



Wage Bargaining and Behaviour of Talented Labour in the Defence Market

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Abstract

One of the enduring issues of business cycle theory has been the search for a theoretical framework that would aid apprehending the behaviour of wage rates in times of undulations in employment with respect to output. There has been a focus on how real wage movements can be affected by a business cycle and studies showed that there is no systematic pattern. The demand for labour would naturally, *ceteris paribus* result in a rise in employment but not necessarily in the wage rates. This, assuming, that the level of prices is unchanged, and the impulse in terms of output is merely an increase in the average propensity to consume and not the marginal. Per contra, an increment in the marginal consumption of a product, *ceteris paribus*, would lead to an increase in the marginal product of labour stimulating, thus, a rise in wage rates.

Introduction

It is the purpose of this paper to give a theoretical discussion of the behaviour of labour in terms of wages in the defence market, knowing the uniqueness of the latter and its nowadays business appearance so to obtain a concrete “solution”—evidently, making certain assumptions in order to do so. Here, a “solution”, in the sense, that we would seek to explicitly decrypt the behaviour of labour in the defence market subject of this study, and answer the research question of how would a shift in the wage rate lead to the divergence of labour from the defence to the civil sector and vice versa.

In general we idealize the wage bargaining and behaviour of labour in the defence market, by assuming that labour takes the form of engineers and scientists with exceptional talents, forming together an association (part of a Union) to defend their rights and increase their chances for better prospects. The players in the market take the shape of a monopoly/oligopoly in the supply side, and monopsony in the demand side. The demand side is unique in this case, as it is merely represented by the government who has the upper hand on every single order of weaponry. That is, they can change, adjourn or even cancel a contract, which may engender an increase in the marginal cost, thus, the prices per unit of output. On the other hand, the defence giants speculating the majority if not all the primary contracts represent the supply side.

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To embrace network centric warfare (NCW)¹, there is an absolute need for innovative technology, thus, for abundant capital and labour with exceptional expertise and skills. Further, the future of defence lies in advanced technologies, programs and systems² - as a way to avoid casualties - and ideally the only reason that would lead the demand side to acquire ordnance is to gain superiority³.

In this context, the research question would be tackled through an explicit bargaining over wages and employment by the trade association, and a company or group of companies, whilst emphasizing upon the behaviour of talented labour in the market of defence. We believe that labour association could be a source of wage stickiness. That is, in such instance where after agreeing upon the nominal wage rate, labour association stipulates that with the understanding of unchanged salaries, talented labour would be entitled to yearly public grants.

The impulse of this study was macroeconomic, but our interest lies in the micro aspect where the relationship between labour with exceptional talents⁴ (for instance, in the U.S., the Federal government employed in 2010 an estimated 845,198 aerospace and defence skilled workers at National Aeronautics and Space Administration (NASA), Federal Aviation Administration (FAA). Other defence agencies including Defence Advanced Research Projects Agency (DARPA) and civilians working at the Department of Defence) and a single or several employers (for simplicity we focus on a single employer) in a single labour pool dwelling in the defence market. Furthermore, the methods utilized, and consequently the conclusions, are entirely partial equilibrium. Labour is perfectly mobile by virtue of their level of skills and expertise, and fluctuations in the effective demand for ordnance are at *prima facie* due to a rise in the defence budget.

We begin by introducing a model in which the association of exceptional talents (AET) is a simple monopolist, setting the wage rate unilaterally to maximize the total or expected utility of its members, and permitting the employer some discretion over employment and working conditions, taking into account the sensitivity of the activity. We then analyze a different, yet complex institutional format in which the AET and the defence company are meant to bargain over both wage and employment and reach a rational outcome that would satisfy both parties⁵. Obviously, there is a bulk of efficient ways to bargain, and a complete theory or one that brings about the “solution” must select one of them, but worldly wisdom teaches that it is improbable to embrace a perfect conventional agreement on the exact method to do so. The approach used in this paper comes simply to solve the bargaining problem precisely in the defence market with an amalgam

1 Sami Chraa (2012) Network Centric Warfare and Defence Industrial Implications. J Def Stud Resour Manage 1:2.

2 B Buley (2008) The New American Way of War, chap 1; and Hoffman, Decisive Force, 5.

3 HP Segal (2005) Technological Utopianism in American Culture; B Buley (2008), The New American Way of War, 47; D Adamsky (2010) The Culture of Military Innovation, 61, 82, 85–87, 91.

4 Deloitte (2012) The Aerospace and Defense Industry in the U.S. — A financial and economic impact study.

5 AM Cartter (1959) Theory of Wages and Employment, Homewood: Irwin.

of simple conventions and creative theorems. Interestingly, we will provide a framework and a set of methodologies, which commonly embrace family similarities to one another. Furthermore, the effect of an upward or downward trend in the demand for labour with exceptional talents (in the defence market) on the negotiated outcome can be sawed into two routes, which reinforce each other with respect to wages and counteract each other with respect to employment. That is, assuming the limited amount of talented labour in the market, it will not be astonishing to discover large undulations in real wages in times of increasing output in the business cycle in defence.

The key assumption is that reservation wage is more susceptible to the decision of the demand side than the product/market conditions are. This would be the case, if, for instance, (I) the government who is representing the “desired output” make special orders necessitating talented, yet exceptional knowledge of labour to meet its requirements, and therefore has the upper hand (II) the employment in non military sector provides talented workers with the same if not greater level of pecuniary satisfaction, and/or (III) horizontal mobility: talented labour is free to move from the defence to the civil sector with the possibility to cross the borders. For reason (I), we might expect de facto the reservation wage in the defence industry to vary systematically during business cycles.

We also assume that talented labour expects superiority in the reward, stability of the contract, but most importantly extensive facilities as part of the non-pecuniary satisfaction. On the other hand, labour demand is function of the labour expertise in segment or set of segments, readiness, and inventiveness. Besides, there will be a consideration of the nature of the negotiated contract linking both labour to defence firms which as our model suggests, would lead to a series of wide variations in wages and small fairly fluctuations in employment, depending on whether or not talented workers are risk averse. That is, the contract is supposed to give labour maximum stability during its life-unless struck by a change in the economic or political environment causing a fissure in the AET’s homogenous membership to be unemployed-, so that every member of the AET will endeavour to maximize their utility of the contract subject to unfortunate events, thus, increasing the wage rate to the extent that would protect them from being laid off at random.

A Simple Monopoly Union in the Defence Market

In a simple non-competitive environment, the monopoly association can set the wage unilaterally. The one or bulk of employers then agrees on the level of employment or bill of employment N. Generally it is seldom to find a union that would control wages. The AET however, might exert a level of control by means of the high necessity and productivity rate of their members. The employment in the defence industry has been to date analyzed in most cases from macroeconomic perspectives⁶, and we have merely a few novelties to add.

The defence company is characterized by a revenue function $Z(O_D)$ consistent with the level of output (function of the effective demand), and inducing a level of employment LD leaving proceeds merely a function of employment such that, $Z(O_D) = \hat{\epsilon}(L_D)$. The demand for labour will breed a wage rate W_D , if $DL_D = f(W_D)$. That is, a change in defence spending will foster a change in the demand

for labour DL_D at W_D . The change in the demand for labour is not necessarily accompanied with a change in the wage rate. On the other hand, the price (P) is function of the level of output O_D , and the marginal cost $\dot{\eta}$, so that $P = f(O_D, \dot{\eta})$. The inclusion of the marginal cost comes to rationalize the price-setting, assuming the upper hand of the government which as cited before can delay or even cancel defence projects/programs, with $\dot{\eta} = (W_D/dO_D)/dL_D$. Yet, the defence production function takes the form $O_D = f(I_1, I_2, I_3, \dots)$, with $\Sigma(I)_{i=1}$ sum of production inputs.

We assume that, $Z(O_D)$ is concave, with marginal revenue becoming eventually small or negative. Profit is $\Pi = Z(O_D) - pW_D$ (1) with, $P = f(O_D, \dot{\eta})$ (2). Using Euler’s homogeneous function of the first degree in O_D and $\dot{\eta}$ so that,

$$P = O_D \cdot (dP/dO_D) + \dot{\eta} \cdot (dP/d\dot{\eta}) \quad (3)$$

Substituting (3) into (1)

$$\Pi = Z(O_D) - [O_D \cdot (dP/dO_D) + \dot{\eta} \cdot (dP/d\dot{\eta})] W_D$$

$$[\Pi - Z(O_D)] + W_D O_D \cdot (dP/dO_D) = \dot{\eta} \cdot (dP/d\dot{\eta}) W_D$$

$$\dot{\eta} \cdot [O_D/P \cdot (dP/dO_D)] = M_R - M_{\Pi}$$

Hence, marginal profit is $M_{\Pi} = M_R - [e_{po}] \cdot \dot{\eta}$, where e_{po} is the price elasticity of required output (function of the effective demand), and M_R the marginal revenue. Here, e_{po} varies from 0 to 1 and may be negative. The elasticity of the price in response to a change in the level of supply required, in the sense that if $e_{po} = 1$, a rise in the level of effective supply (function of the effective demand) of military output based technology will result, ceteris paribus, in a change in the marginal cost thus a change in prices. Per contra, if $e_{po} = 0$, the marginal profit will be merely function of the sales proceeds or marginal revenue. That is, if the defence firm were to maximize its revenue function with respect to employment of talented labour (subject to an abundant capital), marginal cost would gradually decrease other things being equal, leaving the marginal profit merely a function of the marginal revenue product of talented labour. The elasticity e_{po} could be negative however, say, in the absence of talented labour or capital resulting in the decrement of any marginal costs related to military ordnance –assuming the defence firm decides not to invest in the required military output-. It follows from this, that in times of increased level of output due to the increment in the level of demand, the profit of the defence firm will be equal to the change in the price of talented labour in terms of their wages. That is, the profit will merely be function, ceteris paribus, of the price of the members of the AET.

Now if the firm is a profit maximizer, the points (w, L) represented in the iso-profit curve will be indifferent. That is, the $(Z(L_D) - pW_D)$ will stay constant. Note that $Z(O_D) = \hat{\epsilon}(L_D)$, so that $Z(L_D) = \hat{\epsilon} O_D$. The future of defence however, is to rely upon the development of advanced technologies⁷, so ideally if the defence firm wants to maximize its profit, it needs to heavily invest in innovative technologies, thus, subject to the abundance of capital in highly qualified labour (i.e. engineers and scientists).

MAX $\Pi = (Z(L_D) - pW_D)$, using first-order condition, the slope of the iso-profit curve via (w, L) plane is $dW/dL = Z'(L_D)$, that is, the

6 Keith Hartley (2008) The Industrial And Economic Benefits of Eurofighter Typhoon, Centre for Defence Economics, York University.

7 H Segal (2005) Technological Utopianism in American Culture; Sami Chraa (2012) Network Centric Warfare and Defence Industrial Implications. J Def Stud Resour Manage 1:2.

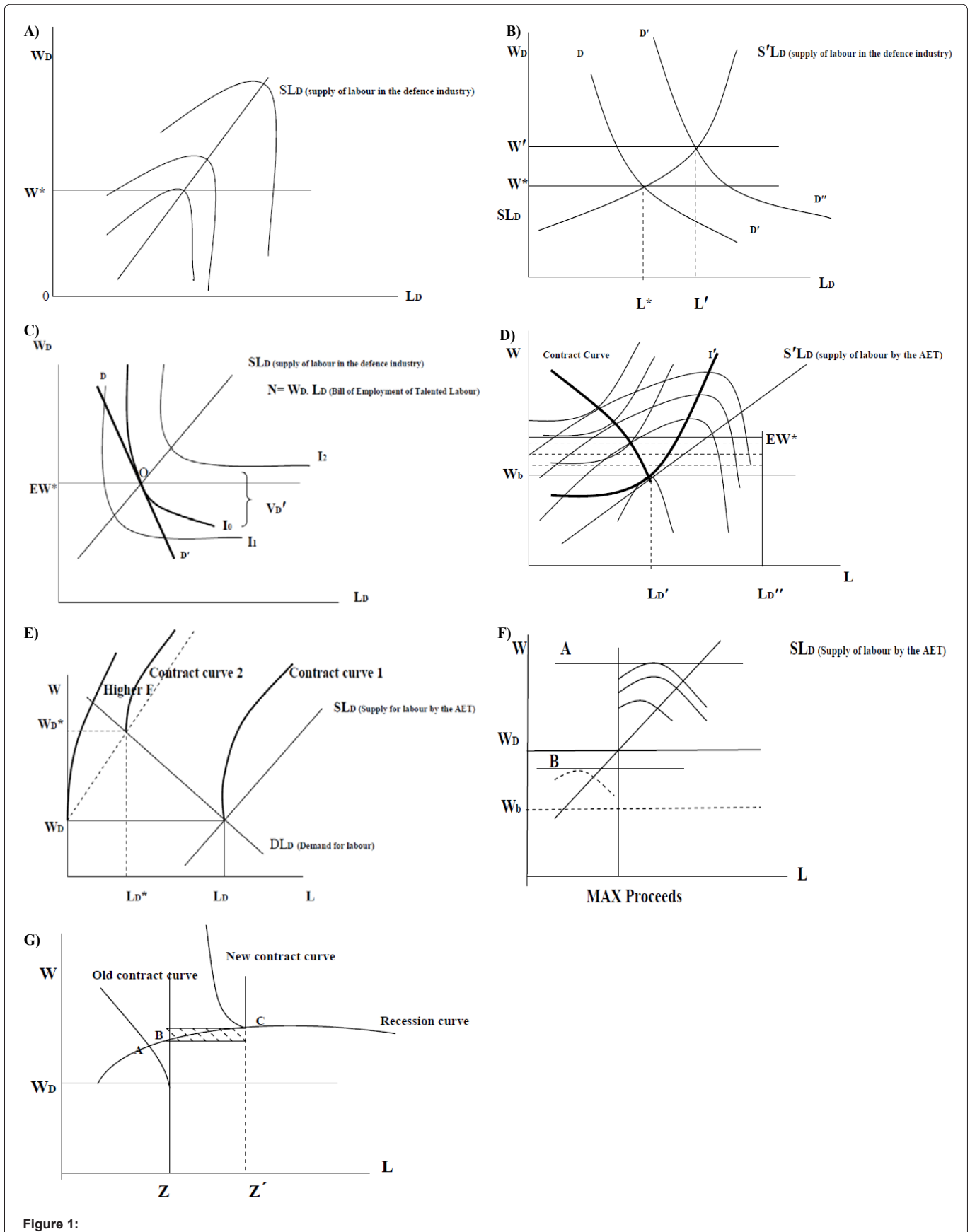


Figure 1:

marginal revenue product⁸ breeding marginal profit M_{II} . These iso-profit curves touching the (w, L) plane can be used as indifference curves for the defence company. For any L_D in the tangent line, a smaller W^* will result in a rise in the profit of the defence firm, and in turn to a positive slope of the iso-profit curve (i.e. higher profit) until it reaches the point Z' (L_D), then negative leading the firm to lose competitiveness defined by technology, which will encourage the want side represented conventionally by the government to finding another supplier.

Assuming that the defence company decides to cut expenses in terms of wages, let us say by means of a slack in the demand side, then the function $(Z(L_D) - pW_D)$ will be negative, and so will the slope. Therefore, for any quantity of labour L_D , the switch occurs at a lower W , so the defence company's indifference map is as displayed in Figure 1A. That is, for any L_D the defence firm is to increase its profit down the tangent line by decreasing wages. Notwithstanding, a decrease in terms of wages will limit the capability of the highly talented and skilled labour or even drive them away from the defence industry to land in some other industries where there is superiority in rewards. Further, with regard to the reasoning just worded, a study conducted by Deloitte⁹ showed that the current economic challenges leading to a slump in the defence budget in America, may affect both direct and indirect employment (in the long term), and the ability to conduct research and development (this would directly impact talented labour).

Now, let us assume that the engineers, scientists and highly skilled labour form an association that is meant to act for their best interest. Let the association of exceptional talents (AET) quote a wage W^* . The defence company then seeks the lowest indifference curve that touches the horizontal line at height W^* . That is, $Z'(L_D) - W^* = 0$, the marginal revenue product of talented labour equals the wage (this has been proven above). The proceeds function of labour L^* producing a level of output O^* will be equal to the change in wages.

Figure 1B represents an increasing return by the defence firm. For the defence company decides to recruit labour L^* at wage W^* , the price will be set at points $(S'L_D, SL_D)$ which is the supply curve, and (D, D') representing the demand curve. The price is the conciliation of the demand or "desired output" and supply. If the defence firm decides to recruit labour L' at wage W' , then the demand curve will shift from (D, D') up to (D', D'') resulting in an increase in the supply, thus the increase in profit subject to a containment of the marginal cost. The labour L' is defined in this context as exceptional talents (i.e. engineers, scientists and other highly skilled individuals) creating advanced products and breeding high technologies, which may be seen by governments or nations desiring to gain superiority and modernize their arsenals, as an impetus to rise their level of purchasing and order more advanced weaponry from the defence firm lodging talented labour L' .

The utility of an arsenal will diminish if the want side consumes the produce at a uniform rate. That is, every increase in the stock of weaponry of any nation will result in a decreasing return as long as the nation involved is supplied from the same stock. Ordnance is in constant demand by virtue of its necessity for every nation. One may question this statement, by emphasizing upon the decrease in military

spending in times of peace. Indeed, one's statement is decent and realistic, though decreasing demand for ordnance on the one hand and weaponry in constant demand on the other are not antithetical. Even in peacetime nations still have an appetite either for modern, yet advanced ordnance that comes to replace the obsolete ones or as a supplement to the existing. Therefore, the analysis provided above (Figure 1B) holds plausibility under a perception such that, the purchase of Weaponry is induced by its utility, and the utility of it is derived from technology, so that merely defence firms lodging labour with exceptional talents (assuming the abundance of capital) capable of revolutionizing contemporary ordnance would invade the market of defence.

Now if the exceptional talents refuse to work in the defence industry, they will embrace a utility $V(wC)$, where wC is the opportunity to work in the civil sector, which would give them great or equal satisfaction as that in the defence industry, depending upon the discrepancies in terms of wages, non pecuniary satisfaction and the facilities provided. The association can fulfil any point along the firm's demand curve. The AET vehemently assimilates the value of its labour, thus, intends to maximize their utility. Suppose the association has N employees all having the same expertise and skills. If L_D of them is employed, then each unit of them (L_D/N) has the probability $[\gamma(W_D), \gamma > 0]$ of having a position in the defence company at wage W_D , and probability $[(1-\gamma)(wC), (1-\gamma) < 0]$ of not being employed by the defence company and join the civil sector at wage wC .

Let's study the utility function of a pool of talented labour (homogenous group) in the defence industry:

It has already been noted that $DL_D = f(W_D)$, so that $V(W_D) = f(S)$, where S is the set of expertise and skills inducing the wage rate W_D , and V is the utility. Ideally, it is also perceived and acknowledged that non pecuniary aspects or "good job content"¹⁰ (interest, prestige and independence) play a vital role in increasing the overall utility which in normal salutary circumstances would lead labour to fine tune their performance, thus, an increase in the productivity per unit of labour. Hence, the variable (λ) will be added, which is the satisfaction factor in the shape of non-pecuniary pleasure. Therefore, $V(Ps.S + P\lambda.\lambda)$ ¹¹ is the level of utility achieved from working in the defence industry. That is, the utility of the wage for labour will be based upon their skills and expertise and the non-pecuniary aspect so that for an exceptional set of skills, the utility of the wage and the non pecuniary pleasure would be expressed by a convex curve, corresponding to a non satiation. In other words, labour will be willing to infinitely increase its return from the job in terms of money wages and the satisfaction factor.

Mathematically, the expected utility function of labour $E(L_D)$ will take the form of

$$[\gamma V(Ps.S + P\lambda.\lambda) + (1-\gamma)V(wC)]. \text{ Therefore,}$$

$$E(L_D) = [\gamma V(Ps.S + P\lambda.\lambda) + (1-\gamma)V(wC)]$$

$$= \gamma V(Ps.S) + \gamma V(P\lambda.\lambda) + V(wC) - \gamma V(wC)$$

10 Clark AE (1998) Measures of Job Satisfaction: What Makes a Good Job? Evidence from OECD Countries, OECD Labour Market and Social Policy Occasional Papers, No. 34, OECD Publishing.

11 Assuming $V(WD) = \alpha(S, \lambda)$ (i.e. utility of the wage function of both the set of expertise and non pecuniary pleasure), and based on Euler's theorem, if WD is a homogenous function of the first degree in S and λ , whilst substituting Ps and $P\lambda$ (price of S and λ) for dWD/dS and $dWD/d\lambda$ respectively, then $V(Ps.S + P\lambda.\lambda)$.

8 AM Cartter (1959) Theory of Wages and Employment, Homewood, Irwin.

9 Deloitte (2012) The Aerospace and Defense Industry in the U.S. — A financial and economic impact study.

By manipulating the equation, this becomes $E(L_D) = V[(P_s.S) + (P\lambda.\lambda)]$.

The utility of the wage for talented labour is function of the set of skills and expertise that the latter lodges. That is, talented labour expects a wage that is relatively proportional to their set of skills, expertise, and experience. A major element in the satisfaction of this high calibre labour however, is the non-pecuniary aspects of the job. The satisfaction variable comes to highlight upon the non-pecuniary pleasure emanating from the work in such industry. The satisfaction variable (λ) is sui generis in the defence firms, as labour enjoys privileges such as full security clearance, public grants, and direct contact with senior staff in government, and extensive facilities, which are restricted to the public¹². Further, it is purely through the special interest on the industry in question (which might be temporary) that talented labour displays their utility.

Labour's expectation as to the industry in general (at least from the mathematical point view), seems to be high as to the defence sector, which can partially (under the assumption of labour's special interest and prestige in the defence sector) be explained by the non-pecuniary satisfaction variable. This is a best-case scenario, where defence companies in times of increased level of defence spending procure the AET members (I) with decent wages with respect to their skills/expertise, and experience, and (II) high level of non-pecuniary satisfaction¹³, that makes them eager to excel their chore. Further, it is argued that greater non-pecuniary work incentive stimulates an increase in individual labour supply¹⁴.

Defence focused companies do business almost exclusively with governments, which have the legitimacy to increase or decrease the defence budget after approval of the legislative authority (for instance, senate or houses of parliament). In normal circumstances nations would rather decline any proposal aiming at augmenting military expenditure unless necessary (in the instance of real threats). It is assumed as part of the idealization, that, in times of increased spending the wage rate in the defence sector would be higher (for instance, Hartley finds that on "Typhoon development work, typical salaries were some 60% higher than the average earnings in all EU industries")¹⁵ than that in the civil one such that,

$$(V(P_s.S + P\lambda.\lambda) > (V(wC)).$$

Let $V_c = (V(wC))$ and $V_D = (V(P_s.S + P\lambda.\lambda))$, where V_c and V_D are the utilities of talented labour from working in the civil and the defence sector respectively. Now let's assume that the AET desires to maximize the utility gap of their members—between utility gained in defence and that gained from civil work- largely determined by $MAX(V_D - V_c)$, then differentiating with respect to W_D , ceteris paribus, that is $(V_D' - V_c)$ which is the aggregate function permitting the talented labour to gain a level of income that is above the current wage in defence (W_D). This level of income is assumed as the wage by which the workers will start their journey in the defence industry. The

12 For instance, a survey conducted by the U.S. office of personnel management showed that NASA workers have the highest job satisfaction (see Federal Employee View Point Survey Results 2012:- <http://www.fedview.opm.gov/2012/Reports/Ranking.asp?HCAFF=JS>).

13 Y. Farzin and Ken-Ichi Akao (2006), Non Pecuniary Work Incentive and Labour Supply, The Fondazione Eni Enrico Mattei Note Di Lavarò Series Index: <http://www.feem.it/Feem/Pub/Publications/WPapers/default.htm>.

14 Ibid.

15 Keith Hartley (2008) The Industrial And Economic Benefits of Eurofighter Typhoon, Centre for Defence Economics, York University.

association's indifference curve is derived from $(V_D - V_c)$ which is a constant. The indifference curves have an upward convex shape in the (w, L) plane. This is with respect to the property $W_D = EW^*$, where EW^* is the expected starting wage in the defence industry which is higher than that in the civil sector (assuming the increase in defence spending) $EW^* > V_c$ (see Figure 1C).

In Figure 1C, the optimum wage to set by the AET is that determined by the line SL_D representing labour supply, which intersects the indifference curve I_0 at point O. In times of increased defence spending, the reward in the defence sector as shown by the indifference curve I_2 is superior to that in the civil industry by V_D' (the marginal increase in utility). Hence, we deduce that the prosperity of the defence industry is function of the availability of over sufficient capital and its ability to attract talented labour through competitiveness not only in terms of wage rates but also size and quality of the facilities provided and the non-pecuniary satisfaction variable.

Inversely, let's study the options of the defence firm in times of decreased funding. How can the defence company possibly convey talented labour towards it in the absence of abundant capital?—assuming say $V_D < V_c$. Mathematically the effect upon talented labour of a marginal increase in V_c , holding W_D constant will lead to a shift of the talented workers from the defence sector to the civil industry. Further, it is empirically argued that through 2022 (for instance, in the U.S.), defence budget cuts would have severe repercussion on employment in the per se industry, as reductions would rise to 243000 (direct employment)¹⁶.

An attempt to increase profit however, through a decrease in input L_D or wage W_D would lead to a diminishing return. That is, the marginal profit M_{II} of the defence firm is to take a form such, $M_{II} = Z'(L_D) - pW_D$ subject to maximized utility gap $(V_D' - V_c)$ with $pW_D = \text{constant}$. Using Lagrange multiplier (L) so that $M_{II} = Z'(L_D) - L(V_D' - V_c) = M_{II} f(wD, L_D)$. Differentiating with respect to WD and LD , so that (I) $\partial M_{II} / \partial wD = L V_D'' = \alpha$, and (II) $\partial M_{II} / \partial L_D = Z''(L_D) = \beta$. Therefore, theoretically the defence firm curves in (w, L) plane, have a concave slope (diminishing return in both marginal revenue product and utility) such that, $\partial L_D / \partial w_D \cdot wD / L_D = \beta / \alpha = Z''(L_D) / L V_D''$.

After a comparison between wages behaviour in both defence and civil sector, and the impact upon labour movement, we can express $(\partial Z'(L_D) / \partial L_D)$ as the reciprocal of the elasticity of the output to talented labour, which measures the rate at which an output based technology increases/decreases, when more talented labour is recruited/ laid off. Here, the profit is merely function of the output, ceteris paribus, to other variables. Further, $(\partial V_D' / \partial wD \& \partial \lambda)$ as the reciprocal of the elasticity of the utility from employment in the defence industry, which measures the rate at which labour reaches a maximum/minimum satisfaction in terms of wage units and non pecuniary satisfaction (interest, and prestige). The condition is that, the elasticity of the utility (in terms of wages and non pecuniary satisfaction) should be greater or equal than the elasticity of the output in order for the firm to lodge highly skilled and talented labour, thus, gaining competitiveness in the market of defence (for

16 National Association of Manufacturers (2012) Defence Spending Cuts: The Impact on Economic Activity and Jobs, Inforum. In their report, they use the Inforum Long-Term Interindustry Forecasting Tool (LIFT) model of the U.S. economy to determine the economic and employment impacts of specific alternative scenarios for federal defence spending from 2012 to 2022.

further discussion of what makes a good job, see Clark¹⁷).

At prima facie, a change in the conditions of the demand for labour in both the defence and civil sector will affect the decision of the AET through two paths, (I) The wage EW^* , and (II) the elasticity of the utility from the job. That is, under the same assumption, a change in the demand side in terms of ordnance orders will lead to a change in the level of output, resulting in a change in the demand for labour, thus, a change in the wage rate (which ideally should be great or equal to the expected starting wage EW^*) and the utility level. Any change in (S) however, would have an impact upon both wD and L_p .

If the wages' behaviour depend upon the degree to which any change in (S) would affect the elasticity of the output to employment in the market of defence (at wage that is great or equal to EW^*), then with the output perfectly elastic at each wage, merely (S) will determine the amount of employment. That is, wages may be flexible on the condition that labour in the defence market (L_p) satisfies a level of expertise/skills (S). Here, wages are assumed to move subject to (S) procyclically, thus augmenting the related fluctuations in employment. Yet, the single utility of talented labour will ultimately be function of the non pecuniary satisfaction, which constitutes a crucial factor for the individual AET workers to flourish in their work and prosper beyond any psychological limitation.

The desired wage in the defence industry could be affected however, by the aggregate activity through the wage W_b that may depend upon endogenous and exogenous variables. The endogenous variables, such as the defence budget, the requirement of the demand side in terms of technology, the ability to import labour are inevitably of importance. The exogenous variables such as regional instability would have less impact. Yet, the other major factor that would affect the desired wage by talented labour is the opportunity for the latter to work in other industries (either nationally or abroad) with an expected value that is higher than that in the defence industry. Further, if the defence firms were able to import labour with the same talent and expertise who is ready to perform a chore at a wage that is less or equal than EW^* , that is W_b . The changes in the wage rate in the civil sector either nationally or over seas will have no affect whatever upon the level of employment in the defence firms, and consequently, the level of output.

We conclude this section with a canonical example. With P as the reciprocal of the elasticity of the output to the effective demand in the defence market (may be negative), and S defined as the set of skills and expertise. Take $V(W_p) = ((S^a)/P) \cdot W_b$, where (a) is an endogenous variable defined as a technology parameter lying between $0 \leq a \leq 1$. Then, $V(W_p/W_b) = (P^{-1}) \cdot (S^a)$. Here, the utility is expressed as the wage ratio (W_p/W_b), which depends negatively on the elasticity of output (P^{-1}) (despite the willingness of the defence firm to maximize the talented labour's utility from the wage). By means of the budget constraint (spending cuts in defence), and positively upon the technology parameter (S^a) which matches the skills and talents of labour with the actual technology required in the market.

If $|P| = 1$ and W_b is a constant, then $WD = (S^a)$. Here, the monopoly wage would depend entirely upon the level of skills and expertise of labour with respect to the technology parameter. That is, if (S^a) is negative then there is a gap between the actual technologies

required in the market of defence and the set of skills and expertise offered by labour. The utility of labour in terms of wages would then diminish and the monopoly wage will be below the desired wage. Intuitively, this is how it should be. For instance, if $|P| = 1/2$ and $(S^a) = 3/2$ (where $S=3$ and $a=1/2$) then the monopoly wage is $W_{D1} = 0.87 W_b$.

On the other hand, if we keep the values for P and S unchanged and shift the value of the parameter (a) to $a=1/4$ using the same method applied to (W_{D1}) then $W_{D2} = 0.66 W_b$. Again, if the parameter (a) is such, that $a=1/8$ then $W_{D3} = 0.57 W_b$. Notice that we merely changed the value of the parameter (a) which lies between 0 and 1, $[0,1]$. When the parameter (a) comes close to 0, the gap between W_p (monopoly wage in the defence industry) and W_b (the wage depending upon endogenous variables) then reduces. That is, if the talent/skills of labour matches with the requirement of the monopoly defence firm in terms of technology required in the market, then W_b would come to equilibrium with the monopoly wage W_p in the defence industry. Yet, the result found in W_{D1} states that the monopoly wage in the defence industry is 0.87 times the "minimum supply price" W_b .

Efficacious Bargains

This section is amended with regard to the classical theory of efficient bargains¹⁸. There has been an attempt to breed a scenario in which the classical concept of efficient bargains is rationally utilized in the sui generis sector of defence.

A more elaborate institutional arrangement is vital for the fulfilment of efficacious bargains in the market of defence. Having said that, the AET will need to waver between the courses of action during the negotiation, and put forth some kind of influence over the level of employment, taking into consideration the uniqueness and exclusivity of their labour. For as the latter case differs from that, where the employer establishes the level of employment unilaterally, the AET will tend to set its objective at farther locus through the increment in the level of wages with an emphasis upon the necessity of advanced facilities. The contract of employment would be practical for the AET members, if it contains in-depth information on the schedule of the projects, the facilities provided and the length of the contract.

For most of the work carried out in the defence industry is subject to a duration that specifies the length of the projects and expected outcome, there will be a focus upon the contract¹⁹, which under circumstances of individual recruitment may be worthwhile scrutinizing. Essentially, if defence firms were to deal with talented labour per unit with respect to a unit of work, viz., defence projects, then, the wage will be the price by which both the firm and talented labour anticipate the success of the project. The variation of the amount of labour will depend upon the amount of the projects secured by the defence company.

In Figure 1D, the defence firm is ready to recruit labour at wage (W_b) subject to lodging a defence project and the ability to import labour with the same set of expertise and skills, ceteris paribus, which would permit a decrease in the costs as displayed by the downward

17 Clark AE (1998) Measures of Job Satisfaction: What Makes a Good Job? Evidence from OECD Countries, OECD Labour Market and Social Policy Occasional Papers, No. 34, OECD Publishing.

18 George de Menil (1971) Bargaining: Monopoly Power versus Union Power, Cambridge, Mass.

19 C Azariadis (1979) Implicit Contracts and Related Topics: A Survey, unpublished working paper.

sloping of the isoprofit curve passing through EW^{*20} to the horizontal point W_b . Per contra, the member of the AET is seeking the contract curve which is convex, and cuts the indifference curve at point EW^* . Beyond the point EW^* , the employment is low and the wages are high, whilst below the latter, the employment is high and the wages are low, (assuming W_b is constant).

The introduction of the wage W_b however, will compel labour to setting a fair wage between W_b and EW^* , say, if the defence firm were reluctant and refuse to pay that wage. Therefore, the area between EW^* (by construction horizontal) and W_b will be the locus of available wage employment outcomes for the defence firm to higher labour for a specified project as stipulated in the contract, and for the member of the (AET) to start their journey in the defence industry. At prima facie, one notice (on Figure 1D) that the contract curve intersects the AET's supply of labour curve at $W = W_b$ because $Z'(L_D) - pW_D$ vanishes along the supply curve. That is, the capability of the defence firm to import labour embracing the same level of expertise and acquainted with what the defence company needs for the project to be a success, would shift the demand for labour from the points (EW^*, L_D'') to the points (W_b, L_D') . The shift can be explained by the marginal rate of substitution between W_b and EW^* .

The defence firm on the margin of whether or not to pay the members of the AET the wage W_b with respect to its budget for some sort of project-focus would substitute the latter for the wage W_D resulting in an increase in profit per unit of output at LD' . Hence, the contract curve is instantly vertical at points (W_b, LD') , and positively beyond those points by virtue of the simple assumption of $EW^* \geq W_b$ which implies that the wage rate in the defence sector is higher or equal than the marginal revenue product such that, $W_D \geq Z'(L_D)$.

Theoretically, no bargain can take place at points where $EW^* < W_b$, thus, the contract is confined and can not be extended to points below W_D . For the members of the AET to be all needed in the defence market, then the contract curve rises to the North West spurring an increase in wages, condition that W_b is equal to zero. Everywhere, in the shaded area between (W_b, L_D') and (EW^*, L_D'') , the wage is equal to the marginal revenue product of employment. If this were true, then all along the contract curve except at $(W_b, W_D; L_D', L_D'')$, the marginal revenue product of employment falls short. That is, the defence firm being induced by a defence project will seek no point along the contract curve as long as the marginal productivity of members of the AET (or any talented labour) is less than the wage. This takes us to the insight that resulted in the pioneering paper of Leontief²¹. One may fathom, that, W_b is the true price of talented labour in the defence industry, but one may consider the interpretation of the bargain as being efficacious merely from the prospective views of both the employer and the members of the AET.

In order to behold how the contract curve is affected by changes in the aggregate activity, we re-conceive the revenue function as $Zf(L_D, F)$, and assume that both Z_F and Z_{LD} are positive. The variable F is the level of funding: - An increase in the level of funding, will lead to an increment in the prospective yields of the defence firm, thus, a rise in the marginal productivity of labour at any level of employment (assuming labour is perfectly elastic to the effective output). Hence,

subject to the AET perfectly aware of the economic outlook and the increment in the level of funding (F), the wage W_b would be declined, and talented labour would decide to start the wage-employment from the point (W_b, L_D') , on the new supply curve resulting in a shift of the contract curve to the right (Figure 1D).

An increase in W_D triggered by favourable economic outlook, and chiefly the increment in funding will give birth to a new value W_D^* , thus, new contract curve which begins at points (W_D^*, L_D^*) . This is shown in Figure 1E.

Hence the starting point of the contract is shifted to the North West of the plane (W, L) , and the new contract curve lies everywhere above the old one. If the aggregate activity induces an improvement in the market of defence, efficacious bargains have a higher wage at any level of employment.

Variations in the individual's supply of labour in the defence industry conventionally rise from any three kinds of economic causes, ceteris paribus: (I) they may result from a change in the aggregate activity as whole; (II) they may be the AET's reaction to a change in the wage offered- As illustrated in Figure 1E; (III) they may be the reaction of the employer to a change in the marginal productivity of labour; (IV) they may be the result of undulations in the abilities of AET's members.

Since F and W_b are the reflection of a theoretical framework, and are not easily measurable, it is difficult to model a generalized pattern in the defence industry. Yet, in an attempt to do so, we will consider the factor F overbalancing W_D and W_b , so to allow for a shift in the contract curve towards the North West when the aggregate activity conditions enhance and to the South West when they deteriorate.

Bargaining and Proceeds Limitation

Here, the potential case of a fixed price defence firm experiencing progressively more limitations in terms of sales as a result of a slack in the government spending. We use this scenario as a frame to introduce another perception, viz., bargaining conventions, which may be applied to the sharing of gains and loses after a shift in the economic and financial environment or in the level of productivity²². Finally, the same scenario aids to clarify the underlying reason why efficacious bargains may hold a countercyclical movement aspect as to wage rates.

A model can be drawn for a sale-confined defence firm through the assumption that every isoprofit curve simply finishes when it reaches the value of L_D' corresponding to the maximum amount of sales, as illustrated in Figure 1F. The latter assumption however, does not take into account the marginal substitution amongst factors of production. Here, talented labour (homogenous) is assumed to lodge high level of efficiency, thus, any decrement in terms of productivity would lead to an increase in the marginal cost, ceteris paribus, causing a decline in proceeds. The substitution among factors of production comes to right what is wrong at the expense of wages, other things being equal.

Any decline in sales will push the isoprofit curve upward the right hand side resulting in the increase in the wage rate, which is now set at a higher point in the W ordinate. If the decrement in sales is a matter

20 Note that EW^* is equal to W_D , so that the use of the former does not negate the latter and vice versa.

21 W Leontief (1946) The Pure Theory of the Guaranteed Annual Wage Contract. *J Polit Econ* 54: 76-79.

22 N Meager and S Speckesser (2011) Wages, Productivity and Employment: A Review of Theory and International Data, Institute of Employment Studies, United Kingdom.

of productivity and not environment, then the substitution takes place in the closed interval [A, B]. In line with this assumption, Meager and Speckesser argues, “wages and productivity will be aligned in the long run, because firms with productivity increases below the level of wage increases will eventually be unable to pay their wage bills and go out of business”²³. The change in wage rates taking place because of a sharp decline in proceeds will effectively shake the contract curves. As explained above, if the recession is merely stemming from a decrease in the demand for weaponry, then the proceeds Z will move to the right towards Z'. The initial bargain is no longer tenable at this stage, regardless of any speculation on the labour's side.

Now, the defence firm at the intersection of the recession curve and the contract curve may offer a new wage-employment. The point (A) can be set as the new wage rate in the defence firm subject to an agreement with the AET. The shift in the behaviour of the market may cause a natural, yet systematic gain or loss for both the Defence Company and talented labour. In the case of recession, both parties lose but to a less extent on the side of the former. That is, if the defence company were to decrease its marginal cost in times of recession, whilst combining the cost of the different fragments related to the production, so as to embrace the minimum cost for the production in its aggregate function, and maximize the marginal productivity by factor of production, then, it can still not only survive in the market, but also expand through the targeting of nations whose defence budget can afford the now reduced selling price.

Defence firms can nowadays be found interconnected with other companies working in the same or different industries, and sometime even forming pan-defence movements²⁴, might succeed in the elimination of additional costs, only if they were to set the production in a uniform way. That is, as long as the production cycle is the constellation of segregated workshops, the likelihood to decrease costs would be feeble. An increase in the supply of a factor of production in one of those plants, will result in an increase in the other factors, thus, an increment in the aggregate cost function. This proposition can be broken down into the following interpretation. In so far as the consumer's demand and the technology factor are both in constant change (allowing for growth), with the latter in the shape of an upswing curve, there would be always a shift in the variable factors of production. Any rise in a particular factor, say, the demand for talented labour, would increase to a certain level their real income. To make this scenario plausible, we will refer to the elasticity of substitution which for the purpose of simplicity goes from zero to unity [$0 < \epsilon < 1$]. If talented labour is uncorrelated with the factor technology, but elastic ($\epsilon = 1$), in the sense that it can easily be substituted, then the marginal productivity would decline.

Therefore, the wage would per force rise as employment declines, and the bargain would take place in the shaded area at any point between (BC). This is shown in Figure 1G. This is the perfect demonstration of the mechanism whereby wages and employment can follow a countercyclical model. For the firm to cut expenses, other things being equal, it is vital to minimize the volume of employment to a level at which the production could still be running but at a minimum cost. At this stage, the AET is worse-off, and the defence firm is better-off. Notwithstanding, even though the AET as an association is not benefiting from this situation, the single talented

labour is; by virtue of the increase in the real income for the single worker.

Conclusion

This paper comes to exert the relationship between talented labour through the AET and the defence firm. We emphasize upon the role of the AET in the undulations in the wage-employment function. We explain how the aggregate activity can foil any attempt of the AET to ask for high wages. The study of the bargaining has been subject to partial-equilibrium theorems and models, which generally put forth the correlation between the demand for the ordnance and the fluctuations in terms of employment of talented labour (with respect to the level of technology desired). Diagrams come to complement the theoretical framework and allow for lucidity to the reader.

Furthermore, the paper tackles a specific set of problems that would put both the employer and employee at risk of loss in the bargain. First, we introduce the notion “efficacious” in the bargain dwelling precisely on the defence industry, whilst highlighting upon the role of the AET in pushing the defence firm to recruit more and more of its members than it would like, which leads to the slump of the isoprofit curve. Then, we assume that the distortion in the market of defence results in a decrease in employment by means of the fall in proceeds, giving the defence company (being the employer) perfect control over the bargaining in its aggregate function. Technology seems to dominate the future of the defence industry and its players. We also show how countercyclical policy can put forth the traditional rules of the bargaining game even if the labour involved is with high calibre.

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Top

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23 Ibid.

24 For instance, the Eurofighter Typhon project which is a Pan-European defence programme between the UK, Spain, Germany and Italy.