

---

---

# The Defense Offset Valuation Model

By

**Dr. Won-Joon Jang, Dr. Chul HwWhun Kim, Professor Tai Yoo Kim**

and

**Mr. Tae-Yun Joung**

**Defense Technology and Quality, Seoul National University Republic of Korea**

## Introduction

Defense offsets are a type of counter-trade obligations related to the transfer of defense core technologies and component parts production required by the importing country as part of a large defense procurement contract for export of arms, equipment and related services.<sup>1</sup> Given the growing scale of foreign weapon procurement contracts in the Republic of Korea, the importance of defense offsets is being highly recognized as an efficient way of building up defense strength. Therefore, defense offsets provide a window of opportunity to obtain defense core technologies from the more advanced countries while not violating the relevant world trade organization (WTO) agreements.<sup>2</sup>

To value something is difficult, but this is one of the most important activities today.<sup>3</sup> The value is quite different from the cost itself. In the matter of defense offset estimation, the buyer focuses on the value whereas the Seller mainly deals with the cost itself. From the seller's point of view, the cost is the money itself incurred to implement the offset obligation. However, from the buyers' point of view, the value is greater because the offset program gives the buyer a chance to acquire intangible assets including technology, parts production opportunity, and so on. Therefore, the buyer continues to take a chance of getting defense technology and other valuable opportunities by using offset programs.

The policy concerning offset programs include greater than \$10M projects of foreign defense acquisition, and in this case, the Republic of Korea (ROK) government needs over 30 percent of the value of the amount in the defense acquisition contract.<sup>4</sup>

## The Types of Defense Offset Programs

The offset program has two distinctive types according to the relation to the imported weapon systems: direct and indirect. Direct offsets are related to the weapon systems or related services exported by the defense firm and usually include technology transfer<sup>5</sup>, buybacks, overseas training, technical assistance, co-production, acquisition of maintenance capability and others. Indirect offsets are unrelated to the weapon systems or related services from the overseas defense firms. These include purchase of defense equipment, training, technology transfer, technical assistance and others.<sup>6</sup>

---

1. DPA, *Defense Offset Guidelines*, Ministry of National Defense, ROK, 2003.2. Available on web at: <http://www.atypon-link.com/CTO/doi/abs/10.5555/ogqb.2004.October.103>.

2. Nothing in these agreements shall be construed to prevent any party from taking any action or not disclosing any information which it considers necessary for the protection of its essential security interests relating to the procurement of arms, ammunition or war materials, or to procurement indispensable for national security or for national defense purposes. (WTO GPR/Spec/77, Article 23, 1993. 12.15).

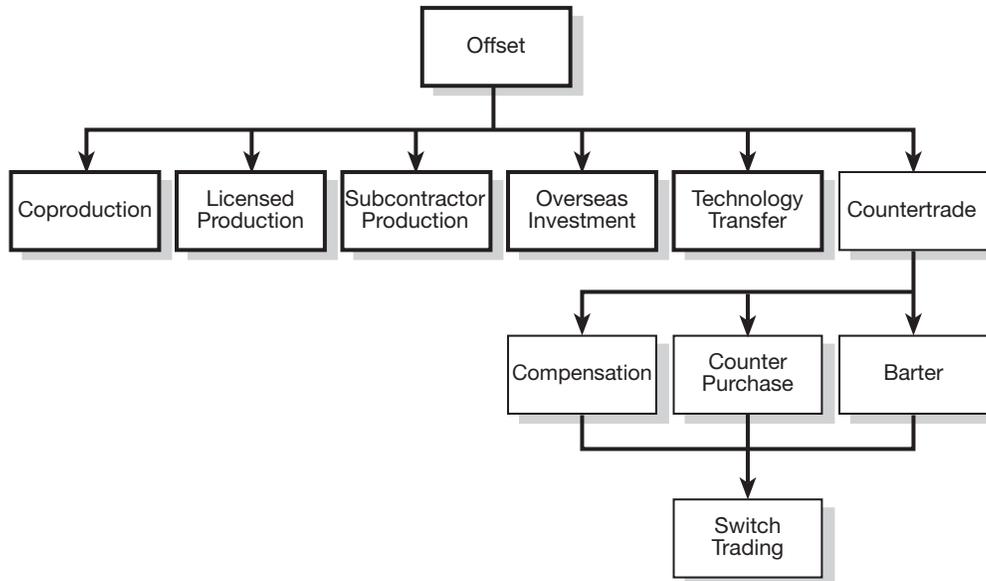
3. Boer, F.P., *The Real Options Solution: Finding Total Value in a High-Risk World*, John Wiley & Sons Inc., 2002.

4. DAPA Regulation, 2006.

5. Technology transfer contains three types of technology, which is research and development (R&D), manufacturing and depot level maintenance. (DAPA regulations, 2006).

6. U.S. Department of Commerce, 2003: DAPA Regulations, 2006.

They are also distinguished by five different types of offset programs. It is important to keep in mind the various types of defense offset programs when evaluating defense transfer technology since the offset value varies across different types of offset.<sup>7</sup> Figure 1 displays five different types of offset programs and illustrates the concept of counter-trade.<sup>8</sup>



**Figure 1. Types of Defense Offset Programs**

Whereas defense offsets are used in defense terminology, the counter-trade refers to the type of agreement involving reciprocal purchase of civilian goods.<sup>9,10</sup> Table 1 presents the definition of five different types of defense offset programs.<sup>11</sup> According to the definitions of offset programs below, technology transfer distinguishes itself quite substantially from the processes of co-production, licensed production, overseas investment and subcontractor production.

Recognizing the importance of defense offset programs, however, the purchasing countries have scarce means of estimating the defense offset value due to the lack of an objective and credible technology valuation model. Most previous research on the issue of defense offsets chiefly focused on impact analysis.<sup>12</sup> Also, only cost approach was used for defense offset valuation. Even the technology data and multiplier are evaluated based on its number of pages and its status of equipment. For these reasons, the paper has developed a framework for evaluation of the defense offset technology based on the appropriate technology valuation approaches.

7. Technology transfer is usually required for its know-how. But, for parts production cases, the offset value is credited at 100% due to its amount, therefore, the know-how is only credited when the seller transfers its manufacturing technology to the KIP for the first time. (ROK Offset Guidelines, 2003).

8. Neuman, G. S., *Co-production, Barter and Countertrade: Offsets in the International Arms Market*, Orbis, Spring 1985, p. 186.

9. Counter-trade is not an available way of the trade because the WTO does not allow this type of trade in the global market.

10. Kim et al., "Performance Evaluations of Defense Offsets and its Developments," *Korea Institute of Defense Analysis Publication*, 1994 (Korean).

11. DISAM, *The Management of Security Assistance*, 2003, pp. 487-511. Kim et al., "Performance Evaluation of Defense Offsets and its Developments," *Korea Institute of Defense Analysis Publication*, 1994 (Korean).

12. Kim et al., "Performance Evaluation of Defense Offsets and its Developments," *Korea Institute of Defense Analysis Publication*, 1994 (Korean).

<b>Table 1</b> <b>Definitions of Defense Offset Program</b>	
<b>Types of Offset</b>	<b>Definition</b>
Co-production	Based on the government-to-government contract, either importing governments or commercial firms acquire relevant technology data and information in order to produce either the finished weaponry or component parts abroad.
Licensed Production	Based on the technology data from the firm-to-firm or the firm-to-government direct contract, the exporting manufacturer's weapons or parts thereof are produced in the buyer's country
Subcontractor Production	The subcontractor produces component parts according to the direct contract between export manufacturers and foreign subcontractors, not necessarily involving the licensed production or technology transfer.
Overseas Investment	Investment arising from an offset agreement, taking the form of capital investment to establish or expand a subsidiary or joint venture in the foreign country.
Technology Transfer	Occurs as a result of an offset agreement that may take the form of research and development conducted in the buyer country, technical assistance provided to the subsidiary or a joint venture in the foreign country, or other activities under direct commercial arrangement between exporting manufacturer and the buyer entity.

### **Introduction of Technology Valuation Approaches**

Technology valuation has been spurring increasingly growing attention since the beginning of the 1990's. As distinct from the issue of technology assessment,<sup>13</sup> technology valuation is an evaluation activity to review technology, industrialization, and market factors with intangible technology. It presents the technical values as money terms, levels, points, and other suggestions.<sup>14</sup> The defense offset technology valuation is slightly different from the definition of technology valuation. It focuses on the valuation of defense technology from the offset contracts; therefore, it defines an evaluation activity of defense technology itself to describe money values with a review of its technical, economic, and defense strength effects. Technology valuation is different depending on its purpose, usage, a point of view and intention of managers, and evaluation methods. Therefore, the real technical value is decided in the consideration of who, when, what for and how factors.<sup>15</sup>

There are basically three well-known approaches to the valuation of technology, namely, the cost-based, market-based and income-based approaches.<sup>16</sup> The cost approach is based on the basic economic assumption that neither buyer nor seller would be willing to pay more for an asset than the cost of creating or replacing the asset. The cost approach thus typically falls into two different types,

13. Technology assessment is focused on the strategic point of view of the business firms and mainly evaluates the strategic value of the firms own technology.

14. Smith, G. V. and Parr, R. L., *Valuation of Intellectual Property and Intangible Assets*, Second Edition, John Wiley & Son, 1994.

15. Boer, F. P., *The Valuation of Technology*, John Wiley & Sons, 1999.

16. Mard, M., "Financial Factors; Cost Approach to Valuing Intellectual Property," *Licensing Journal*, August 2000a, pp. 27-28.

namely, the reproduction cost and replacement cost, both of them taking account of depreciation and obsolescence.<sup>17</sup> This approach has an advantage of simplicity and easiness of application, especially in case of the defense critical technology. However, the cost-based approach is unable to capture the wealth-creating potential of the technology due to the difficulties of obtaining the underlying data and identifying depreciation factors.

The income approach is measured by the net present value of the stream of the associated economic benefits over the lifetime of the technology. The benefits in this case are typically classified by the different types of underlying factors, namely, the technology, market, entrepreneurial, and management factors. It appears reasonable to incorporate measures of the real value of technologies, patents, trademarks, copyrights and other technology-related factors into the value of the technology transfer contract. The income approach makes use of the option approach, which is highly popular these days.

The market approach is more appropriate to use if the real-world market for technology is in place since it is based on observing similar transactions that take place in the market and using them as a benchmark for evaluating one's own transactions. It is a simple and reasonable method; however, it is impossible to apply if the data on similar technology-transfer transactions are not available. One of the reasons is that the market for trading defense technologies is quite limited, prohibitively narrowing down the scope for the application of market approach to the valuation of technology.<sup>18</sup> Table 2 summarizes the characteristics of alternative technology valuation approaches in defense offset program.

<b>Table 2</b> <b>Comparison of Technology Valuation Approaches in Defense Offset Program</b>			
<b>Approach</b>	<b>Cost Approach</b>	<b>Market Approach</b>	<b>Income Approach</b>
Definition	Valuation based on reproduction or replacement costs	Valuation based on the comparable market price	Valuation based on the present value flow of benefits
Advantages	Easy to use and calculate if cost data are available	Easy to rationalize if the market data are available	Makes use of the well-developed concept of net present value
Disadvantages	Difficult to obtain the data; ignores potential future value	Lack of comparable market data especially in defense field	Chance of error due to subjective estimation only deals with the amount of revenue ignore defense strength effects

17. Boer, F. P., *The Valuation of Technology*, John Wiley & Sons, 1999.

18. Jang, W. J., "The Application of Real Options Theory in Defense Acquisition Projects", *Ph.D. Dissertation*, Seoul National University, 2005.8.

---

---

## Defense Offset Valuation Model

The defense offset valuation (DOV) model consists of four areas of technology valuation. Because there is no single perfect valuation approach in the world today, neither is the offset technology valuation perfect. Therefore, within the limited time and available data, all necessary valuation approaches are essential to use to get the ideal values of the offset program.

### Cost Approach

The cost approach is the base of the defense offset valuation model. Based on the valuation principles, the formula is presented below:

$$\text{Offset Value} = \text{Suggested Value} \times \text{Peer Review Value} \times \text{Adjusted Value}$$

With the suggested value from the seller, the valuation process begins with appropriate tools and approaches. The cost approach consists of three phases. The first phase, with the deep analysis of the offset proposal, the technology experts from relevant institutes and defense firms are grouped to evaluate its real values. In this phase, the expert evaluates the suggested technology with the use of proven tools including the Delphi and Analytic Hierarchy Process (AHP). The questionnaire consists of three factors:

- Economic
- Technical
- Arms strength

The three major factors are divided with nine sub factors each. Economic factors are composed of budget reduction, economic spillover, and technical usefulness factors. Technical factors are made up of the technical level, technical importance and technical difficulty factors. Finally, defense strength factors are comprised of urgency of technology, defense contribution, and defense needs factors.

After evaluation of peer review phases with the questionnaire, the second phase mainly deals with valuation factors. Time to transfer affects the technology value much. The faster the transfer, the technology gets more value of offset credit. The extent of technology transfer requires a deep analysis by experts. If the seller fully follows the offset request for proposal (RFP), they get more offset value. The technology right is also an important factor to evaluate technology. The more rights of technology transferred to the Buyer, the more offset value they can get. And other factors including the credibility of offset proposal are also considered and affect the offset technology valuation. Finally, the offset value is estimated by these deep analyses using proven tools and approaches. Table 3 shows the procedures of the cost approach of the offset technology valuation.

**Table 3**  
**Cost Approach of Defense Offset Technology Valuation**

Sector	First Phase	Second Phase	Final Phase
Methods	Peer Review (Questionnaire)	Adjusted Valuation	Final Estimated Value
Tools	Delphi, APH	NPV, Peer Review	
Consideration	Economic Factor Technical Factor Defense Strength Factor	Time to Transfer Extents of Technology Technology Rights	

### Income Approach

The income approach is a widely used technology valuation model in commercial sectors and can be also applied to the offset program. There are two different ways of using income approach in the offset program. First, when the seller proposes manufacturing technology with the amount of buy-backs, the paper can be used the traditional income approach to get the associated offset values using the equation below.<sup>19</sup>

$$\text{Offset Value} = \left\{ \sum_{i=1}^N \frac{FCF_t}{(1 + WACC)^i} + \frac{V_t}{(1 + WACC)^N} \right\} \times (\text{Technology Factor})$$

(where, -  $FCF_t$  : Future Cash Flows at Times t,  
 N : Estimation Period,  
 $V_t$  : Salvation Value at Time t,  
 Technology Factor : Technology Contribution Factor,  
 WACC : Weighted Average Cost of Capital 1,  
 $i = T_1, T_2, \dots \dots T_n$  : Offset-proposed Technology

As seen above, the income approach of the offset program starts when the seller proposes manufacturing technology with the amount of buy-backs. This consists of two phases. When it is proposed as an offset program, the experts present the appropriate data and prepare the questionnaire. With the use of proven tools including net present value (NPV) and technology contribution methods, the questionnaire is analyzed to get the final estimated values. Table 4 shows the procedures of the income approach of the offset technology valuation.

19. Lee J. D., Jang, W. J. Ryoo, T. H. and Lee, C. J., "The Application of Real Options Theory in Defense Offset Contract," *Military Operations Research Society of Korea*, 2005.6 (Korean).

<b>Table 4</b> <b>Income Approach of Defense Offset Technology Valuation</b> <b>(Revenue Creation Value Creation)</b>		
<b>Sector</b>	<b>First Phase</b>	<b>Second Phase (Final Phase)</b>
Methods	Revenue Creation (Questionnaire)	Final Estimated Value
Tools	NPV, Technology Contribution Method	
Consideration Factors	Estimated Income Statement Surplus Value Technology Contribution Ratio	

Second, when the seller proposes the defense equipment, the paper can be also used the income approach to get the values, too. This consists of two phases. When the seller proposes the defense equipment as an offset program, the buyer could get the budget reduction effects while the buyer could use it during its lifecycle time. The equipment usually contains depot maintenance and test equipment. So, with the deep analysis with the experts and the use of AHP and NPV methods, the paper could estimate the values of budget reduction effects. Table 5 shows other procedures of the income approach.

<b>Table 5</b> <b>Income Approach of Defense Offset Technology Valuation</b>		
<b>Sector</b>	<b>First Phase</b>	<b>Second Phase (Final Phase)</b>
Methods	Budget Reduction Valuation (Questionnaire)	Final Estimated Value
Tools	APH, NPV, Peer Review	
Consideration Factors	WBS Level Expected Lifecycle Costs	

Therefore, in the offset program, the paper presents the income approach, which is the widely used valuation methodology with the adjustment of its own defense offset circumstances as well.

### **Line of Code method**

The Line of Code method is quite useful to value the software source code evaluation. According to the increasing importance of software upgrade needs with weapon system and relevant equipment, the appropriate valuation tools are also becoming important. Based on these principles, the formula is presented below.

$$\text{Software Value} = \text{Lines of Code Value} \times \text{Peer Review Value}$$

When the seller proposes the software source code with a relevant weapon system, the valuation process begins with the appropriate valuation tools. The method is mainly applied with the “Software Project Valuation Guidelines.”<sup>20</sup> With the guidelines, the first phase, the proposed lines of code are evaluated with the number of code lines and adjusted factors. The second phase follows the peer review process with its economic, technical, and arms strength effects in the buyer’s point of view. The final value is also presented with these firms, solid tools and methods. Table 6 shows the procedures of the lines of code method of the offset technology valuation.

<b>Table 6 Lines of Code Method of Defense Offset Technology Valuation</b>			
<b>Sector</b>	<b>First Phase</b>	<b>Second Phase</b>	<b>Final Phase</b>
Methods	Line of Code	Peer Review (Questionnaire)	Final Estimated Value
Tools	Software Valuation	Delphi, APH	
Consideration Factors	Number of Code Lines Adjusted Factors	Economic Factor Technical Factor Defense Strength Factor	

### Case Studies Method

The case studies method is useful when the relevant databases are appropriate. It is also possible that the defense offset technology valuation can use this method. After valuating the offset program, the databases include more than hundreds of offset proposed technology and equipment. Therefore, with the use of cost, income and line of code method, finally the case studies are used to verify the estimated offset values with their mean, maximum, and minimum values. Table 7 shows the procedures of the case studies method of the offset technology valuation.

<b>Table 7 Case Studies Method of Defense Offset Technology Valuation</b>			
<b>Sector</b>	<b>First Phase</b>	<b>Second Phase</b>	<b>Final Phase</b>
Methods	Cost Approach Income Approach Line of Code	Case Studies	Final Estimated Value
Tools	Delphi, AHP Peer Review Software Valuation	Offset Valuation Databases	
Consideration Factors	Three Major Factors Number of Code Lines Adjusted Factors	Mean Value Minimum and Maximum Value	

20. It is the government guidelines of Ministry of Information and Communication in 2005, ROK.

**Overall Defense Offset Valuation Model and its Major Outcomes**

With the deep research and advice of the technology valuation experts worldwide, the defense offset valuation (DOV) model is developed and used for the offset valuation methodology today. Because there is no golden rule of valuating the technology, each approach and methods have their own pros and cons. Therefore, it is most important to use these approaches together and compare the results to get the most objective and credible values. Table 8 shows the overall DOV model approach including cost, income, lines of code, and case studies methods.

<b>Table 8 Case Studies Method of Defense Offset Technology Valuation</b>			
<b>Sector</b>	<b>Valuation Tools</b>	<b>Contents</b>	<b>Final Values (\$)</b>
Offset Technology	Cost Approach	Technical Data	
		Overseas Training	
		Technical Assistance	
		Equipment	
		Know-how	
		Sub Total	
	Income Approach	Budget Reduction Value	
		Revenue Creation Value	
		Sub Total	
	Lines of Code	Software Source Code	
Case Studies	Offset Database Values		
Total			



<b>Total Project Cost</b>	<b>Suggested Offset Value</b>	<b>Final Estimated Offset Value</b>	<b>Others</b>
\$	\$	\$	\$

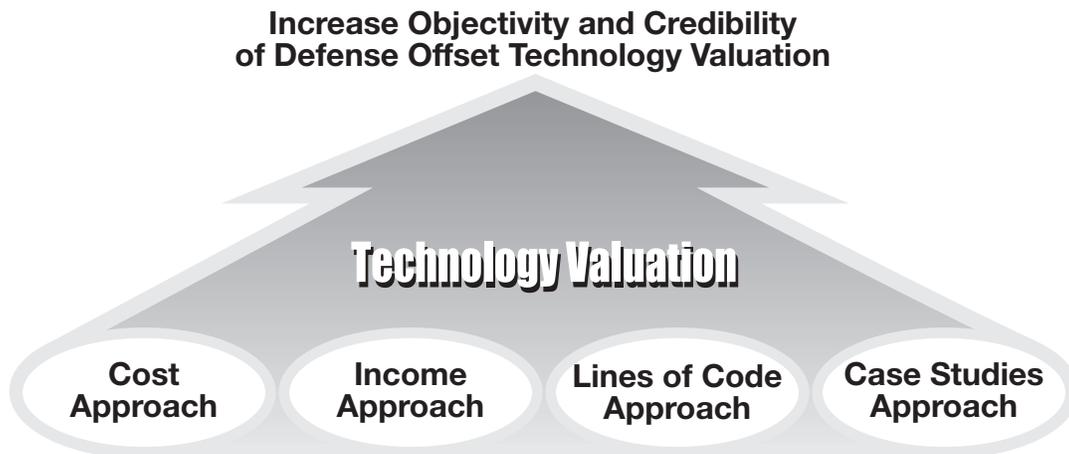
The defense technology and Quality (DTAQ) has the responsibility to evaluate the defense offset technology valuation in ROK. With the DOV model, it had outstanding outcomes last year shown in Table 9.

Table 9 Defense Offset Technology Valuation Outcomes in 2006				
Number of Projects	Number of Offset Technology	Suggested Dollar Value	Final Dollar Value	Ratio
16	64	7.28 M \$	2.39M \$	32.80%

## Conclusion

As the importance of defense offset is currently increasing today, more than 100 countries have an offset policy of their own for the foreign defense acquisition. The annual report of the offsets in defense trade shows the great attention to the defense offset program today.<sup>21</sup> Although the demand for technology valuation has been growing, there have hardly been any attempts at evaluating the defense offset programs today. In this paper, based on an extensive review of existing technology valuation methods and real implementation today, the paper presented a model of valuation of defense offset programs, DOV model, which features the following characteristics.

By mixing the cost, income, lines of code and case studies methods, the paper presents a more objective and credible defense offset valuation model. Therefore, the DOV model is unique in the sense that it is able to use all proven valuation tools and approaches for the offset technology valuation, thus rendering it as credible and valuable to the potential buyer countries planning to engage in the process of defense acquisition Figure 2 shows the overall summary of defense offset valuation (DOV) model.



**Figure 2. The Overall Summary of the Defense Offset Valuation Model**

21. U.S. Department of Commerce, Bureau of Industry and Security, *Offsets in Defense Trade*, Sixty Report to Congress, 2003. U.S. Department of Commerce, Bureau of Industry and Security, *Offsets in Defense Trade*, Tenth Report to Congress, 2005.

---

---

The paper suggests that our DOV model provides a helpful basis for a useful valuation tool of the defense offset contracts. Defense offsets have become a well-established part of international arms trade.<sup>22</sup> It is firmly believed that the DOV model could be a great contribution to the objective and credible valuation tools of the defense offset program and should be a solid bridge to being a win-win relationship between the buyer and the seller in the future.

### **About the Authors**

Dr. Won-Joon Jang has received his Ph.D. in economics from the Seoul National University, Republic of Korea. He graduated from the Korean Military Academy in 1991 as a member of 47th class and also has graduated from the U.S. Air Force Institute of Technology in 1998 with an M.S. in logistics management. He is an ROK Army Major on Active Duty and has been working for a defense offset program manager in the Defense Technology and Quality (DTAQ) in Seoul since 2006. In 2005, he was the Integrated Logistics Support manager of the Army Tactical Communication and Information Command, ROK Army Headquarters. His major interests include technology valuation, technology transfer, performance evaluation, and priority selection.

Mr. Tae-Yun Joung has received his B.S. in mechanical engineering from the Hanyang University, Republic of Korea. Between 1981 and 2005 he worked as a Researcher in the Defense Quality Assurance Agency in Seoul. He is a Senior Researcher and has been working for a defense offset program manager in the Defense Technology and Quality (DTAQ) in Seoul since 2006. His major interests include quality assurance of defense articles and technology.

---

22. Yang, C., & Wang, T. C., "Interactive Decision-Making for the International Arms Trade: the Offset Live Cycle Model", *The DISAM Journal of International Security Assistance Management*, Vol. 28, No. 3, 2006.