How does military spending affect the economy: a closed economy approach

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Abstract

This thesis examines the macroeconomic effects of military spending through a static general equilibrium model of a closed economy. The model features three representative agents: households, firms, and the government; and captures two main transmission channels: the provision of security as a public good entering household utility, and the augmentation of labour productivity. The government allocates fiscal revenues between military and civilian expenditure, financed through consumption, income, and profit taxes. The model is solved numerically across nineteen scenarios varying the military spending share, the productivity elasticity, the financing instrument, and household preferences for security. The results indicate that an equal allocation of fiscal revenues between military and civilian expenditure maximises household welfare, consistent with the non-linear relationship documented in the existing literature. Among the financing instruments considered, the profit tax generates the smallest welfare loss as it leaves the household's consumption-leisure trade-off undisturbed. Finally, when households place a higher value on security, they supply less labour and produce lower output, but achieve substantially higher welfare, reflecting the public good dimension of military spending.

Declaration of Authenticity

I hereby declare that this thesis is my own original work and that all sources have been properly cited and acknowledged. This thesis has not been submitted for any other degree or qualification.

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Contents

1 Introduction **5**

2 Literature Review **6**

2.1 Private Consumption 14

2.2 Private Investment 15

2.3 Research and Development 17

2.4 Cost-Benefit Analysis 19

3 The Model **20**

3.1 Representative Household 20

3.2 Representative Firm 22

3.3 Government Sector 23

3.4 Macroeconomic Equilibrium 24

4 Results and Discussion **26**

4.1 Baseline Equilibrium 26

4.2 Optimal Military Spending Share: Scenarios 1–4 28

4.3 Productivity Elasticity of Military Spending: Scenarios 5–6 30

4.4 Endogenous Military Spending Share: Scenarios 7–10 31

4.5 Optimal Financing Instrument: Scenarios 11–13 32

4.6 Household Preferences for Security: Scenarios 14–19 33

5 Conclusion **34**

1 Introduction

The relationship between government spending and economic growth has been a central topic in macroeconomic research for decades. Within this broad debate, the specific role of military expenditure has attracted considerable attention, given its dual nature as both a fiscal burden and a potential driver of economic activity. Defence spending differs from other categories of public expenditure in several important respects: it provides national security, a non-rival public good that constitutes a precondition for private economic activity, while simultaneously competing with civilian expenditure for fiscal resources.

The existing literature has approached this question from a variety of theoretical perspectives, ranging from neoclassical and Keynesian frameworks to Post-Keynesian and endogenous growth models, yielding a heterogeneous and often conflicting set of results. A common idea found in the literature is that military spending affects the economy through multiple channels simultaneously, including private consumption, private investment, research and development spillovers, and the provision of security, resulting in the difficulty to isolate the net effect. Within this framework, this thesis develops a static general equilibrium model of a closed economy in which the main transmission channels of military spending are explicitly formalised, in order to analyse how the allocation of fiscal revenues between military and civilian expenditure affects output and household welfare.

The model is solved numerically across a range of scenarios that vary the military spending share, the productivity elasticity of defence expenditure, the financing instrument, and the household preference for security. The remainder of the thesis is structured as follows. Section 2 reviews the relevant literature on the macroeconomic effects of military spending, organised around the main transmission channels. Section 3 presents the theoretical model and derives the equilibrium conditions. Section 4 discusses the numerical results across the different scenarios. Section 5 concludes.

2 Literature Review

Macroeconomic analysis has consistently theorized the effects of the public sector on output and more specifically, through which channels fiscal easing (or tightening) affects other elements of aggregate demand and supply. Blanchard and Perotti (2002) have shown that government spending influences output positively, while fiscal tightening, such as higher taxes, hinders investment spending. Empirical evidence consistently shows a positive effect of government spending on private consumption, an outcome mostly aligned with Keynesian models, but more difficult to reconcile with neoclassical approaches, except if one assumes future increases in taxation. Although both approaches predict a positive impact on output, they diverge mainly in their effects on consumption: neoclassical models typically imply a decline (see, e.g., Baxter and King, 1993), while Keynesian models predict an increase (Blanchard and Perotti, 2002). However, for a given level of public expenditure, Barro (1974) argued that positive fiscal shocks would lead to no changes in aggregate demand, interest rates, and capital formation. Many studies have further examined the relationship between private and public consumption, without converging to a unified consensus, with some supporting the existence of a substantial relationship between the two, while others (e.g. Amano and Wirjanto, 1998) consider the two forms of consumption unrelated from a Pareto-Edgeworth perspective. With regard to the channel of private investment spending, there is further debate on whether any kind of fiscal policy affects it positively or negatively. Results from the research of Blanchard and Perotti (2002) find that both fiscal expansion and contraction exert a negative effect on private investment. This time, their results are more congruent with the neoclassical model of distortionary taxation, yet discordant with Keynesian theory which predicts opposite effects of tax and spending shocks. Yet, a common idea is that, for a given number of available resources, policy making consists of trade-offs.

When further analysing the different categories of government spending, the study regarding military expenditure adds more nuances to the discussion. The analysis of the effects of military spending has been approached from diverse theoretical perspectives, spanning from neoclassical, Keynesian, and Marxist frameworks, each emphasizing different transmission mechanisms and yielding divergent

predictions. Gbadegesin (2025) summarizes the results by showing that neoclassical, Keynesian, and Marxist approaches offer contrasting evaluations of military expenditure: while neoclassical theory tends to view it as efficiency-enhancing, Keynesian analysis highlights its potential demand-stimulating effects, and Marxist perspectives interpret it as structurally driven by the interests of the military-industrial complex, with implications ranging from growth-enhancing outcomes to structural distortions and trade-offs with broader social welfare. When analysing the relationship between defence spending and economic growth, further discrepancies have arisen, showing a lack of consensus in cross-country research. Conflicting results have emerged from both mathematical and empirical analyses. Chowdhury (1991) suggests that the relationship between economic growth and defence spending cannot be generalised. These discrepancies in the outcome, as suggested by Chowdhury (1991), could depend on the use of different sample periods, along with variation in the socioeconomic structure and types of government across countries. For instance, when analysing the early 1950s period, Blanchard and Perotti (2002) could extrapolate the different persistence of the spending shocks by dividing government spending between its defence and non-defence components. Moreover, Chowdhury (1991) finds evidence of the existence of a lagged relationship between defence spending and economic growth; further corroborating the theory discussed by Benoit (1978), in which defence spending may be able to bolster growth by increasing aggregate demand. As the additional demand generated by the augmented military spending contributes to the increase in capital stock and labour employment, and the reduction of resource costs. On the other hand, d'Agostino et al. (2019) find that negative effects of military expenditure have been underestimated in the past and stands by the idea that military spending constitutes a substantial constraint on economic growth.

When analysing models of military spending and growth it is crucial to focus on the indirect impacts as well as the direct, as mentioned by Elveren et al. (2023). Current literature has spanned across different approaches and models, some focusing on the effects on aggregate supply and other on aggregate demand, resulting therefore in plenty of different outcomes. Kennedy (2022) explains that one of the most common approaches is "the neoclassical production function approach",

which analyses the impact of military burden on capital, labour, and productivity, impacting economic growth. Other models presented by Elveren et al. (2023) include the Feder-Ram model, the Deger-type model, the endogenous growth model, the augmented Solow growth model, the new macroeconomic model, and a small open economy stochastic growth model. Furthermore, based on the neoclassical growth theory introduced by Solow (1956), which implies that long-run economic growth cannot be achieved through government expenditure, there has been introduced the idea of the impact of externalities and productivity effects, that Kennedy (2022) defines as the interaction of sectoral technological progress, differential productivity, and spillovers to the rest of the economy. Through this process it is possible to analyse the effect of military spending on growth by dividing the economy into sectors whose externalities influence one another. The effects of government policies could positively influence the private sector through means that are not connected with competitive markets; for instance, if skilled labour is endorsed by educational investments from the government, the result is a public good, non-rival in use, which can be used freely by the output-producing sector, as described by Berthélemy et al. (1995). Positive externalities of military spending could result from infrastructure development, training and education of the population, research and development and most crucially from security. Higher security can improve social welfare, thus providing a stable environment, such as protection of property rights, that are a precondition for private investment to occur at all. Deger and Smith (1983) find that military expenditure may affect growth through its role in maintaining internal stability, shaping sociopolitical structures, and ensuring security from external threats. Furthermore, it can support production by preventing internal conflict, promoting modernization, and strengthening ties with foreign powers, facilitating technology transfer and access to aid. Within this framework, Barro and de Rugy (2013) analyse the Keynesian arguments against defence cuts, which corroborate that a smaller budget could hinder economic growth as these spending reductions would impair national security.

As the channels through which defence spending can influence the economy are broad, the existing literature has found difficulties in identifying valid instru-

ments to address the endogeneity of the effect of military spending. Against this background, military expenditure is often correlated with economic growth because it is itself driven by insecurity, which in turn affects economic performance, making causal inference particularly challenging (d'Agostino et al., 2019). Consequently, much of the empirical literature, which is largely based on cross-country regressions, may suffer from biased estimates due to this limited treatment of endogeneity, helping to explain the heterogeneity in reported results. d'Agostino et al. (2019) have further analysed the difference in outcomes when choosing models that focus either on the demand side or the supply side. The former usually yields a negative outcome, influenced by the crowding out effect of investments. On the other side, the latter suggests positive effects, mainly because of the structural assumptions.

Literature also highlights the importance of differentiating the study between Developed and Less Developed Countries (LDCs), as the former typically show lower unemployment rates and generally stronger aggregate demand. Following Benoit (1978)'s reasoning, increased capital use can raise profit rates and stimulate investment in LDCs, generating both short-run multiplier effects and long-term growth (Chowdhury, 1991). In these scenarios, defence spending may precede and promote growth, both directly and through spillovers, such as research and development, skill formation, and infrastructure development, supported by the relatively advanced role of the military within the socioeconomic structure (Chowdhury, 1991; Deger, 1986). Yet, though there can be determined that, to a certain degree, military spending can result in economic growth, as Chowdhury (1991) suggests, it could be also plausible that the inverse causal relationship exists, where growth may lead to defence spending. Moreover, a crucial point to analyse is the actual presence of war, or active military conflict, in the past, or present, or even further future possible escalation in conflict internally or externally. As war entails major destruction of property and human capital, many of the most severe macroeconomic downturns, such as those related to World Wars I and II, coincide with substantial increases in military spending. Under this condition, sharp expansions in defence outlays are observed alongside significant declines in real GDP, not due to a negative spending multiplier, but because of severe supply-side

contractions (Barro and de Rugy, 2013). Ultimately suggesting, that the possible negative relationship found in some empirical analyses may indeed reflect the underlying effects of conflict, rather than the causal impact of military burden per se. d'Agostino et al. (2019) have also underscored the importance of considering natural resource endowments, as for resource-rich countries it is easier to finance military expenditure, while also they could be more prone to domestic conflict and international tensions. Moreover, military forces could be deployed for protecting resource extraction and trade, which from d'Agostino et al.'s (2019) perspective could actually offset some of the negative growth effects associated with defence expenditure.

While traditional research and certain structural VAR models suggest that defence government spending exerts a positive influence on aggregate output, the degree to which this truly bolsters the economy is determined by the size of the fiscal multiplier. This is defined by Barro and de Rugy (2013) as the effect of an additional dollar of defence or other government purchases on total economic output, gauged by real GDP. Therefore, a positive multiplier yields a positive effect on output, specifically for a multiplier greater than 1, the effect of 1 extra dollar of spending will result in a more than 1 change in output. A common view is that the multiplier for military spending is large, therefore a reduction in defence spending would ultimately drive to a negative outlook. Empirical evidence from long-term U.S. data from Barro and Redlick (2011) indicates that defence-spending multipliers typically range between 0.4 and 0.8 over the policy horizon, implying that for every dollar spent on defence, the contemporaneous boost to GDP is less than the outlay itself, however, if the change in fiscal policy is actually permanent, the multipliers are higher by approximately 0.2. Consistent with the size of the multiplier, event-study evidence also finds a concurrent increase of defence spending and of output. Studies such as Ramey and Shapiro (1997), Edelberg, Eichenbaum, and Fisher (1999) document a closely timed increase in defence spending and GDP. In these studies, defence spending typically peaks after about two years at roughly 2.5% of GDP before gradually declining, while output peaks earlier, after about four quarters (around 3.5%), and returns to trend within two to three years. As shown by Blanchard and Perotti (2002), in contrast

to military spending, non-defence spending tends to decline after the initial shock and is characterized by a smaller and less significant output response, underscoring the difference in the persistence of fiscal shocks across spending categories.

This limited effectiveness of the impact of defence spending (size of multiplier) is largely attributed to a "crowding-out" effect, where increased military purchases can divert resources away from more productive private-sector components, specifically suppressing private investment, net exports and, in some cases, consumer expenditure. Arguably, a more permanent increase in military spending could mitigate this negative effect on investment, as mentioned in Barro and Redlick (2011), at the cost, however, of other non-defence government purchases. Yet, the net impact on growth is significantly influenced by how such spending is financed. In the case of a balanced budget, where the increase in expenditure is sustained by an analogous increase in taxation, the net effect (given by the multipliers) could also be negative and therefore reduce GDP, according to Barro and Redlick (2011). On the other hand, if the spending is financed through the issuance of government bonds, and they are perceived as net wealth (Barro, 1974) the resulting outcome could be positive. In addition, Elveren et al. (2023) suggests that the ultimate effect on output depends on whether the growth regime is wage-led or profit-led. The former, as he describes, consists of an economy where positive demand effects through consumption dominate the negative effects through investment and competitiveness, while the latter describes the opposite.

Another channel through which defence can influence growth is savings, which in turn can influence future investments. Deger and Smith (1983) suggest that there had been evidence regarding the adverse impact of military burden on growth, operating primarily through reduced savings. Yet they also analyse the impact of the "militarism" effect on the increase of savings. Later, Deger (1986) further expands this study and ultimately considers the mobilization of extra savings one of the most important results of defence spending; specifically, the "militarism" effect consists of higher savings achieved by the sale of defence bonds and by promoting a moral dedication toward savings and austerity in times of national crisis. Both researches found that military may contribute to technological diffusion, infrastructure development, and workforce training, potentially enhancing

productivity. However, they highlight how these effects are context-dependent, as infrastructure may primarily serve defence needs rather than civilian priorities. Overall, it is found that military expenditure can generate both positive and negative effects on absorptive capacity, influencing saving, therefore investment, and growth (Deger and Smith, 1983).

The impact of defence spending also depends on whether the economy stands at an equilibrium, or else if there is deficient demand relative to supply. If the economy is characterized by the latter, Deger (1986) implies that, by increasing defence spending, extra demand can be generated, which as well could meet increased utilization of capital stock and greater employment of labour. In his analysis, he does not only consider short-term benefits, but also long-term growth effects. As general lack of demand lead to less efficient use of capital, an increase in aggregate demand could lead to more efficient capacity utilization, which in turn may raise the profit rate, thereby stimulating investment and ultimately increasing the growth rate of the economy (Deger, 1986; Dangal and Gajurel, 2022).

A central component of the growth-defence nexus is the non-linear effect of military expenditure, where the marginal impact of the military burden is not constant across different economies or levels of spending as noted by the literature. Pieroni (2009) finds that this non-linearity is often driven by shocks to insecurity, which can trigger a re-allocative effect within government expenditure, potentially leading states to substitute inefficient spending with more efficient civilian outlays and infrastructure. Such efficiency gains suggest that the steady-state growth rate may be positively influenced by the productive reallocation of government resources, rather than a simple supply-side or demand-side stimulus. To achieve a comprehensive cost-benefit analysis of the defence-growth relationship, it is necessary to account for the trade-offs between military expenditure and investments in national well-being, specifically health and education. Within this framework, Gbadegesin (2025) stresses the importance of the inclusion of the Geopolitical Risk (GPR) index, which is essential to isolate these impacts, as external risks frequently alter government priorities and the trade-offs between defence and societal investments. Empirical evidence suggests that while benefits may exceed costs when the military burden is small, excessive military expenditure tends to

hinder growth unless it is balanced by a high level of non-military expenditure that mitigates these negative effects. Ultimately, by providing security and fostering a safe environment for domestic and foreign private investment, defence spending can facilitate multiple growth regimes through its indirect benefits and endogenous technological impacts.

Beyond pure economic multipliers, the impact of defence expenditure could also be significantly moderated by institutional and political variables. Evidence suggests that government allocation decisions are sensitive to electoral cycles and political ideology (d'Agostino et al., 2019), with spending often shifting toward non-military categories during election periods. Furthermore, d'Agostino et al. (2019) explain that the effective negative impact of military spending may be underestimated in traditional models that fail to treat turmoil as an exogenous shock or account for feedback effects where higher growth directly facilitates higher spending. They have also identified another political variable which could exacerbate the causal inference of military spending, that is corruption. As corruption is found to be positively correlated with military spending, robust empirical models must account for this institutional distortion, if not the results could exaggerate the estimated negative impact of military expenditure on growth, because of the direct effects of corruption on growth by distorting tax collection and the level and composition of public expenditure. d'Agostino et al. (2019) also find that within the defence sector, the inherent lack of competition often facilitates rent-seeking behaviour, which serves to increase costs and further crowd out productive private investment. In the context of non-high-income countries, as highlighted by Deger and Smith (1983), military expenditure has been identified as a substantial constraint on development, largely because it diverts resources from alternative uses while imposing inflationary pressures that can lead to capital flight rather than forced savings. Consequently, in order to achieve an unbiased result, it is necessary to develop a model that takes into consideration these institutional distortions as well as four primary channels of influence described by Deger and Smith (1983): resource mobilization, production organization, sociopolitical structure, and external relations.

2.1 Private Consumption

The question of whether government expenditure can influence private consumption and on what magnitude has been a point of discussion in past literature, starting from Barro's (1974) contribution to the study of government bonds as net wealth. Further research has concentrated on the different influences that come from different kinds of government spending, mainly civilian and military government spending. Pieroni and Lorusso (2013), Pieroni and Lorusso (2015), and Lorusso and Pieroni (2017) have used a New Keynesian approach to examine the magnitude of the impact on aggregate demand, through the channel of private consumption, from both military and non-military spending. Their results from the VAR estimation show that civilian expenditure can induce a positive response on private consumption, while military spending has shown to provoke a negative effect. The discrepancy in the effect of the different government spending is mainly due to the persistence and financing nature of the expenditure; military shocks generally last longer and are deficit-financed, while civilian shocks tend to be shorter and tax-financed. As introduced above, to determine the overall impact on private consumption it is important to account for the financing mechanism used, specifically in the case of budget deficits. In the case of issuance of government bonds to finance the deficit, much importance is given to the expectation of consumers, that is if they follow rational or non-rational expectations on future taxation. The latter may be consistent with real life characteristics of consumers, but it is inconsistent with the Ricardian equivalence, which requires intertemporal utility maximization and rational expectations that together yield an Euler equation specification (Graham and Himarios, 1991). Literature has shown that it is possible to have deviations from Ricardian equivalence when consumers are forward-looking, as uncertainty about future income makes future tax liabilities less noticeable than current tax cuts. Within this framework, Barro (1974) suggests that households may treat government bonds as net wealth and increase consumption following a tax cut, despite understanding that taxes will rise later. Graham and Himarios (1991) have found that empirically, the hypothesis that consumers are at least partially myopic cannot be rejected, and the data are even consistent with the extreme case in which taxes and government spending are

largely ignored in consumption decisions. Therefore, it is possible in cases where consumers follow non-rational expectations, to expect that the response of an increase in military spending, financed through bonds, could result in an increase of private consumption, following the net wealth effect and increased security sentiment. Conversely, when considering Ricardian households, as depicted in the research of Lorusso and Pieroni (2017), the effect of the spending shock is negative and persistent. This line of reasoning is also explained by Galí et al. (2007), who show within a New Keynesian framework that the empirical evidence of a positive consumption response to government spending can be achieved even with the presence of Ricardian consumers, that is when they coexist with rule-of-thumb (non-optimizing) consumers. In their model, rule-of-thumb consumers are characterized by a behaviour that is consistent with limited forward-looking reasoning or effective myopia, ultimately making aggregate consumption more responsive to current income and fiscal expansions, and therefore providing a theoretical foundation for the mixed empirical results found in literature. However, the effectiveness of the rule-of-thumb model has been challenged by the "entry puzzle" identified by Lewis and Winkler (2017), who show that while such characteristics can explain consumption crowding-in, they do not capture the rise in firm entry following spending shocks.

2.2 Private Investment

The discussion regarding the potential effect of defence expenditure on private investment has been largely heterogeneous, ultimately resulting in no unified consensus. The debate, however, does not regard solely the military spending, in fact literature has focused recursively on the impact of public spending on private investment, and thus aggregate demand. Supporters of the crowding-out hypothesis believe that the result of a fiscal expansion, supported by deficit budgets, displaces private investment, thereby hindering economic growth. As introduced above, critics of the crowding-out hypothesis support the theory that increases in government expenditure are followed by equal increases in private saving thus yielding no negative effects on private spending and investment. The debate further highlights that public spending can increase private sector profitability through higher aggregate

demand, which is described as the Keynesian effect, and/or cost reductions, namely the infrastructural effect, while simultaneously competing with the private sector for funds and thereby, ceteris paribus, reducing the total volume of private capital formation (Looney, 1994). Furthermore, on the discussion about the impact of various forms of public spending, specific categories have been found to positively affecting private capital formation, for instance Laopodis (2001) suggests that public infrastructure could favourably increase private investment through output production and transportation. Moreover, Malizard (2015) shows the importance of distinguishing between equipment and non-equipment expenditure, as the former is found to crowd in investments, because of the complementary relationship between military equipment and investment, while the latter is found to crowd out them, as military wage expenditures do not generate an immediate increase in private sector productivity. In this context, military equipment is considered to be capital-intensive, as well as having a spillover effect through Research and Development (R&D) which could contribute to the private sector productivity. European Journal of Government and Economics (2022) has contributed by further differentiating the analysis in short run and long run effects of military spending; specifically, he noted that there is crowding out of private investment in the short run after the fiscal shock, while in the long run it has been shown to result in crowding in, ultimately stating that an increase in spending could not yield a permanent effect on private investors. His analysis relates to the distinction made by Malizard (2015) about equipment and non-equipment expenditure, as he suggests that government military spending, while necessary to provide public goods such as national defence, law enforcement, and investor confidence, given the lack of private incentives to supply these services, may nonetheless crowd out private investment, particularly as it encompasses both capital expenditures (e.g., arms procurement) and recurrent spending such as personnel wages.

As mentioned above, the difficulty in obtaining a homogeneous result from the analysis of the impact of military spending on economic growth lays mainly on the differences between the characteristics of each country analysed, the time period chosen to analyse and the economic cycle in which each economy finds itself. Therefore, empirical evidence has shown different outcomes and thus different in-

terpretations on the relationship between spending and growth. In countries facing severe insecurity, such as Nigeria and several MENA economies, increased military spending can have a positive effect on private investment by improving security conditions and signalling government commitment to stability, thereby fostering a more conducive environment for economic activity; in this context, expenditures on arms and security operations aimed at countering insurgency are not merely costs but can enhance investor confidence and support investment in the long run (European Journal of Government and Economics, 2022). In the case of Pakistan Looney (1994) highlights that defence expenditures appear to stimulate private investment in large-scale manufacturing, suggesting a positive relationship possibly driven by demand expansion or linkages with military procurement; although the evidence is not conclusive of crowding-out dynamics, it indicates that, compared to public investment and infrastructure spending, which often exert weak or even negative effects due to pressure on domestic capital markets, military spending can, under certain conditions, act as a catalyst for private sector investment. Laopodis (2001) has studied the case of France, where public expenditure appears to have a modest but generally positive effect on private capital formation, while military spending shows no direct impact on private investment, though it may exert an indirect positive effect by enhancing national security. Lastly Kalaitzidakis and Tzouvelekas (2011), in a panel study of 55 developed and developing countries, show that the effects of military and infrastructure spending differ across country groups, with public capital generally supporting growth and private capital accumulation, especially in OECD economies. However, it is relevant to mention that they have identified an inverted U-shaped relationship which suggests that military spending may foster investment through improved security and productive externalities only up to an optimal threshold, beyond which it may crowd out more productive uses of capital and hinder long-run economic performance.

2.3 Research and Development

The primary channel through which defence Research and Development (R&D) impacts economic growth is technological spillover, yet this variable remains one of the most difficult to identify within the general theory of military expenditure. Al-

though any spin-off of technologies from defence-related R&D is usually not a prime motivation but more often an unintended consequence (Okur, 2013). Furthermore, one can argue that the ultimate output of defence R&D is national security, which unlike market-based activities, is a public good that is not priced in the market, making its direct economic value nearly impossible to capture through conventional measures (Mowery, 2012). Within this framework, literature has noted that much of the civilian innovative impact is dependent on indirect benefits associated with the application of knowledge or technologies originally developed for military preparedness. Empirical evidence suggests that military demand is often indispensable in producing General Purpose Technologies (GPTs) (Schmid, 2018) such as the Internet, GPS, nuclear power and semiconductors, which the private sector alone would likely under-produce due to the long-term required capital and the difficulty of a single firm capturing widely dispersed gains. Therefore, through military R&D efforts this process is bolstered, mainly by government's support for fundamental research infrastructure, direct technological spin-offs, and public procurement. However, literature also underscores that the bolstering effect of these spillovers is often counterbalanced by a resource diversion or crowding-out effect, as mentioned in the above section. Apart from redirecting resources from civilian expenditure to military in the government sector, defence R&D could also lead to a smaller number of total patent applications by siphoning skilled scientists and engineers away from the civilian sector, as analysed by Mowery (2012). In his research, however, he estimated that albeit a larger quantity of defence R&D may be associated with fewer total patents, it has been found to increase the productivity of R&D funded by private businesses and universities, suggesting a positive externality that enhances the efficiency of the remaining civilian research. Empirically Okur (2013) has reported that a positive correlation exists between defence R&D expenditure and military capability, as well with technological spillover index, which includes the production of researchers, patents, and scientific publications. Furthermore, the net innovative impact of defense R&D is fundamentally contingent upon a nation's existing research landscape; according to McDonough (2017), while military outlays significantly bolster the productivity of university and business-funded research—with the effect being notably larger for the former—they simultaneously diminish the productivity of non-profit R&D,

suggesting that the 'bolstering' effect is highest in economies with robust academic research infrastructures.

The effectiveness of this channel also varies significantly by national strategy and development level. Okur (2013) has distinguished two strategies, based on priority principles; the two approaches are the spin-off and spin-in. In this context, nations that adopt a "spin-off" approach (like the US or France), prioritise military tech to simultaneously develop strategic civilian industries, whereas countries that prefer a "spin-in" approach (like Japan), favour civilian R&D, which in turn replaces military dominance. Additionally, Wang and Choi (2023) have noted that for mid-sized or developing nations, imports from developed countries act as an effective international R&D spillover channel, facilitating a "virtuous cycle" of introducing, learning, and re-innovating foreign technologies. Ultimately, despite the strong historical linkage between military demand and technological change, Weston and Gummett (1987) believe that the "secrecy" of defence outputs and the lack of market prices mean these spillovers remain a speculative black box in growth equations, often leading to an underestimation of the long-term structural changes triggered by military technological primacy.

2.4 Cost-Benefit Analysis

The ultimate economic utility of national defence expenditure is determined by the cost-benefit trade-off between the provision of security and the fiscal burden of its financing. While positive spending shocks can stimulate output, through the channels we have analysed above, research indicates that the spending multiplier is often less than one, which implies that defence outlays may crowd out other components of GDP such as private investment. A crucial detail that determines the ultimate outcome of the fiscal expansion is the chosen method of financing; whereas deficit financing may withdraw resources into government bonds, tax-financed expansions introduce substitution effects through higher marginal income-tax rates that can hinder GDP with a multiplier slightly above the unit. Therefore, some empirical models such as Barro and Redlick (2011) suggest that a balanced-budget increase in defence spending may ultimately result in a negative net impact on growth. Recent literature has tried to find models that best depict all channels and variables

that are influenced by military expenditure, resulting in some findings that find this fiscal pressure is balanced by the military's capacity to bolster national well-being and provide a stable environment for economic activity. Contrary to traditional "crowding-out" theories, Gbadegesin (2025) found in recent evidence from G7 nations that military expenditure can have a statistically significant positive impact on health and final consumption, effectively raising indicators of societal welfare alongside defence objectives. When analysing the impact of defence spending on economic growth it is important to not focus solely on the direct channels such as the constraint on the budget, but also on indirect mechanisms, the security-growth nexus for instance, where the productive reallocation of resources and the restoration of investor confidence can facilitate long-term stability. Therefore, the challenge for policymakers lies in maintaining an optimal, efficient level of military expenditure that secures the state without reaching the non-linear thresholds where fiscal distortions outweigh the benefits to societal well-being.

3 The Model

In order to analyse the effects of military spending on output, we consider a static, closed economy composed of three representative agents: households, firms, and the government. The use of representative agents enables the analysis to focus on aggregate behaviour without loss of generality. Defence spending affects the economy through two distinct channels: it enters the household's utility function directly as a public good providing security, and it augments factor productivity in the production sector. The government collects tax revenues from three sources, a consumption tax, an income tax, and a profit tax, and allocates total fiscal revenues between military and non-military expenditure according to a fixed share parameter.

3.1 Representative Household

The representative household derives utility from four arguments: consumption C, leisure $(1 - \ell_h)$, the civilian public good provided by non-military government expenditure g, and the security yielded by military spending S. Utility takes a

log-linear form in all four arguments:

$$u = \mu_1 \log C + \mu_2 \log(1 - \ell_h) + \mu_3 \log g + \mu_4 \log S \tag{1}$$

where security enters as a public good, non-rival in use and available to all households simultaneously, and is modelled as a power function of the military spending share m, with elasticity θ_1:

$$S = m^{\theta_1} \tag{2}$$

A higher military burden therefore raises security and, through it, household welfare directly. The household maximises utility subject to the following budget constraint:

$$(1 + \tau^c)C = (1 - \tau^y)(w\ell_h + d) \tag{3}$$

The household chooses its optimal labour supply ℓ_h to maximise utility over consumption and leisure, taking wages, dividends, and tax rates as given. The budget constraint requires that consumption expenditure, comprehensive of the consumption tax τ^c, does not exceed after-tax disposable income, which consists of wage income w and dividend payments d from the household's ownership stake in the representative firm.

The household solves its optimisation problem by forming the Lagrangian, which augments the utility function with a multiplier on the budget constraint. The first-order condition with respect to consumption equates the marginal utility of consumption to the shadow price of income scaled by the gross consumption tax rate. The first-order condition with respect to labour supply equates the marginal disutility of labour to the marginal utility of the after-tax wage income it generates. The detailed derivation of the optimisation problem is provided in Appendix 5. Combining these two conditions yields the optimality condition, which states that the ratio of the marginal utility of leisure to the marginal utility of consumption equals the after-tax real wage, adjusted for the consumption tax.

$$\mu_1(1 - \tau^y)w(1 - \ell_h) = \mu_2(1 + \tau^c)C \tag{4}$$

Together with the budget constraint, this gives a system of two equations that determines optimal consumption and labour supply for given wages, dividends, and tax rates.

3.2 Representative Firm

The representative firm produces output using labour as the sole factor of production, consistent with the static nature of the model. The production function, based on the assumptions of Dunne et al. (2005), is characterized by an aggregate neoclassical production function, where the share of military spending affects factor productivity via a level effect on the efficiency parameter, resulting in labour-augmenting technological progress:

$$y = \hat{A} \cdot \ell_f^{\alpha} \tag{5}$$

where $\alpha \in (0, 1)$ is the labour share parameter and $\hat{A}$ is the effective productivity parameter, which depends on the military spending share m through a power function with elasticity θ_2:

$$\hat{A} = A_0 \cdot m^{\theta_2} \tag{6}$$

where A_0 is the baseline productivity level.

A higher military burden therefore raises the effective productivity of labour, shifting the firm's labour demand ℓ_f and increasing equilibrium output. Since θ_1 and θ_2 are distinct, the security channel and the productivity channel respond to military spending with different elasticities, allowing the model to capture asymmetries between the two transmission mechanisms.

The firm maximises after-tax profits by choosing its optimal demand for labour ℓ_f, taking the wage rate and the profit tax rate as given:

$$\max_{\ell_f} \quad \pi = (1 - \tau^{\pi})y - w\ell_f \tag{7}$$

The detailed derivation of the optimisation problem is provided in Appendix 5. The first-order condition with respect to labour demand equates the after-tax

marginal product of labour to the wage rate, yielding an explicit expression for the equilibrium wage as a function of labour input, the military spending share, and the profit tax rate:

$$w = (1 - \tau^{\pi})\alpha \hat{A} \ell_f^{\alpha - 1} \tag{8}$$

Substituting this back into the profit function yields equilibrium profits as a function of output and the labour share parameter.

$$\pi = (1 - \tau^{\pi})(1 - \alpha)\hat{A}\ell_f^{\alpha} \tag{9}$$

In the macroeconomic equilibrium, profits are distributed in full to households as dividends, so that $d = \pi$.

3.3 Government Sector

The government balances its budget each period. Total tax revenues T consist of proceeds from the consumption tax on household expenditure, the income tax on wages and dividends, and the profit tax on firm output:

$$T = \tau^{c} C + \tau^{y}(w\ell_h + d) + \tau^{\pi} y \tag{10}$$

Total government revenues are allocated between military expenditure m and civilian public good provision g according to a share parameter b:

$$m = b \cdot T \tag{11}$$

$$g = (1 - b) \cdot T \tag{12}$$

such that the government budget is at balance, therefore:

$$m + g = T \tag{13}$$

The share parameter $b \in (0, 1)$ serves as the key fiscal policy variable of the model. A higher value of b implies a larger fraction of total revenues allocated to

military expenditure, and consequently a smaller fraction allocated to the civilian public good. The effects of changes in b on output and household welfare constitute the central object of analysis of this model.

3.4 Macroeconomic Equilibrium

The macroeconomic equilibrium is defined by the simultaneous clearing of the labour market and the capital income market. In the labour market, the quantity of labour supplied by the representative household equals the quantity of labour demanded by the representative firm:

$$\ell_h = \ell_f \tag{14}$$

In the capital income market, the dividends received by the household equal the profits distributed by the firm:

$$d = \pi \tag{15}$$

These two clearing conditions, combined with the optimality conditions of each agent and the government budget constraint, close the model. The full equilibrium system consists of ten equations in ten unknowns. The endogenous variables are:

$$\{C, \ell, y, \pi, w, S, \hat{A}, T, g, m\}$$

The ten equilibrium equations are the following:

$$\mu_1(1-\tau^y)w(1-\ell) = \mu_2(1+\tau^c)C \tag{16}$$

$$(1+\tau^c)C = (1-\tau^y)(w\ell+\pi) \tag{17}$$

$$w = (1-\tau^\pi)\alpha\hat{A}\ell^{\alpha-1} \tag{18}$$

$$\pi = (1-\tau^\pi)(1-\alpha)\hat{A}\ell^\alpha \tag{19}$$

$$g + m = T \tag{20}$$

$$T = \tau^c C + \tau^y(w\ell+\pi) + \tau^\pi y \tag{21}$$

$$m = b \cdot T \tag{22}$$

$$S = m^{\theta_1} \tag{23}$$

$$\hat{A} = A_0 \cdot m^{\theta_2} \tag{24}$$

$$y = \hat{A} \cdot \ell^\alpha \tag{25}$$

The system is solved taking as given the fiscal policy parameters and the structural parameters of the model. The fiscal policy parameters are:

$$\{\tau^c, \tau^y, \tau^\pi, b\}$$

The structural parameters are:

$$\{\mu_1, \mu_2, \mu_3, \mu_4, \alpha, A_0, \theta_1, \theta_2\}$$

where $\mu_1, \mu_2, \mu_3, \mu_4$ are the household preference weights over consumption, leisure, the civilian public good, and security respectively; α is the labour share in production; A_0 is the baseline productivity level; θ_1 is the elasticity of security with respect to military spending; and θ_2 is the elasticity of effective productivity with respect to military spending. The equilibrium therefore characterises the endogenous determination of all variables in the economy as a function of fiscal policy and structural parameters. The comparative statics of interest concern the response of output and household welfare to changes in b.

4 Results and Discussion

The following section presents the results obtained from the numerical solution of the equilibrium system. The analysis is organised as follows: we first establish a baseline equilibrium, then examine the effects of varying the military spending share b exogenously, followed by an analysis of the productivity elasticity parameter θ_2, the endogenous determination of b, the optimal financing instrument, and finally the role of household preferences for security.

4.1 Baseline Equilibrium

The baseline calibration sets the three tax rates at $\tau^c = 0.23$, $\tau^\pi = 0.25$, and $\tau^y = 0.30$, with a military spending share of $b = 0.5$, implying an equal allocation of total tax revenues between military and civilian expenditure. The structural parameters of the model are calibrated as follows:

Table 1: Baseline Parameter Calibration

Parameter	Description	Symbol	Value
Preference weight: consumption		μ_1	0.35
Preference weight: leisure		μ_2	0.50
Preference weight: civilian good		μ_3	0.05
Preference weight: security		μ_4	0.10
Baseline productivity		A_0	1.00
Labour share		α	0.80
Security elasticity		θ_1	0.10
Productivity elasticity		θ_2	0.10
Consumption tax rate		τ^c	0.23
Income tax rate		τ^y	0.30
Profit tax rate		τ^π	0.25
Military spending share		b	0.50

It follows a description of the parameters and their calibration. First, the preference weights sum to unity, $\mu_1+\mu_2+\mu_3+\mu_4 = 0.35+0.50+0.05+0.10 = 1.00$, which is the standard normalisation for log-linear utility functions and confirms the internal consistency of the calibration. Congruent with past research, the highest weight is assigned to leisure ($\mu_2 = 0.50$), reflecting the importance of the labour-leisure trade-off in determining equilibrium labour supply, followed by consumption

($\mu_1 = 0.35$). The preference weights for the civilian public good and security are relatively small ($\mu_3 = 0.05$ and $\mu_4 = 0.10$), consistent with the interpretation that households derive most of their utility from private goods rather than public provision.

Second, the labour share parameter $\alpha = 0.80$ is consistent with the context of a static model in which labour is the sole factor of production.

Third, the security and productivity elasticities are set equal at baseline, $\theta_1 = \theta_2 = 0.10$. Since both S and $\hat{A}$ are power functions of the same variable m with the same exponent, they take identical numerical values in the baseline equilibrium. In the following Scenarios (5 and 6) the symmetry is changed, specifically θ_2 is varied while θ_1 is held fixed, allowing the two channels to respond to military spending with different elasticities.

The baseline equilibrium yields the following values:

Table 2: Baseline Equilibrium ($b = 0.5$)

Variable	Symbol	Value
Output	y	0.4406
Consumption	c	0.1511
Labour supply	ℓ	0.3590
Wage	w	0.5918
Dividends	d	0.0531
Security	S	0.8036
Total revenues	T	0.2246
Civilian expenditure	g	0.1123
Military expenditure	m	0.1123
Effective productivity	$\hat{A}$	0.8036
Welfare	$\mathcal{W}$	-1.0149

The baseline equilibrium serves as the reference point for all subsequent comparisons. Since utility is log-linear and defined over strictly positive quantities, welfare takes a negative value throughout the analysis; the welfare-maximising allocation is therefore identified as the scenario that minimises the absolute value of the welfare loss. It is worth noting that in the baseline, security S and effective productivity $\hat{A}$ coincide numerically at 0.8036, as a direct consequence of the symmetric calibration $\theta_1 = \theta_2 = 0.10$ discussed above. Output and labour supply

remain stable across most scenarios, indicating that the primary margin of adjustment operates through wages, consumption, and the allocation of revenues rather than through aggregate production.

4.2 Optimal Military Spending Share: Scenarios 1–4

Scenarios 1 through 4 vary the military spending share b exogenously between 0.4 and 0.6, holding all tax rates and structural parameters at their baseline values. The purpose of this exercise is to identify the welfare-maximising value of b under the baseline calibration, using the fiscal allocation as the sole policy measure. The results are presented in Table 3.

Table 3: Equilibrium Outcomes: Varying b Exogenously (Scenarios 1–4)

Scenario	b	y	c	ℓ	w	d	m	g	T	$\hat{A}$	$\mathcal{W}$
Baseline	0.50	0.4406	0.1511	0.3590	0.5918	0.0531	0.1123	0.1123	0.2246	0.8036	−1.0149
1	0.60	0.4406	0.1541	0.3590	0.6033	0.0541	0.1361	0.0907	0.2268	0.8192	−1.0169
2	0.40	0.4406	0.1476	0.3590	0.5780	0.0519	0.0888	0.1332	0.2219	0.7849	−1.0170
3	0.45	0.4406	0.1495	0.3590	0.5853	0.0525	0.1005	0.1228	0.2233	0.7947	−1.0154
4	0.55	0.4406	0.1527	0.3590	0.5978	0.0536	0.1242	0.1016	0.2257	0.8117	−1.0154

The results that emerge from this analysis are as following. First, aggregate output y and labour supply ℓ remain virtually unchanged across all values of b, suggesting that the military spending share does not affect the aggregate production in the short run within this model. This is consistent with the static nature of the framework, in which labour is the sole input and production is determined by the interaction of wages and the optimality conditions of the household and firm.

Second, higher values of b are associated with greater military expenditure m, higher effective productivity $\hat{A}$, higher wages w, and higher consumption c, but at the cost of reduced civilian expenditure g. This reflects the fundamental trade-off presented in the model: reallocating revenues toward military spending enhances productivity and security but crowds out the provision of the civilian public good, consistent with the crowding-out literature reviewed above (Malizard, 2015; Laopodis, 2001).

Third, and most importantly, the welfare loss is minimised in absolute value at $b = 0.45$ and $b = 0.55$, both yielding $\mathcal{W} = -1.0154$, symmetrically around the

baseline. The baseline value of $b = 0.5$ therefore represents the welfare-maximising military spending share under the given calibration, confirming that an equal split of fiscal revenues between military and civilian expenditure is optimal in this setting. This result is consistent with the non-linear relationship between military spending and growth identified by Pieroni (2009) and Kalaitzidakis and Tzouvelekas (2011), who find that the welfare-enhancing effects of military spending are bounded by an optimal threshold beyond which further increases become detrimental.

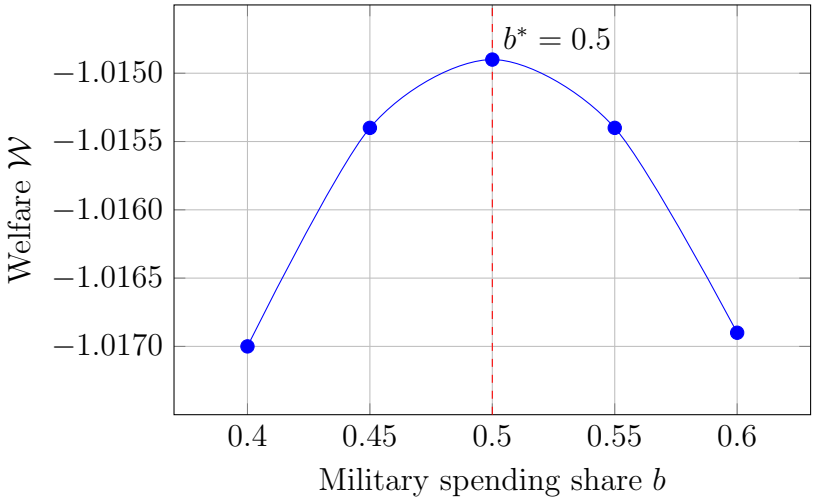

Figure 1: Welfare as a function of the military spending share b. The dashed vertical line identifies the welfare-maximising allocation at $b^* = 0.5$, corresponding to the minimum welfare loss.

This theory is further depicted in Figure 1, which illustrates the relationship between the military spending share b and household welfare $\mathcal{W}$. The curve clearly displays a minimum in absolute value at $b = 0.5$, confirming the optimality of the equal allocation identified in Table 3. The shape of the curve resembles a Laffer curve, in the sense that both increasing and decreasing b from its optimal level generate welfare losses, with the welfare function displaying approximate symmetry around $b^* = 0.5$ (Barro and de Rugy, 2013; Pieroni, 2009).

4.3 Productivity Elasticity of Military Spending: Scenarios 5–6

Scenarios 5 and 6 examine the sensitivity of the equilibrium to the parameter θ_2, which represents the elasticity of effective productivity $\hat{A}$ with respect to the military spending share m. As $\hat{A} = A_0 \cdot m^{\theta_2}$, with $m < 1$ in all scenarios, since the base m is strictly less than unity, a *smaller* value of θ_2 yields a *larger* value of $\hat{A}$ for any given m. Therefore, by keeping the baseline value $m = 0.112288$, changes in θ_2 give the following results:

- $\theta_2 = 0.05$: $\hat{A} = A_0 \cdot 0.112288^{0.05} \approx 0.899$
- $\theta_2 = 0.10$: $\hat{A} = A_0 \cdot 0.112288^{0.10} \approx 0.804$ (baseline)
- $\theta_2 = 0.15$: $\hat{A} = A_0 \cdot 0.112288^{0.15} \approx 0.714$

The two scenarios are designed to explore how sensitive welfare and the remaining equilibrium variables are to this parameter, holding $b = 0.5$ and all tax rates and other parameters at their baseline values. The results are presented in Table 4.

Table 4: Equilibrium Outcomes: Varying θ_2 (Scenarios 5–6)

Scenario	θ_2	y	c	ℓ	w	d	m	g	T	S	$\hat{A}$	$\mathcal{W}$
Baseline	0.10	0.4406	0.1511	0.3590	0.5918	0.0531	0.1123	0.1123	0.2246	0.8036	0.8036	−1.0149
5	0.05	0.4406	0.1691	0.3590	0.6621	0.0594	0.1191	0.1191	0.2382	0.8083	0.8991	−0.9721
6	0.15	0.4406	0.1343	0.3590	0.5259	0.0472	0.1059	0.1059	0.2118	0.7989	0.7141	−1.0598

The results confirm the theoretical prediction. When $\theta_2 = 0.05$, effective productivity rises to $\hat{A} = 0.899$, generating higher wages ($w = 0.662$), higher consumption ($c = 0.169$), and a substantially improved welfare of $\mathcal{W} = -0.972$. Conversely, when $\theta_2 = 0.15$, productivity falls to $\hat{A} = 0.714$, wages and consumption decline, and welfare deteriorates to $\mathcal{W} = -1.060$. Output and labour supply remain unchanged across all three cases, confirming that the productivity channel operates primarily through wages and consumption rather than through aggregate output in this static framework.

These results could be interpreted as follows: the stronger the productivity response of military spending, or equivalently, the lower θ_2 when $m < 1$, the higher

are wages, consumption, and household welfare. The outcome of the analysis is consistent with the spillover effect described in literature, particularly Mowery (2012) and Schmid (2018), who document that the civilian productivity gains from military expenditure depend critically on the degree to which defence-related technological progress diffuses to the broader economy.

4.4 Endogenous Military Spending Share: Scenarios 7–10

In Scenarios 7 through 10 the variable b is adjusted endogenously, holding either civilian expenditure g or military expenditure m fixed at $\pm 10\%$ of their baseline values. Within this framework, it is possible to examine how the fiscal allocation responds to exogenous changes in the level of one component of government spending, and to assess the welfare response of such adjustments. The results are presented in Table 5.

Table 5: Equilibrium Outcomes: Endogenous b (Scenarios 7–10)

Scenario	Fixed variable	b	m	g	$\mathcal{W}$
Baseline	—	0.500	0.1123	0.1123	−1.0149
7	$g + 10\%$	0.447	0.0997	0.1235	−1.0155
8	$g - 10\%$	0.552	0.1247	0.1011	−1.0155
9	$m + 10\%$	0.547	0.1235	0.1022	−1.0154
10	$m - 10\%$	0.452	0.1011	0.1223	−1.0154

The results show consistency within the scenarios; specifically when civilian expenditure is fixed at a higher level (Scenario 7), the model solves for a lower $b = 0.447$, implying that a smaller share of revenues is allocated to military spending in order to accommodate the higher civilian provision. Conversely, fixing g at a lower level (Scenario 8) raises b to 0.552. The same logic applies when military expenditure is held fixed: a higher m (Scenario 9) requires a higher $b = 0.547$, while a lower m (Scenario 10) is consistent with a lower $b = 0.452$.

In all four cases, welfare losses takes values around -1.015, consistent with the results obtained under the exogenous treatment of b in Scenarios 1–4. This confirms that the equal allocation of fiscal revenues between military and civilian expenditure remains the welfare-maximising outcome, regardless of whether b is

determined exogenously or endogenously. The model therefore displays stability with respect to ±10% shocks to either spending component, with the endogenous adjustment of b replicating the baseline 50–50 split. This result echoes the findings of Dangal and Gajurel (2022), who document a similar trade-off between military and civilian expenditure in panel data for SAARC and ASEAN countries, and Gbadegesin (2025), who find that the net welfare effect of military spending depends critically on the level of complementary non-military expenditure.

4.5 Optimal Financing Instrument: Scenarios 11–13

Scenarios 11 through 13 address the question of which is the optimal mean to finance military spending. Specifically, we set $b = 0.6$ and fix civilian expenditure at $g = 0.2548 \cdot y$, then allow each of the three tax rates to adjust endogenously in turn to restore budget balance. The purpose is to identify which financing instrument generates the smallest welfare loss, providing a model-based recommendation for fiscal policy. The results are presented in Table 6.

Table 6: Equilibrium Outcomes: Optimal Financing Instrument (Scenarios 11–13)

Scenario	Endogenous tax	Rate	c	$\mathcal{W}$
11	τ^y	0.5284	0.1060	−1.1350
12	τ^π	0.4323	0.1191	−1.0942
13	τ^c	0.8259	0.1060	−1.1350

The results show that financing through the profit tax τ^π (Scenario 12) generates the lowest welfare loss of $\mathcal{W} = -1.094$, with an endogenous rate of $\tau^\pi = 0.432$. By contrast, financing through the income tax τ^y (Scenario 11) and the consumption tax τ^c (Scenario 13) yield identical welfare losses of $\mathcal{W} = -1.135$, with endogenous rates of $\tau^y = 0.528$ and $\tau^c = 0.826$ respectively.

The consumption tax requires a substantially higher rate, close to four times the initial rate, to achieve the same revenue target, reflecting its narrower tax base relative to the income tax. The identical welfare outcomes of Scenarios 11 and 13 suggest that, in this model, income and consumption taxes impose similar distortions on household behaviour, consistent with the structure of the budget constraint in which both taxes enter symmetrically through the consumption-leisure

trade-off. The profit tax emerges as the least distortionary instrument, as it does not directly affect the household's optimality condition, leaving the consumption-leisure channel undistorted and generating a smaller welfare loss. This result is consistent with the findings of Barro and Redlick (2011), who document that tax-financed increases in defence spending can yield negative net effects on growth, and underscores the importance of the financing method in determining the ultimate welfare impact of military expenditure, as discussed in the cost-benefit analysis section of the literature review.

4.6 Household Preferences for Security: Scenarios 14–19

With Scenarios 14 through 19 we examine the interaction between the household preference weight for security μ_4 and the choice of financing instrument. Two values are considered: $\mu_4 = 0.15$ (stronger preference for security, Scenarios 14, 16, 18) and $\mu_4 = 0.05$ (weaker preference, Scenarios 15, 17, 19), each combined with the three tax instruments. The civilian expenditure share is fixed at $g = 0.2548 \cdot y$ throughout.

As the welfare value of security is a key parameter in the model and in this analysis, changing values of μ_4, which directly scales the utility contribution of $S = m^{\theta_1}$, provides the flexibility to further evaluate the effects of military spending on the economy and specifically to estimate the contribution of the security channel. A higher μ_4 implies that households place greater value on the security provided by military spending, which in turn affects their labour supply decision and the overall welfare evaluation of any given fiscal allocation. Understanding how this preference interacts with the financing choice is therefore essential for a complete welfare analysis. The results are presented in Table 7.

In line with existing literature, the first consideration to mark is that the preference weight μ_4 has a substantial effect on both output and welfare. More specifically, when $\mu_4 = 0.15$, households place greater value on security, leading them to supply less labour ($\ell = 0.324$ vs $\ell = 0.390$) and accept lower output ($y = 0.406$ vs $y = 0.471$). Despite lower output, welfare improves significantly to approximately -0.939, reflecting the direct utility gain from the higher valuation of security. When $\mu_4 = 0.05$, households value security less, supply more labour,

Table 7: Equilibrium Outcomes: Household Preferences for Security (Scenarios 14–19)

Scenario	Tax	μ_4	y	ℓ	Rate	$\mathcal{W}$
14	τ^y	0.15	0.4062	0.3243	0.3041	−0.9389
15	τ^y	0.05	0.4711	0.3902	0.2963	−1.0883
16	τ^π	0.15	0.4062	0.3243	0.2531	−0.9384
17	τ^π	0.05	0.4711	0.3902	0.2472	−1.0889
18	τ^c	0.15	0.4062	0.3243	0.2373	−0.9389
19	τ^c	0.05	0.4711	0.3902	0.2235	−1.0883

generate higher output, but experience a greater welfare loss of approximately −1.088. This result is consistent with the theoretical argument of Deger and Smith (1983) and Barro and de Rugy (2013), who emphasise that the welfare-enhancing role of military spending operates primarily through the provision of security rather than through direct output effects.

Second, the optimal choice of tax instruments is preserved across both values of μ_4: the profit tax τ^π generates the lowest welfare loss in both cases, confirming the robustness of the result from Scenarios 11–13. The income tax and consumption tax yield similar welfare outcomes regardless of the preference weight, ultimately suggesting that the efficiency of the profit tax as a financing instrument does not depend on the household's valuation of security.

Third, the required tax rates are substantially lower, and closer to the baseline scenario, across all instruments when $\mu_4 = 0.15$ compared to $\mu_4 = 0.05$, reflecting the lower output base and smaller revenue requirement associated with the lower labour supply equilibrium. Overall, these results highlight that household preferences for security are a crucial determinant of welfare in this model, with stronger security preferences generating lower output but substantially higher welfare, independently of the financing instrument chosen.

5 Conclusion

This thesis has examined the macroeconomic effects of military spending through a static general equilibrium model of a closed economy. By explicitly modelling

the two main channels through which defence expenditure affects the economy, namely the provision of security and the augmentation of labour productivity, the analysis provides a structured framework for evaluating the welfare implications of different fiscal allocation decisions.

The conclusions drawn from results of the nineteen scenarios are summarized below. The welfare-maximising military spending share under the baseline calibration is $b = 0.5$, implying that an equal allocation of fiscal revenues between military and civilian expenditure is optimal. This result is robust to moderate variations in the composition of government spending and holds regardless of whether the spending share is determined exogenously or endogenously. The finding is consistent with the non-linear relationship between military spending and growth documented by Pieroni (2009) and Kalaitzidakis and Tzouvelekas (2011), who identify an optimal threshold beyond which further increases in military expenditure become detrimental.

The productivity elasticity parameter θ_2 plays a central role in determining welfare outcomes. Due to the mathematical structure of the model, a lower value of θ_2 generates a stronger productivity effect and higher welfare, highlighting the importance of the degree to which military expenditure translates into efficiency gains for the broader economy, consistent with the spillover literature reviewed in Section 2 (Mowery, 2012; Schmid, 2018).

Among the three tax instruments considered, the profit tax emerges as the least distortionary means of financing an increase in military spending, as it leaves the household's consumption-leisure trade-off undisturbed, resulting in a smaller welfare cost relative to the income and consumption taxes. This finding suggests that when governments need to increase defence expenditure, the choice of financing instrument matters, broadly consistent with the argument of Barro and Redlick (2011).

Finally, the preference weight for security μ_4 is shown to be a significant determinant of welfare. Households that place a higher value on security supply less labour and generate lower output, but achieve substantially higher welfare, reflecting the direct utility gain from the public good dimension of military spending, as emphasised by Deger and Smith (1983) and Barro and de Rugy (2013).

Although the analysis has yielded significant results, in line with existing literature, there are several limitations that should be acknowledged. The static nature of the model abstracts from dynamic considerations such as capital accumulation and intertemporal optimisation. The closed economy assumption rules out trade and international spillover effects, and the model does not account for institutional factors such as corruption and rent seeking behaviour, which d'Agostino et al. (2019) show can significantly affect the estimated impact of military spending.

Overall, the analysis confirms that the macroeconomic impact of military spending is fundamentally multidimensional, mainly because the net welfare effect depends on a multitude of variables, such as: the spending share, the productivity channel, the financing instrument, and the household valuation of security, all of which interact in ways that the general equilibrium framework developed in this thesis helps to make transparent.

References

Amano, R. A. and Wirjanto, T. S. (1998). Government expenditures and the permanent-income model. *Review of Economic Dynamics*, 1(3):719–730.

Barro, R. J. (1974). Are government bonds net wealth? *Journal of Political Economy*, 82(6):1095–1117.

Barro, R. J. and de Rugy, V. (2013). Defense spending and the economy. Technical report, Mercatus Center.

Barro, R. J. and Redlick, C. J. (2011). Macroeconomic effects from government purchases and taxes. *The Quarterly Journal of Economics*, 126(1):51–102.

Benoit, E. (1978). Growth and defense in developing countries. *Economic Development and Cultural Change*, 26(2):271–280.

Berthélemy, J.-C., Herrera, R., and Sen, S. (1995). Military expenditure and economic development: An endogenous growth perspective. *Economics of Planning*, 28:205–233.

Blanchard, O. and Perotti, R. (2002). An empirical characterization of the dynamic effects of changes in government spending and taxes on output. *The Quarterly Journal of Economics*, 117(4):1329–1368.

Chowdhury, A. R. (1991). A causal analysis of defense spending and economic growth. *The Journal of Conflict Resolution*, 35(1):80–97.

d'Agostino, G., Dunne, J. P., and Pieroni, L. (2019). Military expenditure, endogeneity and economic growth. *Defence and Peace Economics*, 30(5):509–524.

Dangal, D. N. and Gajurel, R. P. (2022). Trade off between military expenditure and fixed capital formation on economic growth: Panel study of some SAARC and ASEAN countries. *Journal of Nepalese Management and Research*, 4(1):23–35.

Deger, S. (1986). Economic development and defense expenditure. *Economic Development and Cultural Change*, 35(1):179–196.

Deger, S. and Smith, R. (1983). Military expenditure and growth in less developed countries. *The Journal of Conflict Resolution*, 27(2):335–353.

Dunne, J. P., Smith, R. P., and Willenbockel, D. (2005). Models of military expenditure and growth: A critical review. *Defence and Peace Economics*, 16(6):449–461.

Elveren, A. Y., Töngür, Ü., and Myers, T. (2023). Military spending and economic growth: A post-Keynesian model. *The Economics of Peace and Security Journal*, 18(2).

European Journal of Government and Economics (2022). Effect of military spending on private investment in Nigeria: Does a crowding-out effect exist? *European Journal of Government and Economics*, 11(2):167–192.

Galí, J., Lopez-Salido, D., and Valles, J. (2007). Understanding the effects of government spending on consumption. *Journal of the European Economic Association*, 5(1):227–270.

Gbadegesin, T. K. (2025). Defense expenditure and national well-being: Evidence from the G7 countries. *Defence and Peace Economics*, 36(7):1030–1041.

Graham, F. C. and Himarios, D. (1991). Fiscal policy and private consumption: Instrumental variables tests of the "consolidated approach". *Journal of Money, Credit and Banking*, 23(1):53–67.

Kalaitzidakis, P. and Tzouvelekas, V. (2011). Military spending and the growth-maximizing allocation of public capital: A cross-country empirical analysis. *Economic Inquiry*, 49(3):1029–1041.

Kennedy, P. S. J. (2022). Applied mathematics model: The effect of national defense on economic growth seen from the supply side. *Journal of Electronics, Computer Networking and Applied Mathematics*, 2(3):5–16.

Laopodis, N. T. (2001). Effects of government spending on private investment. *Applied Economics*, 33(12):1563–1577.

Lewis, V. and Winkler, R. (2017). Government spending, entry, and the consumption crowding-in puzzle. *International Economic Review*, 58(3):943–971.

Looney, R. E. (1994). Defense expenditures, investment and crowding out: Problems of capital formation in Pakistani manufacturing. *Journal of Third World Studies*, 11(2):292–316.

Lorusso, M. and Pieroni, L. (2017). The effects of military and non-military government expenditures on private consumption. *Journal of Peace Research*, 54(3):442–456.

Malizard, J. (2015). Does military expenditure crowd out private investment? a disaggregated perspective for the case of France. *Economic Modelling*, 46:44–52.

McDonough, M. D. (2017). *The Effects of Defense R&D on Technological Progress: Resource Diversion versus Spillover Benefits*. Phd dissertation, The University of Texas at Dallas.

Mowery, D. C. (2012). Defense-related R&D as a model for "Grand Challenges" technology policies. *Research Policy*, 41(10):1703–1715.

Okur, C. (2013). The effect of defense R&D expenditures on military capability and technological spillover. Technical Report AFIT-ENV-13-M-20, Air Force Institute of Technology.

Pieroni, L. (2009). Military expenditure and economic growth. *Defence and Peace Economics*, 20(4):327–339.

Pieroni, L. and Lorusso, M. (2013). The role of fiscal policy components in private consumption: A re-examination of the effects of military and civilian spending. Unpublished manuscript.

Pieroni, L. and Lorusso, M. (2015). Are all the fiscal policy shocks identical? analysing the effects on private consumption of civilian and military spending shocks. Unpublished manuscript.

Schmid, J. (2018). The diffusion of military technology. *Defence and Peace Economics*, 29(6):595–613.

Wang, M. and Choi, B. (2023). An analysis of the impact of international R&D spillovers and technology innovation in China. *Sustainability*, 15(3):1968.

Weston, D. and Gummett, P. (1987). The economic impact of military R&D: Hypotheses, evidence and verification. *Defense Analysis*, 3(1):63–76.

Appendix: Optimisation Problems

A.1 Representative Household

The household maximises the following Lagrangian with respect to C and ℓ_h:

$$\mathcal{L} = \mu_1 \log C + \mu_2 \log(1-\ell_h) + \mu_3 \log g + \mu_4 \log S + \lambda \left[(1-\tau^y)(w\ell_h + d) - (1+\tau^c)C\right] \tag{26}$$

The first-order condition with respect to consumption C:

$$\frac{\mu_1}{C} - \lambda(1+\tau^c) = 0 \implies \lambda = \frac{\mu_1}{(1+\tau^c)C} \tag{27}$$

The first-order condition with respect to labour supply ℓ_h:

$$-\frac{\mu_2}{1-\ell_h} + \lambda(1-\tau^y)w = 0 \tag{28}$$

Substituting the expression for λ from the first condition into the second yields the optimality condition:

$$\mu_1(1-\tau^y)w(1-\ell_h) = \mu_2(1+\tau^c)C \tag{29}$$

A.2 Representative Firm

The firm maximises after-tax profits with respect to labour demand ℓ_f:

$$\max_{\ell_f} \quad \pi = (1-\tau^\pi)\hat{A}\ell_f^\alpha - w\ell_f \tag{30}$$

The first-order condition with respect to ℓ_f:

$$(1-\tau^\pi)\alpha\hat{A}\ell_f^{\alpha-1} - w = 0 \implies w = (1-\tau^\pi)\alpha\hat{A}\ell_f^{\alpha-1} \tag{31}$$

Substituting the equilibrium wage back into the profit function:

$$\pi = (1-\tau^\pi)\hat{A}\ell_f^\alpha - (1-\tau^\pi)\alpha\hat{A}\ell_f^\alpha \tag{32}$$

$$\pi = (1 - \tau^{\pi})(1 - \alpha)\hat{A}\ell_f^{\alpha} \tag{33}$$