
TOTAL	**2,900**	**1,780**	**2,960**	**2,450**

TABLE 4: DATA FOR US FIGHTERS
[Prices (fly-away), availability, efficiency score and CEI]

Data / Types	**F-16/50+**	**F-16/52+**	**F-15E**	**F-22A**
Price (in m. $)	32	33 (*)	50	70+ (**)
Availability	2003-2004	2003-2004	2003-2004	2008+
Score	2,120	2,625	2,730	3,450
ECI (s) 3/1	66,25	79,5	54,6	44,2 (***)
ECI (e) ****	18,12		34,56	13,16

(*)= Data for the F-16s block 52+ which were ordered during the 1999-2000 period. Any estimate about the per unit cost of July 2005 order is premature.
(**)=According to one source [Hartley & Hooper (1993: 16)] the cost per unit is estimated between $80m-$110m in 1992 prices].
(***)=Assuming per unit cost of $78m.

TABLE 5: DATA FOR EUROPEAN FIGHTERS
[Prices (fly-away), availability, efficiency score and CEI]

Data / Types	**Rafale B (France)**	**Mirage-2000-5 (France)**	**EF-2000 (European)**	**Su-27/30 MK (Russian)**
Price (in m. $)	50-60	35	50-65	40-50
Availability	2003/ 1-2	2002 /1	2003 / 3+	2002 /3
Score	2,900	1,780	2,960	2,450
ECI (s) 3/1	58,6	51,4	59,2	61,25
ECI (e) *	23,19 (34,79) (**)	18,54	34,15 (**)	14,42

1. **ECI (s)=Efficiency Cost Indicator-simple,**
2. **ECI (e)=Efficiency Cost Indicator-enlarged,**
3. **(**)= On the assumption that Greece would participate in production.**

[1] The technical characteristics in the tables are included as collected by the manufacturing companies and the Hellenic Air Force.

[2] The suggestion of the use of cruise missiles was followed by the Hellenic MoD, which ordered in 2001 40 SCALP-Storm Shadow cruise missiles to be carried out on modified Mirage-2000 (as well as the new M-2000-5 which have been ordered).

[3] We estimated for example that the personnel cost per hour for 1997 for a Greek F-15E is 674 USD, calculated as follows: 1,25 ratio of crew to aircraft, 300 hours flying time per year per aircraft, 80.903 USD per year for salaries – insurance etc. for each pilot.

[4] On the assumption of 300 flying hours per year per aircraft, and a salary of 35.910 USD on average for each support personnel per year, this amounts to 1.982 USD ground personnel per flying hour. The two numbers, 674 and 1982 together would give an indication of “labour cost” per flying hour. Similar calculations have been made for the other cost elements, as for example for fuel consumption for an F-15E according to the “flying customs” of the USAF – Continental US Operations and JP-S fuel as reported in document AFI-65503.

[5] This assessment may be biased in an attempt to favour the “Rafale” compared to its US made rivals. However, we use it in order to prove the point, due to shortage of comparative information.

[6] The F-22 and Rafale were not included in the official HAF list, so that no “official” offer was made for them. Thus, prices for them are estimates, while for the EF-2000 the price is according to, at the time DASA’s, communication to the authors. From the time of the gathering of the data, until the final draft of the paper a survey has been published in http://www.defenceindustrydaily.com which provides the following estimates of per unit cost for the following fighters: Rafale-C: $62,1m, Rafale-M: $67,9m, Jas-39C Gripen: $68,9m, F-18E Hornet: $78,4m, Eurofighter Typhoon (for German orders): $102,8m, Eurofighter-Typhoon (for UK orders): $118,6m, F-15E: $108,2m, F-35 JSF: $115m, F-22A Raptor: $177,6m. It is obvious that the per unit cost of modern airplanes differs from country to country according to the size of the order, the avionics with which the aircraft will be delivered, type of weapons etc. The different per unit procurement cost of Eurofighter for the German and the British airforces respectively illustrates the point. The cost of Eurofighter is expected to rise since the consurtioum has reduced the number of aircrafts and the Russian defence industry has recently purchased the 5% of the shares of EADS. The per unit costs which we include in our tables (see Tables 4-5) apply exclusively for the case of the HAF. However for the case of Eurofighter the total per unit cost is expected to be higher from that which was originally provided to the authors by the company, if this is ordered by the HAF.