AN EMPIRICAL EVALUATION OF OFFSET ARRANGEMENTS

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Abstract—This paper develops an empirical model to examine offset arrangements in government procurement. Previous contributions focus on the transaction cost (Taylor, 2000a, Udis and Maskus, 1991, Liesch, 1991) and bundling (Hall and Markowski, 1994) rationale for offsets. These studies are meaningful, but are devoid of quantitative models needed to test the theoretical claims. This study fills part of the gap in the literature. The results—which are preliminary and will require more testing in the future—suggest that while economic variables (transaction costs, price, quality) are part of the offset selection process, political economy variables (security alliances and rent-seeking) tend to exert more influence on policy.

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INTRODUCTION

Offsets are now common practice in government procurement of defense and civil goods from foreign sellers. Although a bit slow to respond to the rise of offsets in the 1980s, economists have begun to study this nonstandard contract during the past decade. The descriptive papers of the 1980s and early 1990s (Hammond, 1985, Verzariu, 1985, Liesch, 1991) spawned the applied micro and organization analyses more recently (Udis and Maskus, 1991, Martin and Hartley, 1995, Hall and Markowski, 1996, Taylor, 2000a). These studies, while varied, generally agree on the following: the offset is far more complex than barter-style countertrade, it is not necessarily an inefficient form of exchange, and it involves a heavy dose of political economy variables.

Curiously missing from the literature is empirical studies. Empirical testing of offset theory is a difficult and involved task, primarily because transaction data are not readily available. In this paper, I attempt to fill part of this gap in the literature. The transaction-level data used to estimate the models distinguish this study from other contributions. The two empirical models presented in this paper will help us to understand offset policy design more clearly.

The principal objective of this study is to investigate whether procurement officials are actually selecting offsets according to the economic rationale purported in the literature. The empirical findings suggest that while government procurement officials take transaction cost issues into account, political economy variables are also very important in the offset selection process. In some arrangements, the economic variables (price, quality, transaction costs, development policy) will dominate the political variables (bureaucrat maximization, national security considerations, and interest

group theory). In other circumstances, the attributes of the selected offset may reflect political priorities. Clearly, a holistic approach to offsets will provide better policy prescriptions.

The relative scarcity of quality data discourages quantitative research. Price is one of the more important variables in this analysis; it also happens to be quite elusive. Just as some firms have incentive to guard their price lists for price discrimination purposes, sellers offering offset packages typically do not provide delineated information about the price of the base good with and without offsets. If this information were available, economists could compute the willingness-to-pay for offsets, and then compare this figure to the total cost of the base good plus the offset components. In this fashion, we could calculate the deviation of offset pricing from traditional arms-length exchange in markets. Several economists have found creative ways to overcome the paucity of data. The empirical studies to date fall into three categories: case study, survey, and implicit cost estimation.

Case studies pepper the literature. While largely descriptive, some case studies provide supporting data. The data are usually in the aggregate, because governments and firms rarely provide transaction-level information. Hall and Markowski (1996) obtain aggregate offset data from Australia's Department of Defence to analyze offset compliance rates and time-to-completion. Such studies are invaluable for understanding the performance of offsets, but aggregate data fail to unmask the underlying incentives that drive transactions.

Surveys are an attempt to uncover micro-level characteristics of offsets. These papers circumvent the shortage of published data by sending anonymous questionnaires

to firms and governments involved in the offset business. The advantages of this methodology are two-fold. First, a properly designed questionnaire can yield revealing information about the impact of offsets on firms, which would otherwise be unobtainable. Second, this methodology is not costly in terms of price or time, as researchers can send the surveys in bulk to multiple recipients. The drawbacks of survey data are well known. They are subject to the standard critiques concerning survey and sample bias, and they do not assign the transaction as the unit of analysis. Martin and Hartley's (1995) paper is an example of the survey methodology.

The third methodology uses input-output analysis to estimate the implicit cost of offsets on an economy. Obtaining import (procurement) data and comparing it to the estimated cost of the same goods produced domestically, researchers attempt to compute the implicit cost of offset protection. This approach is novel and may provide some insights on the deadweight loss of offsets. To my knowledge, there is only one study that uses this methodology (Joson, 1996), and the results are preliminary in nature. We need a clarification of the data and careful inspection of the methodology before accepting this line of research.

The plan of the paper is as follows. Section 1 discusses offset policy formulation and the data required to conduct empirical analysis. Section 2 introduces a transaction cost model to elucidate the "smoke and mirrors" perception of offset policy formulation in government procurement. The model provides a more clear understanding of how bureaucrats go about selecting a particular offset instrument from quite a variety (countertrade, technology transfer, marketing assistance, subcontracting, co-production, and so forth). Final comments and opportunities for future research are in section 3.

SECTION 1: MODELING OFFSET POLICY

The offset is an extra sweetener—some form of economic activity beyond the base exchange—that governments require or encourage when accepting bids for procurement orders. *Defense* offsets arise when a government purchases military goods from a foreign seller. If the government requires offsets for the procurement of non-defense goods, it is known as a *civil* offset program. While not the norm, civil offsets are gaining popularity despite their illegality under World Trade Organization (WTO) laws.[1] Article XVI of the WTO's Fair Trade Practices prohibits offsets not associated with military purchases. Governments use several strategies to circumvent this article.

Article XVI is virtually impossible to uphold. Offset is one of the more nebulous policy instruments in government. In fact, many procurement requirements never mention the word "offset," preferring the more innocuous and vague "compensation packages," "cooperative agreements," and "industrial development." Another technique is for the purchasing government to consider—though not require—offsets with bids. In other words, the government does not mandate offsets, but it is highly recommended. In some cases, procurement officials will not consider bids without offsets.

The Czech government's procurement policy is illustrative. When it purchased a fleet of jet aircraft in 1999, offsets played a surprisingly large role. In reviewing bids from aerospace suppliers, the Czechs reportedly placed most importance on the offset package. Offset considerations made up 50 percent of the decision calculus of whether to buy, followed by technical specifications (30 percent), and financial factors (20%) (*Countertrade & Offset*, 12 April 1999). This procurement policy departs from the price margin: the content of offset packages is supplanting price and quality competition of the

base good.

Since procurement officials hope to achieve multiple and diverse objectives, it is not surprising that offsets vary considerably in design. A general model of offsets, would, ideally, take into account the economic and political factors that co-determine policy. Equation (1) reflects these political economy variables.

Policy = *f*(development strategy, transaction costs, market structure, political institutions, national security, bureaucrat maximization) (1)

The interaction of these variables makes econometric modeling challenging. The variables in (1) are not generally available in reduced form. It is therefore crucial to find viable proxies to best approximate the offset decision-making process.

The task is further complicated because proxy information is often proprietary. As mentioned earlier, sellers do not publish itemized price lists of the components in an offset bundle. Frequently, the dollar value of the entire bundle (the base good plus the offset) is not available either. Firms offering offsets usually operate in oligopoly or bilateral oligopoly markets, which explains why pricing information is proprietary. These firms may be able to price discriminate under certain economic settings.[2]

Governments have incentive to guard or misstate transaction level data as well. Historically, the political sensitivity of arms transfers caused governments to guard transaction data, understate the true value of the exchange, and equivocate on the topic

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[1] In the data set, 16% of the offsets originate from governmental purchases of civil goods and services.
[2] If information does not transfer from government to government perfectly, the seller may be able to segregate buyers into different groups according to their elasticity of demand. A country's willingness to

when queried. Since the advent of offsets, however, purchasing governments have opted to be more much more open, sometimes exceedingly so. The offset "compensates" the domestic economy, governments assert, for the displacement of local work by imported goods.[3] The greater the value of the offset, the more jobs created and technology transferred, and ultimately more political points for the government. For these reasons, purchasing governments have a tendency to overstate the benefits of a given offset agreement.

The Saudi Arabian offset program offers a compelling example. Since 1984, the Saudi government has used offsets to support an economic development program. The program targets high value-added manufactures like petrochemicals, telecommunications equipment, and aircraft parts and systems. Several multi-billion dollar defense contracts from the 1980s and early 1990s required 35 percent offset obligations. The most notable of these contracts include Peace Shield I (1984), Al-Yamamah (1989), and Peace Shield II (1991).[4] The government was quick to report the handful of successful joint ventures and investments spawned by the offsets.

For example, the Boeing International Technology Group (BITG) set up five high technology joint ventures. The most prominent of these companies is Advanced

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resell products for an undisclosed price to other governments (the weapons exchange of Iran-Contra immediately comes to mind) will tend to erode the profitability of price discrimination in some markets.

[3] To describe an offset as a "compensatory agreement" is really a misnomer. The question we must ask ourselves is, 'For what does the offset exactly compensate?' The conditioned political response is that the offset compensates for the loss of domestic production. Upon closer inspection, we see that in a general equilibrium setting, trade is not a zero-sum game. In other words, there would be a significant opportunity cost if the government chose to purchase the goods domestically instead of from a foreign firm. Government is likely to import if the goods are not available domestically, or the domestically produced goods are not competitive in terms of price and/or quality. To the extent that the desired production set is more costly to produce at home than abroad, the government would incur opportunity costs. International trade does not cause the type of damage or sacrifices in a general equilibrium model that would justify the demand for a bundled compensation package from the seller.

[4] Peace Shield I was signed with Boeing Co. (U.S.), Al-Yamamah with British Aerospace (U.K.), and Peace Shield II with Hughes Aircraft Co. (U.S.).

Electronics Co. (AEC). The government touts AEC as an exemplary offset startup firm. Established in 1988, AEC is now self-sufficient and profitable. It is involved in the design, manufacture, and assembly of advanced electronic equipment. AEC provides components for numerous defense projects including M1A2 tank electronics, F15S and F-16 avionics, Paveway laser guide bombs, and tactical radios (Saudi Economic Survey, 1998, p. 18).

Upon closer inspection, however, the successes of AEC and other joint ventures appear to be more of an exception than the rule. The *Saudi Economic Survey* (1998, p. 21) reports that between 1984 and 1996, U.S., British, and French defense contractors incurred a total of $4.4 billion of offset obligations. By 1997, the contractors had fulfilled only 10 percent of the obligations. Table 1 reports the demonstratively low rates of compliance. Remarkably, after appraising the status of the offset programs, King Fahd said he was satisfied and pleased with the seller's performance.

Table 1. Saudi Economic Offset Program: Offset Obligations and Rates of Compliance.

Nationality of Sellers	Offset Obligation ($ millions)	Rate of Compliance
American	1,700	16%
British	2,000	8%
French	700	6%
Total	**4,400**	**10%**

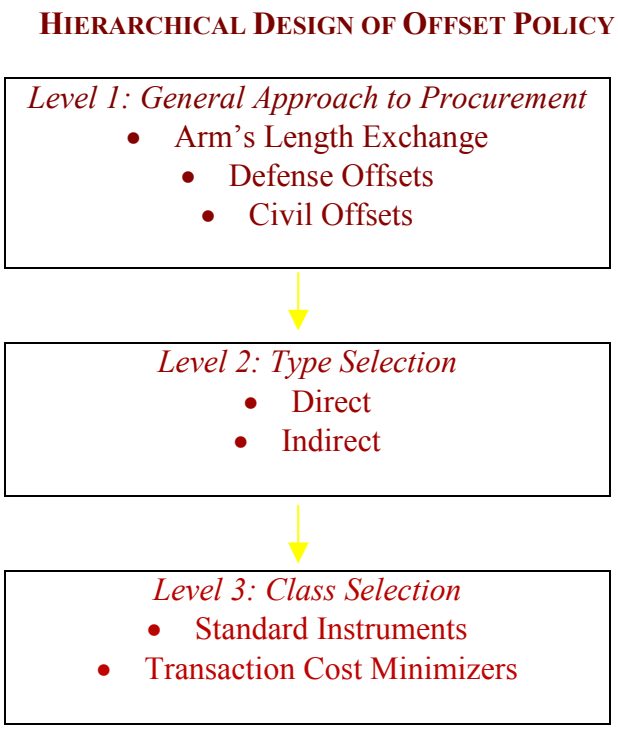
Source: Saudi Economic Survey (1998), p. 21.

Modeling government policy is subject to a time sequencing problem. Government bureaucrats often make policy decisions in a non-causal manner. If a given

policy requires several decisions to accommodate multiple stages, it may be impossible to isolate a causal relationship among variables. For example, suppose a tax policy requires three decision nodes—A, B, and C—for complete implementation. If bureaucrats make the three decisions simultaneously, it will be difficult to ascertain whether a causal relationship between A and B, B and C, or A and C exists. Correlation analysis can yield important information about the policymaking process, but econometric modeling is unlikely to bear fruit.

Offset policy design involves multiple stages, but the stages are sufficiently independent to support econometric estimation. Procurement officials are responsible for three integral decisions: (i) to require civil, defense, or no offsets, (ii) to select a direct or indirect type of offset, and (iii) to choose a specific offset instrument (class). The sequence of policymaking is largely hierarchical, with causal relationships among (i), (ii), and (iii) as shown by figure 1.

Figure 1. The design of offset policy by a purchasing government.



In the next section, I construct an empirical model to analyze the relationship between several explanatory variables and hierarchical policy decisions. The model estimates the impact of transaction cost variables on class selection (node (iii) in figure 1).

SECTION 2: A MODEL OF OFFSET CLASS SELECTION

In this model, the dependent variable is class. Procurement officials have a wide array of offset instruments at their disposal. Some of the more popular instruments include subcontracting, technology transfer, countertrade, co-production, licensed production foreign investment, training and education, management services, marketing,

and loan & import schemes.[5] We can divide these instruments into two general classes: standard instruments, and transaction cost minimizing (TCM) instruments. Table 2 clearly delineates these classes.

Table 2
OFFSET CLASSES

Standard Instruments	Transaction Cost Minimizing (TCM) Instruments
• Technology transfer • Foreign investment • Training and education • Countertrade • Marketing Services • Management Services	• Subcontracting • Licensed/Co-production • Buyback

The distinction between standard and TCM instruments concerns the exposure of assets to risk. Standard instruments represent potential benefits to the purchasing economy, but they do not expose the seller to significant asset risk. The classification of countertrade as a standard instrument is sufficiently counterintuitive to warrant further explanation.

Contrary to popular belief, countertrade does not ensure mutual exposure to risk. The purchasing government achieves reciprocity in the traditional sense that countertrade calls for the foreign seller to purchase goods from domestic firms. However, unless these goods serve as inputs in the seller's production process, it may not lower the transaction costs associated with opportunistic behavior by the seller. Indeed, the advent of the

[5] Please refer to the glossary in the appendix for definitions of these and other key terms.

modern international trading company has reduced the likelihood that countertrade can serve as an efficient tool to achieve reciprocal exposure to risk.

The other class of offset instruments does succeed in exposing the seller to some form of risk—be it reputation or production. These instruments require the seller to post a hostage (Williamson, 1983), thereby reducing—though not eliminating—the probability of seller opportunism. Subcontracting is an example of an offset hostage.

In this arrangement, the seller signs a contract (the offset) to accompany the sale of the base good. The contract typically calls for domestic firms to produce parts or entire stages of the base good. When domestic firms provide key inputs to the seller, they have effectively entered the seller's production function and shifted some risk back to the seller. The new exposure to risk is likely to reduce the probability of opportunistic behavior by the seller.

Subcontracts associated with the purchased good tend to improve the buyer's knowledge of the complete system. In addition, the seller is less likely to shirk on training and maintenance of the subcontracted production because it has incentive to achieve cost-minimizing interface between the different stages of production. Component deficiencies often lead to partial system failure, particularly in high technology production. When system failure occurs, the seller—rightly or wrongly—is usually held responsible (Hennart, 1989).

In some situations, the subcontract may call for domestic firms to produce x amount of specialized inputs for the seller. These inputs serve as a production hostage because they are often specific to the seller's production process. International trading companies have difficulty peddling these items on the world market. In short, some of

the inputs are nonsalvageable assets that have full value only in the seller's production function. Responding to such an arrangement, the seller has new incentive to fulfill its contracted duties more responsibly (better service after the sale, training and support for the subcontracted items, and so forth) for fear of future retaliation. For these reasons, the offset strengthens the integrity of the exchange. These contracts are self-enforcing, which reduces the buyer's *ex post* transaction costs of monitoring.

The other instruments in the TCM class possess similar reciprocal qualities. In licensed production and co-production, domestic firms in the purchasing government's economy receive the technical blueprints to produce part or all of the base good. The output is often sold to the seller (as a production input), or in export markets. In either case, the seller has incentive to train the domestic firms effectively. If a portion of the domestic firms' output is faulty, the prime contractor may damage its reputation in international markets.

In the case of a buyback agreement, the seller builds a fully-operational production facility in the buyer's country. Money may or may not exchange hands. The buyer may pay for the production facility with the output of the firm. In 1999, an Israeli firm built a sunflower processing plant in Vietnam, and received sunflower byproducts as payment (*Countertrade & Offset*, 1999). In another case, Volkswagon set up an automobile factory in East Germany and received payment in the form of 200,000 cars per year (Udis and Maskus, 1991). In each of these cases, both the buyer and the seller face risk. Buyback serves as a transaction cost minimizing contract if the output from the fully-operational plant serves as an input in the seller's general production process. If the output is not linked in some fashion to the seller's production process, this contract loses

its appeal as an economic hostage.

Instruments of the standard class promote different objectives. In some economic settings, exchange hazards may be less of a concern than rapidly building a domestic defense industry, upgrading the technology of key industries, or forming long term strategic alliances with multinational enterprises. Foreign investment need not be related to the seller's production process—or its reputation—which is why it is part of the standard offset class instruments.

Explanatory Variables

In the logit model, two variables influence class selection. I regress TYPE and TECH on CLASS to determine the instrumental choice by procurement officials. To make the estimation tractable, we shall hold constant any rent-seeking and national security rationale for particular offset arrangements. The inclusion of TYPE and TECH allows us to evaluate the degree to which policymakers consider transaction costs in offset selection.

If exchange hazards such as seller opportunism are a concern, the government's selection of a direct offset will, *ex ante*, influence the decision of offset instrument. Taylor (2001a) shows that officials can minimize exchange hazards only if the purchasing government uses the direct offset in conjunction with an instrument from the TCM class. Failure to employ a TCM instrument reduces the offset's efficacy as a hostage, *even when the offset is directly related to the sale of the base good*.

The selection of a direct offset is likely to induce a TCM instrument for another reason. Many countries view a healthy, free-standing defense and aerospace industry as a

critical part of economic development and national security. At present, a majority of these countries cannot compete with the oligopoly leaders in defense and aerospace on an end-product. Instead, governments are encouraging domestic producers to move down their learning curves (via offsets) in the production of components and peripheral systems.

Sellers and their governments are keenly aware of the potential loss of competitive advantage from technology sales and joint ventures. Noting this potential loss of market share in the future, a carrot policy in the form of profits for a foreign investment is not likely to transfer technology efficiently because sellers will guard core competences. A direct offset with the TCM instrument is the stick that governments can employ to assist strategic industries, particularly defense and aerospace.

Indirect offsets, on the other hand, are more wide-ranging and their benefits spread more evenly throughout the economy. Governments less concerned about exchange hazards of the base good, are then more likely to select indirect offsets. Either class of offsets—standard or TCM—are suitable for indirect offsets. For these reasons, the *a priori* sign of TYPE is positive: a direct offset is likely to influence the official's class decision towards a TCM instrument.[6]

TECH is another transaction cost variable. It proxies for the potential exchange hazards a government may encounter when it purchases high technology goods in imperfectly competitive markets. The value of TECH depends on the technological

[6] In a logit model, the sign of the coefficient of an independent variable depends on how one defines the baseline. In the model presented here, the baseline is zero, so that a positive sign on the coefficient of the independent variable means that increases in this variable raise the probability that policymakers will select a TCM instrument. If the sign on the independent variable is negative, increases in this variable lower the probability that a TCM instrument is chosen. Specifically, the effect of a unit change in TYPE or TECH is to increase the log odds by an amount β_i.

intensity embodied in the production of the base good. Using the OECD's (1998) *Revision of the High-Technology Sector and Product Classification*, I placed each transaction of the data set into one of two categories: high technology, or medium-low technology. I hypothesize the sign of TECH to be positive: high technology procurement will raise the probability that procurement officers select an offset from the TCM class. As the level of technology embodied in the base good rises, exchange hazards also increase, *ceteris paribus*. If government officials act to economize on transaction costs, they will attempt to improve the integrity of the exchange in this setting by selecting an offset from the TCM class.

That problems in the exchange of high technology, particularly across borders, may induce transactors to alter contractual design is not new. New institutional economists (Williamson, 1983, 1985 and Kirzner, 1973) argue that exchange is subject to opportunistic behavior when imperfect information combines with bounded rationality. An extension of this analysis is that as the level of technology embodied in a good increases, *ceteris paribus*, the higher the *ex post* exchange hazards and transaction costs.

Markets have trouble exchanging high technology goods because of asymmetric information and uncertainty. In international procurement, governments purchase high technology systems because domestic firms either lack the requisite capabilities or are less efficient. Inflated procurement expenditures arising from imperfect information of the seller's cost function is widespread and well documented in the defense economics literature.[7] Moreover, uncertainty about product quality, service after the sale, and

[7] Standard government contracts such as fixed-price, cost-plus, and rate-of-return compensation attempt to align the incentives of the seller more closely with the government. Fixed price contracts place the onus on the seller to minimize its cost of producing some output, *y*. The seller is responsible for all cost overruns, and is able to retain any surplus (profits) if the cost of producing *y* is less than the fixed price. While this

forecasted demand throw more sand into market exchange. A large proportion of high technology procurement requires considerable training and supervision after the sale to achieve optimal use.

Aerospace goods, particularly those used by the military, require a significant amount of training to transfer the tacit knowledge that is not available in the blueprints of product operation. It is likely the buyer will anticipate *ex post* hazards to be higher for high technology goods that embody tacit knowledge and depend heavily on service after the sale. Agents will endeavor to avert potential hold-up problems and other *ex post* hazards by building safeguards into the base contract.

The U.S. Department of Defense conducted a study (Harben, 1984, p. 29) to estimate the cost shares of different stages of production for Airforce aircraft and weaponry. A somewhat startling finding is that maintenance and repairs account for approximately 70 percent of total cost and is rising.[8] The cost share of product research, design, and development is 13 percent. Production costs now account for only 17 percent.

This distribution of cost shares raises *ex post* contractual hazards and increases the probability that the seller will engage in some form of opportunistic behavior to minimize its costs after the sale. A well-designed offset arrangement may be an efficient, private-ordered solution. The transaction cost proxies of the model allow us to test the following

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policy clearly encourages efficient production, it is not appropriate for new projects that involve substantial amounts of research and development (R&D). For projects involving product design and innovation, governments commonly employ the cost-plus or the rate-of-return compensation. Such policies encourage innovation and scientific research at the expense of cost minimization. International procurement punctuates the problems of asymmetric information, as institutional variables and distance can further complicate the exchange. Teece (1981) empirically tests these variables in the context of international technology transfer.

[8] Harben (1984) reports that in 1960 production accounted for 40 percent of total cost, followed by research and development (30%) and maintenance and repairs (30%).

hypothesis: anticipating *ex post* hazards in high technology exchange, governments will attempt to incorporate contractual safeguards *ex ante*. These safeguards will often take the form of an offset from the TCM class of instruments.

Data and Model Estimation

The methodology for the empirical study is logistic regression. A weakness of the existing literature is its inability to analyze offset as a hybrid form of organization. If we are to understand the offset selection process, it is crucial to analyze the individual contract choices made by procurement officials under different institutional settings. Such evaluation requires transaction-level data—aggregates, surveys, and input-output data cannot discern the incentives at work for the purchasing government.[9]

In this study, the offset transaction is the unit of analysis. I compiled a detailed database of offset transactions reported in *Countertrade & Offset* between 1997 and 1999. *Countertrade & Offset* is a practitioner's journal that reports on developments and transactions of nonstandard contracts. Regarded as the most accurate and reliable source for this information, the journal reports on offset transactions throughout the world.

For each observation, I recorded the following information: government buyer, seller, base good, base industry, offset recipient (if available), offset output, type of offset (direct or indirect), class of offset, location of the buyer's country, and the size of the buyer's defense industry. Offset class, type, base good technology, and location of the buyer were then coded as binaries to reflect the selection process in government. *Countertrade & Offset* reported 93 offset transactions over the three-year sample. Seven

observations were missing at least one important variable, which left 86 complete offset arrangements for estimation.

I introduce a logit model to explain the selection of offset class. Letting p = the probability of CLASS = 1, we can represent the model with equation (2).

$$\text{Logit}(p) = \log [\, p / (1-p) \,] = \beta_0 + \beta_1 \text{TYPE} + \beta_2 \text{TECH} \qquad (2)$$

CLASS is a binary variable. I code a transaction that involves an offset instrument from the TCM class as one, and instruments from the standard class as zero. TYPE is a binary variable that equals one if the transaction calls for a direct offset, and zero if the type is indirect. TECH is also a binary variable. It has a value of one for transactions that embody high technological intensity in the production of the base good, and zero otherwise.

The logit model is appropriate for two reasons. First, the categorical data generated from offset policy are largely binary, which makes the logistic probability model an ideal choice.[10] Second, the logistic function allows us to calculate the probabilities of different outcomes under various institutional environments. Table 3 presents the results of the model. The model explains the variability of class selection reasonably well.

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[9] Such methods do not discern the micro decision-making process of government purchasers. Aggregate data, for instance, can tell us much about general trends in offsets over time, average costs and so forth. It will not, however, show causation among dependent and independent variables.

[10] See Judge *et al* (1985) for a thorough treatment of the logit procedure.

Table 3. Quantification of Offset Class Selection.

OFFSET CLASS MODEL RESULTS

Dependent variable= CLASS. Probability Modeled: Pr(CLASS = 1)

VARIABLE	D.F.	ESTIMATE	STD. ERROR	CHI SQUARE	PR>CHI SQUARE
Intercept	1	-2.1900**	0.8163	7.20	0.0073
TYPE	1	2.4397**	0.6190	15.53	<0.0001
TECH	1	0.7008	0.6988	1.01	0.3159

** = *Significant at the 1% level*
Observations = 86
Degrees of freedom = 83

Goodness of Fit

Criterion	Value
Deviance	93.922[a]
Pearson Chi Square	82.530

The signs of the coefficients for TYPE and TECH are positive as expected. TYPE is highly significant. We reject the null hypothesis that TYPE equals zero at the one percent level.

Despite its solid theoretical justification, TECH is not significant. A variety of reasons may account for this result. Assigning the base good as high technology or otherwise may be masking the codification of information, which is really the central issue. The exchange hazard may not arise from a good embodying high technology in its production, but more precisely because the blueprints of this process do not transfer well.

[a] Tests for goodness of fit of binomial models include the Chi Square and Likelihood Ratio. Since the calculated Chi Square value is below the critical value, the model passes these tests. For an *ad hoc* assessment of goodness of fit, the deviance divided by the degrees of freedom should be close to one. In this case, 93.922/83 = 1.13, which is sufficiently close to one to call the model satisfactory.

This is an important distinction that the econometrics does not take into account well.

Another possible explanation is the 'Middle East effect.' Developing countries in the Middle East—particularly Saudi Arabia, Oman, and the United Arab Emirates—are known to employ indirect offsets as an economy-wide development program. There is only a low correlation between TECH and CLASS for these countries. These countries have a propensity for indirect offsets—largely independent of the level of technology purchased. These countries view the indirect offset as a way to diversify their export base outside of oil. A third reason concerns the nature of the data. While some transactions are clearly high tech (jet aircraft) or low tech (food), government reporting may be vague or misstate the true nature of the production technology embodied in the good.

These explanations notwithstanding, the insignificance of TECH calls into question whether efficiency is the driving force behind offset arrangements. The empirical finding supports the claim that offsets are often the outcome of interest group interaction, bureaucrat maximization, and rent-seeking behavior. In some cases, offset officials may ignore exchange hazards and select an instrument that fills a regional business gap or placates powerful interest groups.

In Saudi Arabia for instance, officials periodically make offset instrument (class) selections to appease regional royalty. Since 1994 Lucent Technologies has been working with venture technology firms in Saudi Arabia to fulfill an AT&T offset obligation. Lucent employees contend that some of the offset decisions made by Saudi's Economic Offset Committee (EOC) derived from rent-seeking behavior rather than

economic efficiency calculus.[11] It appears then, that long run development strategy, bureaucrat maximization, and rent-seeking activity may dwarf the transaction cost rationale under certain economic settings.

The model fits the data satisfactorily. Table 3 also reports the deviance and Chi square values for the model. The criteria assess the overall explanatory power of the model. Both calculations are below the critical levels, which indicates the binomial logit model provides a reasonably good fit of the data.

The model also permits us to estimate the probability that procurement officials will select a particular class under different scenarios. One calculates the probability that the offset instrument is from the TCM class by substituting the parameter estimates into equation (3).

$$\Pr(\text{CLASS} = 1) = \frac{e^{\beta_0 + \beta_1 X_1 + \beta_2 X_2}}{1 + e^{\beta_0 + \beta_1 X_1 + \beta_2 X_2}} \qquad (3)$$

Table 4 reports the probability estimations.

Table 4. Probability estimations of offset class selection.

TECH (High or Low/Medium)	*TYPE (Direct or Indirect)*	*Pr(CLASS = 1)*
LOW/MEDIUM	**INDIRECT**	**0.100**
LOW/MEDIUM	**DIRECT**	**0.562**
HIGH	**INDIRECT**	**0.184**
HIGH	**DIRECT**	**0.721**

[11] This section stems from interviews with a Lucent Technologies official, spring and summer 2000.

The probabilities support the theoretical claims of Taylor (2001a). Transaction cost theory highlights the need for private ordering and nonstandard contracting when parties face exchange hazards. We can think of select offsets as hostages that raise the integrity of the exchange, and enhance learning-by-doing over multiple periods. When the technology embodied in the base good is low and procurement officials select an indirect offset, the probability that the instrument is from the TCM class is low (10%). High technology transactions coupled with direct offsets alter the probability significantly. Under this scenario, the probability that the procurement official will select a TCM instrument rises to 72%.

Data from the U.S. Commerce Department corroborate this finding. *Offsets in Defense Trade* (1998) reports data of U.S. defense industry offset obligations. The report partitions sales into aerospace and non-aerospace goods. High technological intensity in production is the defining characteristic of the aerospace industry. It is therefore not surprising that sellers fulfilled approximately 71% of direct offset obligations with TCM instruments.[12] Non-aerospace exports, on the other hand, account for a larger share of medium and low technology sales. As expected, TCM instruments represent only 22% of these obligations.[13]

The logit model presented here helps us to identify the variables that have important effects on class selection. Economizing on transaction costs appears to influence offset policy somewhat.

[12] U.S. Commerce Department (1998), p. 33, and the author's calculations.
[13] U.S. Commerce Department (1998), p. 33, and the author's calculations.

SECTION 3: CONCLUDING REMARKS

A lack of quality data has discouraged quantitative research and severely limited the scope of investigation. Formalization of offset theory, however, is critical to understanding the complex interplay of political and economic variables. To demonstrate theoretically that transaction cost economizing (Liesch, 1991, and Taylor, 2001a) and bundling (Hall and Markowski, 1994) provide a rationale for offsets in procurement is meaningful; to test such claims empirically is useful to governments. Moreover, modeling offset policy forces us to ascertain causation among the variables, and to come to terms with rent-seeking behavior of government bureaucracies.

This paper set out to test the transaction cost hypothesis of offset theory. The hypothesis, which has strong theoretical backing in the organization literature, states that transaction cost considerations may influence procurement officials' offset selection process. In particular, as exchange hazards increase, *ceteris paribus*, officials are more likely to select a subset of offset class. The results—which are preliminary and will require extensive testing in the future—demonstrate some degree of transaction cost economizing and thus support for the hypothesis, broadly speaking. The estimated probabilities of the model approximate the actual data from the Commerce Department reasonably well. This is encouraging, especially given the interdisciplinary nature of offsets.

However, the modeling also suggests that while economic variables (transaction costs, price, quality) are part of the offset selection process, political economy variables (security alliances, bureaucrat maximization, and rent-seeking) tend to exert much influence on policy. Offset is a hybrid arrangement devised to achieve economic and

political objectives. To place it in one discipline or the other masks the complex interaction of the political economy variables.

Clearly, there will be occasions when the economic rationale for dominates the political rationale, and vice versa. Indeed, sometimes it may be more useful to think of the offset as the offspring of compromises among interested parties and non-optimizing behavior instead of utility maximization.[14] Future investigation of this line of thought would certainly contribute to the existing literature. Finally, extensions of the empirical modeling in this paper are likely to have a large impact on the field since there is still a scarcity of empirical studies on the topic.

[14] I am thankful for discussions with Sidney Winter and Shane Greenstein, and conference participants at the Northwestern University on this point.

APPENDIX. Glossary of key terms as defined by the author and the U.S. government.[15]

Buyback: An agreement by the seller to accept as full or partial repayment products derived from the original exported good (the base good).

Counterpurchase: An agreement by the initial exporter to buy (or to find a buyer for) a specific value of goods (often stated as a percentage of the value of the original export) from the original buyer during the specified period.

Countertrade: Instead of the standard unilateral trade (goods for money), countertrade requires a bilateral exchange of goods. This includes barter (goods for goods), but is much more broad in scope and includes counterpurchase and buyback contracts.

Co-production: Overseas production based upon government-to-government agreement that permits a foreign government(s) or producer(s) to acquire the technical information to manufacture all or part of a U.S. origin defense article. It includes government-to-government licensed production. It excludes licensed production based upon direct commercial arrangements by U.S. manufacturers.

Foreign Investment: Investment arising from the offset arrangement, taking the form of capital invested to establish or expand a subsidiary or joint venture in the foreign country.

Licensed Production: Overseas production of a U.S. origin defense article based upon transfer of technical information under direct commercial arrangements between a U.S. manufacturer and a foreign government or producer.

Loan & Import: A contract that requires the buyer to demonstrate his commitment to a specific investment through financing arrangements. The buyer loans the seller the money required to undertake the investment, and receives payment in the form of output. This arrangement is common in the exchange of raw materials and fossil fuels that require specific asset investments and would otherwise be subject to hold-up problems.

Management Services: The offset may call for employees with the seller's company to work for a specified time in the buyer's country to provide management services for upstart firms.

Marketing Services: The offset may call for employees of the seller's company to provide marketing services and/or training for firms in the buyer's country.

Offsets: Industrial compensation practices required as a condition of purchase in firm-to-government commercial sales of defense or civil articles. Typically, the offset will include some form of in-kind transfer.

Subcontracting: Overseas production of a part or component of a U.S. origin defense article. The subcontract does not necessarily involve license of technical information and

[15] U.S. Commerce Department (1999), pp.4-5.

is usually a direct commercial arrangement between the U.S. manufacturer and a foreign producer.

Technology Transfer: Transfer of technology that occurs as a result of an offset arrangement. It may take the form of R&D conducted abroad, technical assistance provided to the subsidiary or joint venture of foreign investment, or other commercial arrangements between firms.

Training and Education: Offset arrangements often call for employees of the seller to conduct individual instruction and seminars to labor in the buyer's economy. This is the mode by which routines develop and much learning-by-doing takes place.

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