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Democracy at a disadvantage? British rearmament, the shadow factory scheme and the coming of war, 1936-40.

By Neil Forbes (Coventry)

Armament production and the Second World War

Among the vast historical literature on the Second World War, a number of studies have tried to identify the unique features of different national economies which may help to explain why the wartime economic performance of a particular country was above- or below-average from an international perspective. In the case of the production of war materiel, rearmament in the 1930s laid down a basis for a greatly expanded output during wartime. Germany, especially, created a *Wehrwirtschaft* – a war economy during peacetime. In contrast, British rearmament had to keep step with public opinion which was only slowly relinquishing hopes of collective security. Indeed, those closely involved in preparing the nation for war became increasingly anxious at how far and how fast Britain appeared to be falling behind Germany.¹ At the centre of debates over the perceived deficiencies in Britain's rearmament programme was the question of whether, in comparison to what was possible under the coercive power of a dictatorship, a democracy would always and inevitably be at a disadvantage. However, though the dangers were hardly exaggerated, historians have pointed out that, by 1939, Britain was out-producing Nazi Germany in tanks and aircraft.² This certainly calls into question conventional interpretations of the national narrative which emphasise decline and failure. An alternative view – that Britain was a state organised around the successful prosecution of war – has been recently advanced. According to Edgerton, Britain witnessed 'exceptional mobilisation' with the coming of the Second World War; with a concentration on the production of weapons, 'liberal militarism' is said to have been a key characteristic of the state.³

This essay considers the role of *shadow factories* in rearmament. Owned by the state but built and operated by private-sector firms, these factories were established, concurrently, in Britain and Germany from the mid-1930s. Shadow production schemes were to become an important building block in the structure of several war economies. Britain's key shadow industry was the construction of aircraft for the Royal Air Force; the analysis here focuses, therefore, on the production of aero engines for bomber aircraft in the last years of peace and the early stages of the Second World War. The intention, thereby, is to test assumptions concerning Britain's readiness for war and to consider whether, in pursuing this vital aspect of the arms race, the advantage lay with liberal, democratic Britain or the National Socialist dictatorship.

The institutional and organisational context within which armaments are produced may be highly significant: ideological or political factors may act either to constrain or facilitate industrial production and technological innovation, whilst military, business and scientific

1 For a recent, authoritative study see, *J. Maiolo*, *Cry Havoc. The Arms Race and the Second World War, 1931-1941*, London 2011, pp. 142 f.

2 See, for example, *R.J. Overy*, *Why the Allies Won*, London 1996, p. 12.

3 *D. Edgerton*, *Britain's War Machine. Weapons, Resources and Experts in the Second World War*, London 2011, pp. 1-7.

elites exercise varying degrees of power and influence within a state. At the beginning of the Second World War, for example, it is argued that the comparatively low productivity in German armament production was caused by the dominance of military authorities over the civilian administration when it came to the procurement of armament goods. As Richard Overy has commented, procurement processes were carried out with virtually no co-operation between the armed services and scant attention to either rational production methods or the problems of the industrial economy.⁴

In the US, too, civilian mobilization agencies were overruled by the armed forces. Cullen and Fishback suggest that: “The military decided where contracts were allocated with little inference from the War Production Board. Economic problems in counties received virtually no systematic consideration in distributing funds [...]”⁵ But, in contrast to the German case, the dominance of military authorities in the American war economy appeared to increase rather than slow down the velocity of armament production. Clearly, if the validity of both interpretations is to be sustained, it is necessary to understand the precise role of the military in procurement in the national economies of combatants in the Second World War.

More generally, it might be misleading to make a sharp distinction between the market-oriented economies of the Western Allies and the centrally-planned economies of Russia and the Axis powers. Certainly, under the conditions of total war, the ideological distinction between democracy and dictatorship became much less obvious: the British state took emergency powers that imposed sweeping controls, whilst the Nazi regime attempted to maintain a certain level of normality in everyday life and to work together with private enterprise. It is perhaps reasonable to assume, therefore, that the requirements of fighting a material-intensive, global conflict led all warring countries to build up the same type of modern war economy, despite insurmountable ideological differences.

But this also appears to have been the case with the response to a specific problem confronting states as they re-structured their economies in order to prepare for war. During peacetime, some armament goods deemed surplus to requirements could be channelled into export trades; but it was not possible to dispose of mass-produced armaments profitably. It was necessary, therefore, to find a way in peacetime not only to produce armaments and synthetic products but also to lay down the capacity to satisfy, in the event of war, an highly uncertain level of future demand. Both Britain and Germany were driven by the need, in the mid-1930s, to achieve this political objective. Notwithstanding the contrasting ideological position of the two states, they came up with the same institutional solution at the same time: additional capacity would be provided by setting up shadow factories.

In seeking to develop a shadow capacity, both British and German governments encountered several, major complications which made the implementation of any scheme far from straightforward. Apart from the risk-aversion of private firms, these complications included decisions over whether the building-up of new armament plants should be disguised or concealed in some fashion from domestic or foreign observers, the choice of locations which were considered either less vulnerable to attack from the air or feasible from an economic

4 *R.J. Overy*, *War and Economy in the Third Reich*, Oxford 1994, p. 347.

5 *J. Cullen/P. Fishback*, *Did Big Government's Largesse Help the Locals? The Implications of WWII Spending for Local Economic Activity, 1939-1958* (Working Paper NBER W12801, 2006), p. 8.

perspective or a compromise between these two factors, the reaction of the local population to new armament plants and, last but not least, the utilization of the technological know-how of the established armament and engineering firms. It is in this context, therefore, that this essay re-examines the reasoning behind what was planned in Britain from the mid-1930s, the influence of democratic discourse on military strategising, how efficiently the shadow scheme was put into practice, and how effective it proved to be once war had broken out. Where possible, points of comparison are drawn with the shadow factory scheme that was set up concurrently in the Third Reich.

Strategy, armaments and risk-averse manufacturers

In the case of the Third Reich, several studies have analysed the relationship between armaments production and the industrial structure.⁶ By the mid-1930s the Nazi government planned and promoted a considerable increase in investment by private firms in the armament industries and in autarky – the drive to achieve self-sufficiency in strategically-important raw materials by developing industrial capacity, especially in manufacturing synthetic products. Scherner shows that instead of using coercion to enforce investment schemes, the government, in general, tried to attain the voluntary cooperation of firms by offering a set of different investment contracts. Private investors could then choose the contract type that suited their own economic objectives best.⁷ Firms did not want to risk investing in unprofitable, excess capacity and therefore based their choice of contract primarily on their expectations about the return on the respective investment.

Scherner distinguishes between short-run and long-run expectations. In the short run it was assumed that the Nazis would stick to policies of autarky and armament by means of price controls, rationing, re-allocation of labour and raw materials, protectionism and foreign-exchange control. German firms believed that such controls would last only for a transitional period; in the long run, they expected a return to a functioning and internationally-open market economy.⁸ When firms expected that a particular investment project promoted by the government would be profitable, regardless of the timescale, they were clearly interested in owning new plant and were, therefore, willing to finance it completely themselves. Alternatively, firms could choose a risk-sharing contract by which the government committed itself to finance a part of the investment project. In return, firms had to grant the government some control rights and co-determination. Many of the plants for the German synthetic fibre and synthetic rubber industry were constructed using these risk-sharing contracts.

6 See, for example, *J. Scherner*, Nazi Germany's Preparation for War. Evidence from Revised Industrial Investment Series, in: *European Economic History Review* 14, 2010, pp. 433-468, here p. 457; also, *Overy*, War and Economy, p. 245. *Overy* concentrates on state-owned and state-operated firms like the Reichswerke Hermann Göring. See also, *A. Tooze*, The Wages of Destruction: The Making and Breaking of the Nazi Economy, London 2006, p. 213. *Tooze* claims that the building-up of excess capacity in German peacetime armament production meant that war had to be contemplated not as an option but rather as an unavoidable economic consequence.

7 *J. Scherner*, Investment Contracts between State Agencies and Industry in the Third Reich, in: *C. Buchheim (Ed.)*, German Industry in the Nazi Period, Stuttgart 2008, pp. 117-131.

8 For many historical examples that confirm this view see *J. Scherner*, Die Logik der Industriepolitik im Dritten Reich. Die Investitionen in die Autarkie- und Rüstungsindustrie und ihre staatliche Förderung, Stuttgart 2008.

Lease contracts were used, in Nazi Germany, for establishing so-called army-owned factories (*Heereseigene Betriebe*), including the armament industry's shadow factories.⁹ The public-holding company Verwertgesellschaft für Montanindustrie GmbH (MONTAN), owned the factory premises and also financed the building-up of the new facilities with the help of army funds. Reputable manufacturers of armament goods like Deutsche Waffen- und Munitionsfabriken AG, Rheinmetall Borsig or I.G. Farbenindustrie were charged with supervising and accomplishing the investment projects. After a factory was completed, MONTAN leased it to a newly-founded subsidiary of the armament manufacturer which had been responsible for the construction process. This subsidiary operated the factory and paid between a half and two-thirds of its operating profits as rent to MONTAN.¹⁰ Consequently, with the help of such lease contracts, MONTAN could use the technological know-how and experience of the German armament manufacturers who were unwilling to invest in additional production capacity either by constructing the shadow factories before the war or by operating them during it.

The question of how to reorganise armaments procurement in Britain was the catalyst for inviting Lord Weir, one of the leading industrialist-technocrats of the age, to take a position at the centre of decision-making. Weir had been Director of Munitions and President of the Air Council in the First World War, served on important committees in the 1920s, and enjoyed especially close relations with leading political figures. As Hitler began to consolidate his power in Germany, Weir became preoccupied with the issues involved in organising an effective defence of Britain's vital national interests. He was invited, at the end of 1933, to meet members of the Committee of Imperial Defence. By February 1934, he had composed a long memorandum entitled "Some notes on British Policy in regard to National Defence, Peace and Disarmament", and sent a copy to his friend, Neville Chamberlain, the Chancellor of the Exchequer. Weir argued for nothing less than a wholesale restructuring of the CID apparatus. This was immediately followed up by another analysis, undertaken by Weir in conjunction with Sir Arthur Balfour (the steel manufacturer), and Sir James Lithgow (the shipbuilder) on "War Emergency Preparation". This trio of leading industrialists detailed what would have to be done to mobilise industry for armaments production in general; they thought it would be expedient to "make arrangements for the creation, at least on paper, of new shops and facilities operated by the firms".¹¹

Immediately after making his report, Weir was requested to discuss informally with the CID how some constructive proposals might be initiated and, in March 1935, Stanley Baldwin – soon to be Prime Minister – also asked Weir to help Viscount Swinton (Philip Cunliffe-Lister) to develop a new programme for the Air Force. Weir was given the unassuming title of Adviser to the Air Ministry. Indeed, he was always quick to declare to anyone in or outside Whitehall that he acted in a purely advisory rather than in any governmental or executive capacity. But he was no ordinary industrial adviser: both the public in general and those

⁹ See *B. Hopmann*, *Von der MONTAN zur Industrieverwaltungsgesellschaft (IVG) 1916-1951*. Stuttgart 1996, p. 111, 117.

¹⁰ *Ibid.*, pp. 71-76.

¹¹ University of Glasgow Archive Services, William Douglas Weir collection (hereafter UG), GB0248 DC96/21/3, letter from Secretary, CID, to Weir, 14 Dec.1933; GB0248 DC96/21/4, memos dated, respectively, 13 Feb. and 26 March 1934.

inside government immediately grasped the significance of this appointment.¹² As Weir told Baldwin, he was against doing anything that would turn industry upside down but felt that, “we must quietly but very rapidly find an effective British compromise solution as opposed to merely copying the centralised dictator system.”¹³ Within the Air Ministry, plans to establish a shadow industry for the wartime expansion of aircraft capacity had been drawn up in 1927.¹⁴ But it is Weir who is credited with being the progenitor of the shadow factory scheme.

The antecedents of the shadow scheme in Britain can be traced to the establishment of *agency* factories in the First World War. In state-industry relations the scheme demonstrated the ideological complexion of the British government by exemplifying a traditional preference for entrepreneurship.¹⁵ This seems to have extended to a belief on the part of the government that the employers concerned would find it easier to shut the factories when demand for armaments fell.¹⁶ It is certainly the case that this approach to rearmament appealed to the Conservative-dominated National Government: a shadow scheme was a way for the state to pay and own munitions factories that would, it was believed, be built and operated more efficiently by the private sector. But, just as in Germany, so too in Britain, a significant factor driving governmental policy was the knowledge that private armament manufacturers were intent on minimising the risk of investing in excess capacity.¹⁷

The British scheme was also designed to take account of the existing, severe capacity-constraints in the engineering sector of the British economy. The alternatives to using the private-sector – a state owned and operated armaments industry – would certainly have turned industry upside down. It would have required government to take powers to direct and control skilled labour and executive personnel; many feared that measures on such a scale would put the financial and economic stability of the country at risk.¹⁸ At the very least, it would have caused enormous resentment among employers. The scheme also provided a way to switch production, rapidly and comprehensively at the outbreak of war, away from civilian goods.

Reflecting on Churchill’s criticisms in 1935 concerning the enfeebled condition of Britain’s defences, Weir posed the key question: “Are we doing all we ought to anticipate by proper planning and arrangement the grave delays which were the feature of our almost fatal unpreparedness in 1914?” Weir declared himself to be fully in sympathy with Churchill in

12 Churchill Archives Centre, Cambridge, UK, Lord Weir Papers (hereafter CAC, Weir), Weir 19/1, letter, 20 May 1935, from Lord Londonderry (Secretary of State for Air) to Weir. Londonderry, referring to the great problems facing them, wrote: “Your name carries such weight and inspires such confidence in the country [...]”.

13 Quoted in, *R.P. Shay*, *British Rearmament in the Thirties: Politics and Profits*, Princeton 1977, p. 94; see also, *W.J. Reader*, *Architect of Air Power: The Life of the First Viscount Weir of Eastwood 1877-1959*, London 1968.

14 *W. Hornby*, *Factories and Plant. History of the Second World War*, London 1958, p. 24.

15 *D. Edgerton*, *Technical Innovation, Industrial Capacity and Efficiency. Public Ownership and the British Military Aircraft Industry*, in: *Business History* 26, 1984, pp. 247-279 (here pp. 256 f.).

16 *D. Edgerton*, *England and the Aeroplane: an Essay on a Militant and Technological Nation*, Basingstoke 1991, p. 75.

17 *H. Penrose*, *British Aviation: the Ominous Skies 1935-1939*, London 1980, p. 175.

18 CAC, Weir 19/2, note by Weir, 10 June 1936, “Acceleration of defence measures”. This note was drawn up after consulting Sir Thomas Inskip, the newly-appointed Minister for Co-ordination of Defence, and was circulated among ministries.

believing that little or nothing was being done.¹⁹ Thus Weir set himself the objective of pursuing the various alternative ways of increasing peacetime production and at the same time perfecting the arrangements for preparing for war.²⁰ To Churchill, and doubtless to many others, these preparations were far from obvious. He asked Weir whether he was sure he was right to lend all his reputation to keeping the country in a state of comfortable peacetime routine.²¹ But Viscount Swinton, the Secretary of State for Air, told the Committee of Imperial Defence that by erecting factories and allowing the shadow firms to gain experience, the scheme was turning this *war potential* into an actual asset. The firms were engaged in estimating how far their civil plant would be useful for war work and the extent to which it would have to be supplemented by new machinery.²² As the international crisis developed, the ideological battle intensified. Reviewing the position in the wake of the *Anschluss*, Weir believed that Britain had to avoid any admission that Germany's supposed super-efficiency in armament strength, "can only be secured by dictatorship rule. A democracy ought to be able to apply itself to these problems."²³

Rearmament for Britain in the 1930s involved making decisions about where and how to allocate resources after weighing up a bewildering array of geo-strategic issues, risk factors and opportunity costs. In addition to the existing threats posed to British interests by Japanese expansionism in the Far East, and Mussolini in the Mediterranean, German rearmament represented a new and growing danger. In March 1934, Baldwin promised the House of Commons that Britain would not accept in air power a position of inferiority to any country within striking distance of British shores. The deterrent of counter-bombing – specifically targeted against Germany – was considered the most likely guarantee of British security. The Air Ministry, therefore, drew up programmes that put emphasis not only on the production of heavy bombers but also on establishing deep reserves. The combined efforts of the Ministry and the aircraft industry to reorganise the manufacturing base were supported by the Treasury which prioritised these efforts, allowing the necessary industrial resources to be secured.²⁴ But, there were serious deficiencies and weaknesses in the performance of the British aircraft industry. The design of airframes was, for example, prioritised over production of aircraft in any quantity: most aircraft constructors comprised little more than teams of designers, with facilities for building some aircraft.²⁵ Military strategists were especially concerned at the

19 CAC, Weir, 19/12, minute, 22 Aug. 1935, Weir to P. Cunliffe-Lister, (created Viscount Swinton), Secretary of State for Air. In correspondence with Churchill, Cunliffe-Lister described Weir as "an absolute God-send".

20 CAC, Weir, 19/2, minute, 30 Jan. 1936, Weir to Secretary of State.

21 Weir 19/12, letter, 6 May 1936, Churchill to Weir. For a fuller analysis see, *Maiolo*, Cry Havoc, pp. 157 f.

22 CAC, Weir, 19/2, minutes of C.I.D. meeting, 19 Nov. 1936.

23 CAC, Weir, 19/18, note for talk with Secretary of State on 15 March 1938.

24 See *R.A.C. Parker*, *Struggle for Survival. The History of the Second World War*, Oxford 1989, p. 50; *G.C. Peden*, *British Rearmament and the Treasury, 1932-1939*, Edinburgh 1979, p. 160; *W.K. Hancock/M.M. Gowing*, *British War Economy. History of the Second World War*, London 1949, p. 66; *M. Smith*, *British Air Strategy between the Wars*, Oxford 1984.

25 *G. Stone*, *Rearmament, War and the Bristol Aeroplane Company, 1935-1945*, in: *C. Harvey/J. Press (Eds.)*, *Studies in the Business History of Bristol*, Bristol 1988, pp. 187-212; *P. Fearon*, *Aircraft Manufacturing*, in: *N.K. Buxton/D.H. Aldcroft (Eds.)*, *British Industry between the Wars. Instability and Industrial Development 1919-1939*, London 1982, pp. 216-240.

apparent disparities between the British and German aircraft industries. In 1935, the General Staff in the War Office noted that, “The political and economic organisation of the German state is more favourable than our own to the adaption by industry to the production of war equipment of every variety”.²⁶

This view was endorsed by a succession of British visitors to Germany. Lord Rothermere, the *Daily Mail* proprietor who was on friendly terms with Hitler, passed on to Weir statistics from Göring: in 1936, Germany was apparently turning out a plane every half-hour and 80 percent of the Luftwaffe fleet were bombers. Weir privately calculated this amounted to an annual output of 4700 planes – double Britain's rate. Likewise, Frederick Handley Page, the aircraft manufacturer, told Weir that he had toured the Junkers factories in Dessau and Köthen. He found it all very interesting in showing the way that Junkers was organising for mass production.²⁷ A group of senior engineers from Rolls-Royce – an aero engine as well as luxury car manufacturer – also toured German aircraft and engine factories in 1936; so concerned were they with what they saw that one of them – E.W. Hines, appointed General Works Manager that year – wrote to warn Swinton, Weir and Roy Fedden, from the Bristol Aeroplane Company.²⁸

In the face of these dilemmas, and perhaps also partly prompted by Weir's concerns, the Committee of Imperial Defence did indeed reorganise itself. A new sub-committee, known as the Defence Policy and Requirements Sub-Committee, was established in late 1935. It comprised the leading members of the Cabinet and the service ministers. The Chiefs of Staff Committee, Vansittart and Fisher (respectively Permanent Under-Secretary for Foreign Affairs and Permanent Secretary to the Treasury) served as expert advisers. At the end of the year, Sir Maurice Hankey (the Cabinet Secretary) informed Weir that Baldwin not only approved of Weir's proposals, but was appointing him to the membership of the new committee.²⁹ Although Weir was a Privy Counsellor, this was a unique distinction for someone who was not holding one of the high offices of state.

When this special committee first met, on January 13th 1936 at 10 Downing Street, it was Weir who, at Chamberlain's prompting, initiated the case for concentrating resources on air power. In a private letter to Weir, sent from his home in Edgbaston just before the meeting, Chamberlain wrote that, while he was not quite sure what the procedure was to be, “I don't want myself to make the main strategical point lest I should be thought to be prejudiced against the Army on the score of expense, and I am therefore looking to you to make the first step. I believe this was your intention [...]”.³⁰

The committee met nine times in January 1936 – an indication, perhaps, of the intractable nature of the problems confronting British policy-makers. Vansittart and Fisher consistently argued the case for a continental commitment on the part of Britain – that resources should be allocated in order to build up a field force that could help to resist a German invasion of

26 The National Archives, Kew, UK (hereafter TNA), WO 32/3593, ‘British and German Aircraft Industries’, note for the Committee of Imperial Defence, 29 April 1935.

27 UG, GB0248 DC96/21/3, letters, Rothermere to Weir, 15 March 1936, and Handley Page to Weir, 8 May 1936.

28 *I. Lloyd*, Rolls-Royce. The Years of Endeavour, London 1978, p. 171.

29 UG, GB0248 DC96/21/3, letter, Hankey to Weir, 28 Dec. 1935.

30 *Ibid.*, letter, Chamberlain (Westbourne, Edgbaston) to Weir, 9 Jan. 1936.

Western Europe. However, this ran counter to Chamberlain's strategy, which he continued to espouse after he succeeded Baldwin as Prime Minister. Chamberlain's alternative prescription – to remain isolated from the continent and to deter the German threat by building up the strength of the Royal Navy and RAF – prevailed for much of the second-half of the 1930s.³¹

British plans were based on an estimate, dating from 1931, that the requirements for aircraft and aero engines during the first year of a future war would be procured by adding five large motor car firms to the existing aircraft constructors.³² However, very quickly after taking up his new role of adviser in May 1935, Weir could see that even the peacetime demand for aero engines was likely to outstrip the means of supply. He told the Air Ministry, “The best expansion channel for this, if needed, should come from the automobile industry.”³³ Indeed, by the start of 1936, the Ministry had begun to realize that the existing firms were not going to be able to meet the current rate of demand for aircraft – 4000 per year – and that a large order would have to be placed with one or more of the big motor firms. As Sir Christopher Bullock, the Permanent Secretary, noted, the War Office had started to draw on sources outside the normal armament industry and “they will have to rely on orders placed with a shadow supply organization for meeting an appreciable part of their deficiencies”.³⁴ Bullock could see no reason in principle – as long as there was no undue dislocation of normal industry – why aircraft should not be procured in the same way.

However, one factor above all others determined the character of the shadowing of armaments production in Britain: an adequate supply of the right kind of skilled and semi-skilled labour and management expertise. The greatest barrier to expanding the output of the aircraft constructors was a shortage of workers with appropriate skills. One of the firms experiencing these difficulties was Armstrong Siddeley in Coventry. According to one Air Ministry official, the firm was forced to engage in the disputatious practice of dilution – the substitution of semi-skilled for skilled workers – because “skilled labour is now practically unprocureable in Coventry”.³⁵ Yet, paradoxically, the cause of this problem provided, at the same time, the means to solve it.

This city had a long-established background as a national centre for armaments production; the manufacture of munitions and weapons before and during the First World War had already included the participation of the new motor vehicle industry in the production of aircraft. While the Great Depression had wiped out swathes of industry, resulting in the deskilling of many workers, the Birmingham-Coventry industrial axis escaped the worst elements of the crisis by combining technologically-advanced manufacturing with traditional metal-working interests. Buoyed up by the car industry, Coventry drew in waves of skilled

31 *B.J.C. McKercher*, Deterrence and the European Balance of Power. The Field Force and British Grand Strategy, 1934-1938, in: *English Historical Review* 123, 500, 2008, pp. 98-131.

32 CAC, Weir 19/5, Defence Requirements Committee Paper, DC (M)(32) 138, April 1935, ‘British and German Aircraft Industries’.

33 CAC, Weir 19/2, Note on Rearmament, 11 June 1935. Weir believed that the aircraft industry was strong enough, at least, to construct airframes and that it wasn’t necessary to encourage large shipbuilding firms, like Harland & Wolff, to enter the industry.

34 CAC, Weir 19/1, letter, 7 Jan. 1936, Bullock (Air Ministry) to Weir, enclosing a copy of a memo to the Secretary of State.

35 *Ibid.*, letter, 12 June 1935, B.E. Holloway (Air Ministry) to Weir.

and ambitious workers, engineers and entrepreneurs and became the fastest-growing city in Britain in the interwar years.

With aircraft production made a priority, the particular expertise in engineering and metal fabrication of the motor manufacturers, and the concentration of *part-making* firms in the west Midlands, once again brought this region, and Coventry in particular, to prominence in the re-armament effort. These factors made it the obvious choice, in 1936, as the main base for the shadow factory scheme. Facilities to produce airframes, and particularly aero engines, could be located next to the existing factories of the motor companies, in order to utilise relevant skills and expertise of both managements and workers. Few, if any, alternative locations recommended themselves; the only realistic answer was to locate production in or close to those firms able to undertake the work. The willing co-operation of the existing aircraft industry was also required if the scheme was to operate effectively. A key manufacturer was the Bristol Aeroplane Company – responsible for building the Blenheim light bomber.³⁶

As the scheme progressed, earnings in the Midlands shadow factories came to be among the highest in the engineering industry. The Air Ministry felt vulnerable over the difficulties in controlling the distortions in the labour market that this caused, such as the competitive bidding up of wages as managements were released from the constraints that would have operated normally. This risked alienating other employers who did not enjoy such a privileged position. However, the scheme could also take advantage of the stance taken by the Midlands engineering firms on dilution which, in spite of the concerns of the trades unions, was not automatically considered an abnormal practice in the sector. Once war broke out, dilution was introduced rapidly on a large scale.³⁷

The layout and plant of the shadow factories were designed for quantity production rather than experimental or development work. The most important were the factories that were to produce the Mercury – the aero engine which powered the twin-engine Blenheim. The No.1 group (as it came to be called) was laid down in 1937/38; as war grew, and the need to produce a greater quantity of engines became apparent, the No.2 group was established in 1939/40. Swinton initiated the scheme when, on March 24th 1936, he wrote to the motor manufacturers – Austin (based at Longbridge in Birmingham), Morris (based in Cowley, Oxford) and Coventry-based Daimler, Rover, Rootes (in the form of its subsidiary, Hillman Motors), and Standard. The Singer car company in Coventry was also contacted but was to play a very small part in the scheme, largely because the Treasury became concerned about the financial stability of the firm.³⁸ Wolseley (Morris) dropped out of the scheme but, after a lengthy set of negotiations between the government and the companies to agree terms and conditions, contracts were finally signed in November 1937. The companies appeared to secure much of what they wanted. They were to receive what amounted to a management fee for operating the plants. But they were not required to transfer productive labour, material or equipment from their own factories to the shadow factories. Payment would also be made to

Kommentar: material or materiel here?

³⁶ Stone, *Rearmament*, p. 202.

³⁷ P. Inman, *Labour in the Munitions Industries. History of the Second World War*, London 1957, pp. 22-29, 320 f.

³⁸ TNA, AIR 2/1738; AIR 2/1821, letter, B.E. Holloway (Air Ministry) to Sir Thomas Barnes (Treasury Solicitor), 22 July 1936. Morris (Nuffield Organisation) took over the management of the Castle Bromwich Spitfire works in 1938.

the companies for work done by their technical staff in installing the machinery in the new factories and for all work undertaken in preparing machine tools, parts and other goods pending the completion of the factories.³⁹

The first group of shadow engine factories were built alongside or very near to their parent works in Coventry. Most of the land was owned by the firms and might, in any case, have been used at some point for extensions to the car plants. Extraordinarily, only after construction had begun were terms discussed for the sale of the sites. The price the Air Ministry was prepared to pay was largely determined by valuing the opportunity costs for the companies concerned. As Hillman Motors had little room to expand for their own purposes at their Humber works (where the shadow factory was to be built) and because the Ministry wished to avoid alienating Rootes (the parent company), Swinton settled quickly to get the scheme underway as speedily as possible. The price the company wanted for the land was accepted.⁴⁰ In contrast, the Ministry believed that the price sought by Daimler was grossly inflated as their works occupied a large site (the Radford Estate) with plenty of space to expand. A price – £750 per acre instead of £1500 per acre originally sought – was not agreed until September 1937. The land was not legally conveyed until February 1938, by which time the factory was in full production.⁴¹

Vulnerability

German military planners had a strong interest in hiding the location and purpose of the shadow factories from the international public. Rearmament had begun in secret to hide violations of the Versailles Peace Treaty and to avoid antagonising neighbouring powers, and, in the early years of the Third Reich, the exact dimension of the rearmament programme was concealed. During the Second World War, the planners wanted to protect the shadow factories from air raids. To realize these objectives the Nazis used both an institutional and a geographical solution to hide the plants.

As indicated, shadow factories were not run by well-known armament firms but by newly-founded subsidiaries. These subsidiaries took the legal form of a limited liability company (*GmbH*) and so did not have to reveal the type and volume of their business in annual reports, as their parent companies were required to do under stock corporation law. To enhance the deception, existing German limited liability companies which produced civil goods, and which had innocuous-sounding names, were taken over by the parent company and then used to operate the shadow factory. The shadow factories were physically hidden by locating them in rural areas – often within forests – far away from the western borders of Germany and, consequently, beyond the range of British bombers. The big disadvantage of this approach was that militarily-safe locations often lacked both the infrastructure for transporting raw materials and finished products and the workforce needed for the plants. As a result, the

39 TNA, AIR 6/45, note of meeting at the Air Ministry between Swinton, Weir and the motor manufacturers, 7 April 1936; also AIR 2/1822, note of meeting at the Air Ministry between Swinton and the manufacturers leading the scheme, 31 May 1937.

40 TNA, AIR 2/2325, minute by Swinton, 16 Aug. 1936.

41 TNA, AIR 2/2324, letter, 28 Sept. 1937 from Daimler to Capt. Davies, Air Ministry; minute, 7 Feb. 1938, by Treasury Solicitor.

optimal location of a shadow plant was often a compromise between strategic and economic considerations.

Overesch describes the careful and pains-taking process undertaken by Robert Bosch GmbH in weighing up the different factors in regard to the location of its shadow factory. In spring 1937, General Leeb, head of the Army Weapons Office (*Heereswaffenamt*), asked Bosch (based in Stuttgart) to set up a new, army-owned factory needed to manufacture starter motors and dynamos for German tanks in northern Germany. Finally, from a list of not less than 16 different small and medium-sized German towns judged suitable as a location for the new factory the town, Hildesheim was selected. Hildesheim was connected both to the Cologne-to-Berlin railway line and to the Mittellandkanal – the major German canal linking the Rhine and Elbe rivers. What is more, the town promised to provide housing for the workforce of the new firm. To hide the new factory from aerial views it was erected within a near-by forest rather than within the established town. According to the building plans no shed was made higher than the surrounding treetops. In addition, the sites of the various factory buildings were both scattered and staggered to diminish the impact of any bombing attacks not foiled by these means of deception.⁴² Another example of the strategy to locate shadow factories in rural areas, far away from Germany's western borders, were the eight shadow factories of Sprengchemie GmbH – the most important German manufacturer of gunpowder during the war. These works, operated by the traditional gunpowder manufacturer Westfälisch-Anhaltinische Sprengstoff AG (WASAG), were not concentrated in one area but were spread throughout the States of Bavaria and Prussia.⁴³

Although the isolated locations of German plants made them very difficult to spot and bomb from the air, one of the ironies of the pre-war years was that a great deal was known about some of them in Britain. In early 1935 Hitler repudiated the Versailles Treaty. Indeed, the frantic pace of rearmament became evident throughout the country and the growing strength of the Luftwaffe was even used as a propaganda weapon to cower potential enemies. But one British visitor was particularly well informed: prompted by the earlier report from Rolls-Royce, Roy Fedden twice travelled to Germany in 1937 to tour around different production facilities. His reports provided British intelligence with the last accurate and comprehensive account during peacetime of German capabilities and organisation in aircraft production.⁴⁴ That he was permitted such access is a reflection of how familial and close-knit the world of aviation was in the interwar years. Airframe design and engine technology was exchanged between British and German manufacturers such as Rolls-Royce, Supermarine, Heinkel and Messerschmitt, until the early 1930s.⁴⁵ Not only did Fedden remain on friendly terms with German apprentices he had trained in the 1920s but, as one of the leading aircraft engineers of his day – he had, for example, designed and created the Mercury engine – he was held in high respect by aircraft manufacturers everywhere.

Kommentar: Felt "State of" was better to clarify the definition.

42 M. Overesch, *Bosch in Hildesheim 1937-1945*, Göttingen 2008, pp. 40-95.

43 See J. Scherner/J. Streb, *Wissenstransfer, Lerneffekte oder Kapazitätsausbau? Die Ursachen des Wachstums der Arbeitsproduktivität in den Werken der Deutschen Sprengchemie GmbH, 1937 bis 1943*, in: *Zeitschrift für Unternehmensgeschichte*, 53, 2008, pp. 100-122.

44 W.K. Wark, *The Ultimate Enemy. British Intelligence and Nazi Germany 1833-1939*, Oxford 1986, pp. 65, 163.

45 J. Glancey, *Spitfire. The Biography*, London 2006, p. 38.

Fedden's tour included a visit to Eisenach, where BMW had a motor car plant and a shadow aero engine plant; while the former occupied a site in the middle of the town, the latter was located a mile away on the town's outskirts. What amazed Fedden was that the shadow plant was invisible from anywhere in the vicinity: "Passing through the entrance gate you suddenly come upon the different buildings of the engine plant cunningly hidden amongst the pine trees on the sides of the hill". Equally impressive was the way air raid shelters were incorporated into buildings, and the general layout and organisation of the plant. Operations had commenced in early 1936 and the 1500 workers were engaged in switching production from the Hornet – a Pratt and Whitney air-cooled radial engine – to a more powerful German version.⁴⁶

Whenever possible, new munitions plants in Britain were also built in locations away from parts of the country closest to continental Europe, even if no particular attempts were made to conceal them. Also considered, from 1935, were ways to induce the aircraft industry to transfer plants from London and surrounding district – regarded as especially vulnerable – to areas which were strategically safer. At the same time, as the Air Ministry ruefully admitted, absolute safety was becoming increasingly impossible as the range of aircraft developed.⁴⁷

In the case of shadow aero-engine factories, planners thought that they had no option but to concentrate the plants in just one city. Fedden, as part of a Bristol Aeroplane Company delegation, met with Swinton and Weir in March 1936 to discuss how to implement the shadow scheme – specifically, the production of Bristol engines. The Secretary of State raised a specific objection to the company's plan for each of the motor firms to concentrate on just one component of the aero engines. He pointed out that the destruction of one firm by bombing would have jeopardized the entire production process, and he "did not wish to add to the number of cases in which this eventuality was already dangerous."⁴⁸ Yet, because Swinton and Weir appeared concerned to defer to the aircraft manufacturers, and because it was necessary to get the scheme underway, the Bristol firm's plan was put into operation. Each of the motor firms concentrated on manufacturing different components, with Bristols and Austins undertaking the final assembly of the engines. Nevertheless, as the threat of war grew more menacing, the No.1 group's vulnerability became evermore evident. Consequently, the No.2 group was set up in a way to insure against loss by enemy bombing: the four firms involved were organised into two partnerships: Daimler and Standard formed one pair, while Rootes and Rover made up the other, with each pair manufacturing the complete engine.⁴⁹

The same arguments over the concentration of manufacturing could also be applied to situations where the sheer volume of production from a single works rendered a whole dimension of rearmament vulnerable. Weir argued that this was the case with the Rolls Royce aero engine plant in Derby and that, consequently, a shadow factory located elsewhere (but operated by Rolls Royce) was justified.⁵⁰ The Derby plant produced Merlin aero engines for the Hurricane, Hawker's single-seat fighter aircraft. But the Merlin also powered the Supermarine Company's Spitfire. By early 1938, the Air Ministry, believing that the Spitfire showed consid-

46 TNA, CAB 64/17, Report (Part II), by A.H.R. Fedden, of second visit to Germany, 2-12 Sept. 1937.

47 CAC, Weir 19/19, minute, 17 June 1935, Bullock to Secretary of State.

48 CAC, Weir 19/15, Notes of 32nd Progress Meeting, 13 March 1936.

49 For background on the schemes see, *D. Thoms, War, Industry and Society: the Midlands, 1939-45*, London 1989.

50 CAC, Weir 19/2, Note to Air Member Supply & Organisation, 11 Sept. 1936. See also, TNA.

erable potential, had decided to schedule large-scale production of the plane. Similarly, when deciding on additional airframe shadow-capacity at the end of 1937, Swinton ruled that the factories had to be located in safe areas since there could be no excuse for spending public money in establishing them in vulnerable areas.⁵¹

Thus, the British government recognised, albeit implicitly, that basing the shadow aero engine scheme in one major centre would risk turning it into a primary target for the enemy. Herein lay something of a strategic gamble: that the benefits of harnessing the motor industry – the creation of a vastly-expanded bomber force which would act as a deterrent – would mean the likely costs resulting from enemy action would never have to be faced. It was a gamble which was not, of course, to pay off: Hitler was not deterred and the costs – the devastation of Coventry – turned out to be unimaginably high.

What appeared to be the right industrial decision for Britain in the late 1930s – to cluster a high proportion of strategically-vital production in a confined, urban area – seemed sheer folly as the war progressed. Allied fortunes suffered a disastrous reversal with the Fall of France. In planning air-raid protection, the Coventry authorities seemed to recognize that the shadow factory workforce and the general population were equally vulnerable. Certainly, the Standard and Daimler works were among the armaments factories specifically targeted by the Luftwaffe on the night of the Coventry blitz (November 13th/14th 1940). Daimler's No. 1 factory in Radford was singled out for particular punishment – it was hit by an estimated 150 HE bombs and 3000 incendiaries. However, during the eleven hours the raid lasted, 43,000 homes were destroyed or badly damaged and 554 people killed across the city as a whole. In its intensity, the raid was without precedent. It is not the case that the city's defences had been neglected: with over 40 anti-aircraft guns in action, Coventry was as well protected as anywhere in Britain at that stage of the war. But, the vagaries of ground gun-control, and the inability to deploy radar-equipped night fighters, allowed all but one of the German raiders to escape unharmed.⁵²

With much of Daimler's factory severely damaged, the Air Supply Board discussed measures for the dispersal of production.⁵³ Consequently, the big raid, and another destructive one in April 1941, interrupted the policy of localisation; a limited number of shadow factory units and departments were dispersed to minor industrial centres and rural areas. It is difficult to quantify production losses at Coventry's shadow factories as a result of the bombing, but stoppages proved to be temporary. Repairs to the infrastructure (under the leadership of William Rootes) were made a priority. Moreover, as the bombing of Germany later confirmed, factory machine tools were difficult to destroy and could be repaired. Similarly, pessimistic predictions in the immediate aftermath of the 1940 raid were not realised: civilian morale did not collapse. Nonetheless, some people did leave the city, making available undamaged accommodation for the shadow factory workforce. This allowed the authorities to continue a process of voluntary billeting – much as the government had urged. In addition, by 1943 the Ministry of Labour had built 16 hostels with 8,000 places for workers in Coventry and south-east Birmingham.⁵⁴ The city therefore remained a key centre for the war effort.

51 CAC, Weir 19/9, Note of Progress Meeting, 17 Dec. 1937.

52 C. Dobinson, *AA Command. Britain's Anti-Aircraft Defences of World War II*, London 2001, p. 271.

53 TNA, AIR 2/1842, minutes 9 Dec. 1940.

54 A. Shenfield/F.P. Sargant, *The Economies and Diseconomies of Industrial Concentration. The Wartime Experience of Coventry*, in: *Review of Economic Studies* 12/2, 1944-45, pp. 96 f.

The local population

In sharp contrast to how the scheme was structured in Britain, the German shadow factories were not located in established industrialised centres but in rural, under-developed areas. The German decision to hide the shadow factories in rural regions obviously had the not unwanted side-effect of diminishing any local opposition to these investment projects. Indeed, resistance against the establishment of the new armament firms was apparently rather rare. In the case of Robert Bosch's planned shadow factory in northern Germany, the towns under consideration to host the new firm competed with each other for this investment, finally made in Hildesheim. This is illustrated by the way the chairman of the regional council in Hannover complained bitterly about the fact that Bosch had not supported the proposal by Seelz – one of Hannover's suburbs – even though a rapid supply of both additional housing and cultural entertainment for the new workforce had been promised.⁵⁵

In similar fashion, the local authorities of Britain's so-called Special and Depressed Areas engaged in intense lobbying to secure rearmament-based jobs for their regions rather than for the prosperous southern half of Britain. So many requests were received that an inter-departmental committee was set up, in 1937, to examine the issues around the location of new munitions factories. The government felt compelled to declare that its policy was to establish such factories in depressed areas, as far as practical considerations permitted.⁵⁶ But the variety of responses by local people to proposals to build shadow factories reveals a curious paradox. In principle, building a new factory meant a welcome increase in employment opportunities within a region; in practice, the precise sites selected for the new factories frequently stirred up a great deal of local controversy, even anger.

In order to achieve anything like the number of Spitfires that was required, production had to be switched from other types already being constructed by different aircraft companies and shadow capacity added to those and other companies. Initially, a site in Shrewsbury was chosen for Rolls-Royce's Merlin shadow factory. But the Ministry of Labour protested that the factory should, instead, be located in an area where there was unemployed labour. As a result, a site in Crewe was acquired.⁵⁷ Another centre selected for Spitfire production was Stockport, Lancashire – the manufacturing-base of the Fairey Aviation Company. The region was both a depressed one and farther away from an enemy's bombers than many parts of Britain. However, there then followed a protracted dispute over where to put the shadow factory and, once a site was chosen (some redundant works adjacent to Fairey's existing factory), how much land to acquire and whether it should be compulsorily purchased.⁵⁸ This district bordered a purely residential area, and preserving the latter's amenities suddenly became a major concern of the Stockport authorities. Chief among these amenities was the Heaton Moor Golf Club. The Ministry's Lands Officer visited Stockport in November 1938 and reported that the Golf Club's secretary was "very much disturbed at the prospect of the greens and tees being taken away". Fortunately, Stockport's Town Clerk was a club member

55 See *Overesch*, Bosch in Hildesheim, p. 53.

56 TNA, CAB 21/662. The first meeting took place at the Ministry of Labour on 9 Feb. 1937.

57 TNA, AIR 2/1822, notes by E.W. Hines (Rolls Royce), 21 & 23 April 1938. After the Second World War, Crewe became the production centre for Bentley cars - now in the ownership of Volkswagen AG.

58 TNA, AIR2/3304, Notes of meeting – Air Council Committee of Supply, 5 May 1938.

and was asked by the Ministry representative to offer all necessary reassurances to the club committee.⁵⁹

Because the shadow factories built in Coventry under the No.1 scheme were co-located with existing motor vehicle plants, the local authorities raised no objection over the sites and generally supported the scheme. Similarly, the level of local complaints during peacetime was muted in comparison to the protests accompanying the second phase of the shadow scheme from 1939.⁶⁰ Daimler's management wanted to develop its No.2 factory away from the city, but was instructed to build the plant within five miles of Standard's new Banner Lane works. The site selected was adjacent to Browns Lane in Allesley, a district on the outskirts of Coventry. In late June 1939, the local ratepayers and residents association objected strongly. The city surveyor had reassured them that the district was scheduled exclusively for housing; overturning this, they alleged, would be a grave breach of faith as many other, more suitable sites existed.⁶¹ However, given the intention to concentrate production in order to exploit the benefits of industrial clustering, the choice of available sites was limited.

The Council was itself upset, arguing that ordered planning – the objective of the interwar Town Planning Act – was being thwarted and even made ridiculous by the flagrant disregard of local authorities. The impact of the shadow factory scheme raised the same issues in different parts of Britain and led to the same kinds of protest. The Crown was not bound by the Act and, therefore, councils had no effective, legal means of complaint or appeal.⁶² Coventry councillors told the local Members of Parliament that they understood the “national necessities”, but that a complete lack of consultation had resulted in a choice of sites that was “haphazard” and threatened the establishment of the “green belt”. Coventry had pioneered this novel principle in planning future growth – preventing urban sprawl by preserving rural areas around built-up districts.⁶³ This now seemed to have been a waste of time and money. Building and operating the two factories involved large-scale capital projects; a new infrastructure of utility supply networks and systems, together with road construction and widening, were all soon to have a major impact. The council urged the government to set up effective administrative machinery to avoid a recurrence of actions that were “so contrary to the general public interest”.⁶⁴ Ironically, the destruction caused by bombing gave town planners opportunities to redesign an urban environment on a scale scarcely conceivable before 1940. As a result, a modernised city centre was to emerge after the war.⁶⁵

59 *Ibid.*, letter, 18 Nov. 1938, Surveyor's Office, County Borough of Stockport, to E. H. Williams, Lands Officer, Air Ministry, and note by letter, 23 November 1938. The site purchased was that occupied by the Crossley Brothers Works, Heaton Chapel.

60 TNA, AIR 2/1842, statement by residents to the council, 28 Oct. 1937 and letter, 2 Nov. 1937, from Town Clerk to Director of Works, Air Ministry.

61 Herbert Art Gallery & Museum, Coventry, UK, Town Clerk's files (hereafter HAGM), CCA/3/1/7601/1-4, letter, Residents Association to Councillor Myers, 22 June 1939.

62 *Ibid.*, letter, Coventry City Council to Capt. Strickland MP, 28 June 1939.

63 Green Belts were not formally recognised as part of a national legislative framework until 1955.

64 HAGM, CCA/3/1/7604/1-16, *Synopsis*, statement by the Town Planning and Buildings Committee, 10 July 1939.

65 For a discussion see *N. Tiratsoo, Reconstruction, Affluence and Labour Politics. Coventry 1945-60*, London 1990.

Rather curiously, the outbreak of war did not force a re-definition of this view of the public interest; if anything, the obvious need to step up the pace of rearmament heightened local concerns. In October and November 1939, directors of both Standard and Rootes wrote to the council over the slow progress of housing development. Rootes were rapidly constructing their No.2 aero engine factory at Ryton. This lay just outside of the city to the south, but it depended on Coventry for most of its facilities and amenities. The factory was expected to employ between 4,000 and 5,000 workers. But construction of a large housing-estate adjacent to the factory had been halted and Rootes were naturally anxious over how they were going to accommodate their employees.⁶⁶

Whilst the Air Ministry regretted the way the scheme had been imposed, it offered no solutions to the problems. The council believed that a “vast army of additional workpeople” was about to descend on the city. The Engineering Employers' Federation estimated an additional 35,000 workers and 15,000 dependents would migrate to the city in 1940, suddenly swelling the total population from 240,000 to almost 300,000. There was neither anywhere to house these workers nor to attend to their health or educational needs. The Ministry of Health refused to allow permission for an expanded house-building programme, encompassing some 5,000 new houses, because of raw-material shortages. Deploring the apparent absence of any constructive thought by government, the council feared the problem of how to finance the infrastructure required to meet such a rapid expansion in industrial activity put the whole future of the city at stake. Worse still, it was assumed that when armament production ceased at the war's end, the unemployed workers would have to be supported by public assistance.⁶⁷ The faith expressed in an eventual successful outcome to the conflict was clearly tinged with unhappy memories of the recession that followed the First World War.

At the beginning of 1940, Walter Elliot, Minister of Health, and representatives from relevant Ministries met Strickland, the city's MP, and leading councillors. The Minister remained unmoved by the deputation's lobbying. He urged the council to make better use of existing, empty houses and the opportunities for lodging. He pointed out that the City, itself, had asked to be made an “evacuatable” area: hundreds of children and other evacuees were being provided for voluntarily, and without resort to compulsory powers under the Defence Regulations, by the inhabitants of surrounding, rural areas. Elliot challenged Coventry's citizens to demonstrate an equal desire to help – by offering accommodation – in work of national importance, whatever the inconvenience and hardship it might cause.⁶⁸

The disputes between local and central government remained unresolved even as Britain faced, by March 1940, what was euphemistically called the national emergency. Although the government had undertaken to cover all of the costs of new roads required for the shadow factories, the financing arrangements for improving existing roads had been left undecided. The council offered to pay for air-raid shelters, including ones to accommodate the shadow factory workforce, if the government would pay for most of the road improvements;

66 HAGM, CCA/3/1/7601/1-4, letter, 15 Nov. 1939, Col. J.A. Cole (Rootes Securities Ltd) to Town Clerk, Coventry.

67 HAGM, CCA/3/1/7604/1-16, Coventry City Council, notes, 7 Dec. 1939.

68 HAGM, CCA/3/1/7601/1-4, letter, Strickland to Elliot, 12 Dec. 1939; memo, Ministry of Health, 5 Jan. 1940.

the councillors claimed that “it will be an advantage for the Government and the local authority to work in friendly co-operation.”⁶⁹

Knowledge transfer

Decision-makers in both Britain and Germany recoiled from the idea of state-run armament firms. Instead, shadow factories were financed and leased to private enterprise because this procedure was the most promising way to make use of the know-how of established manufacturers who knew better than state administrators how to set up and operate these factories. In Nazi Germany, the new shadow factories were often placed hundreds of kilometres away from the traditional location of a particular armament manufacturer. It seems likely that the wide geographical distances between parent company and new subsidiary made knowledge transfer difficult. In the case of Robert Bosch’s shadow factory in Hildesheim, for example, managers had to deal with the problem that the local workforce did not reflect the level of human capital that was needed for the demanding production of starters and dynamos. As a result, Bosch sent master craftsmen from the parent company in Stuttgart to Hildesheim to train unskilled workers – the only ones who were available. This training programme, set up more than one year before production actually commenced was, apparently, made more difficult by the differences in culture, religion and dialect between instructors and trainees.⁷⁰

Similarly, Scherner and Streb have attempted to evaluate the extent of knowledge transfer between the different works of Sprengchemie by comparing their respective labour productivities. In theory, managers of a well-established factory should have learnt, while running the works, how to increase labour productivity by technological and organisational improvements; this additional knowledge, it is assumed, would have been communicated to the management of a newly-founded factory, thereby obviating any need for learning-by-doing. At first glance, knowledge transfer within Sprengchemie was indeed successful: labour productivity at the newly-founded factories was nearly as high as that, in the same year, for the actual productivity leader which had been practising learning-by-doing for several years. But, the capital endowment of Sprengchemie’s newer works was, in general, considerably higher than that of the older works and, when this is taken into consideration, there would appear to be little evidence of successful knowledge transfer between the firm’s different factories.⁷¹

Naturally, care must be taken in interpreting such results: whilst they might reveal that knowledge transfer from factory to factory was difficult, they do not prove that the difficulties increased with geographical distance. However, it is possible to reach a tentative conclusion here that the strategy of dispersing German shadow factories across the eastern hinterland might have come with the price that knowledge transfer was made more difficult than was the case in Britain. If geographical distance did in fact impede inter-factory knowledge transfer, the decision to locate shadow factories far away from the parent company rather than in the immediate neighbourhood would have led, *ceteris paribus*, to a comparative disadvantage for Germany in the arms race with Britain.

69 HAGM, CCA/3/1/7606, letter, 11 March 1940, to Sir John Nixon (Midlands representative for the Air Ministry) from the Policy Advisory Committee, Coventry City Council.

70 See, *Overesch*, Bosch in Hildesheim, pp. 164-166.

71 For more details see *Scherner/Streb*, Wissenstransfer, Lerneffekte oder Kapazitätsausbau, pp. 100-122.

In Britain, parts of the aircraft industry were bitterly opposed to the idea as a whole of shadow production based around the vehicle manufacturers. In late 1934, Rolls-Royce argued that it would be better to invest in its factory in Derby in order to equip facilities for finishing and assembling additional parts produced by sub-contractors. In the years that followed, Rolls Royce maintained this view of how the country's productive capacity could be most rapidly and effectively increased. When the first shadow factories were built, Rolls-Royce admitted that the facilities were modern but claimed that there was no technical organisation to support them and that they relied entirely on the parent aircraft firm for all the creative skills in relation to design, materials and production methods. Similarly, the Society of British Aircraft Constructors was also hostile to the shadow scheme: car manufacturers, they pointed out, produced standardised goods and therefore lacked the necessary flexibility to accommodate frequent modifications in design inherent in aircraft construction. There was, no doubt, a considerable element of special pleading in this criticism. The aircraft industry had a vested interest in securing continuation orders for existing aircraft types which they assumed would be a more profitable enterprise than developing new models.⁷²

To facilitate knowledge transfer between the parent motor company and the shadow factory, Britain mostly chose – as in the case of aircraft production in Coventry – to locate the latter directly in the neighbourhood of the former. The intention was to bring about external economies in production. It was assumed – not unreasonably for as long as Britain remained at peace – that the parent company's skilled workers and managers would be able to train a greatly expanded workforce coming into the shadow factory to the required high level of efficiency. The large number of ancillary firms in the region would help to facilitate the new production processes. A study completed towards the end of the Second World War concluded that the dominant factor in the shadow factory plan had been the attempt to benefit from the economy of large-scale organisation as distinct from that of large-scale production. In other words, the aim was to make the best use of Coventry's exceptionally able, higher management – an economy of entrepreneurship.⁷³

As indicated above, in organising how the technology should be transferred from the aircraft companies and set up in the new plants, the No.1 scheme went ahead on the basis of an exceptional level of sub-division, in spite of Swinton's reservations and even though some of the firms themselves seemed interested in manufacturing complete engines. The official historian characterised the scheme as, "an outstanding venture into a group organisation for shadow industry development".⁷⁴ The intention was for Bristols to educate the firms in the manufacture of relevant components, to avoid duplication, and to introduce variations in design as necessary. This arrangement, it was said, would be less disruptive to the firms' normal activities. Weir disagreed because he thought there was no time for such a plan.⁷⁵ He may have been right. The No.2 scheme was structured differently not just because of the question of vulnerability but also because a significant element of learning-by-doing emerged

72 Lloyd, Rolls-Royce, p. 150; J. Zeitlin, Flexibility and Mass Production at War. Aircraft Manufacture in Britain, the United States, and Germany, 1939-1945, in: *Technology and Culture* 36/1, 1995, pp. 46-79.

73 Shenfield/Sargant, *The Economies and Diseconomies*, pp. 79-99.

74 Horrnby, *Factories and Plant*, p. 255.

75 S. Ritchie, *Industry and Air Power. The Expansion of British Aircraft Production, 1935-41*, London 1997, p. 59.

from the experience of the No.1 group. The similarity between aero and motor vehicle engine manufacture was over-estimated: it had been assumed that the manufacture of the one could be substituted by the other just by replacing certain items of plant. By 1938, it had become clear that this was not the case, and that a fundamental replacement of plant was required.⁷⁶ Among the motor manufacturers, Standard adapted easily to the close tolerances, design changes and complex co-ordination tasks required for aircraft production, but the experience of the other big vehicle producers proved to be much less satisfactory.⁷⁷

If the aspirations for the shadow scheme proved difficult to realise before the war, they were especially challenging under wartime conditions that brought not only destruction but also raw material shortages and decision-making that was both arbitrary and increasingly centralised. As a result, shadow factory productivity up to 1942 appears to have been in line with the poor performance of the aircraft industry as a whole.⁷⁸ The development of the shadow scheme in Coventry had drawn in many workers from depressed regions, such as mining areas in south Wales, where loyalties to trade unionism were deep-rooted. Parts of the workforce appeared intent on exploiting opportunities presented by the expansionary conditions at the outset of the war: Rootes, for example, complained to the Engineering Employers' Federation about disruption in the polishing shop at its No.1 factory adjacent to the Humber Works.⁷⁹ By May 1942, the position was causing the British government great concern. Jay Llewellyn (Minister of Aircraft Production) admitted to Sir Andrew Duncan (Minister of Supply) that the excessive wage rates being paid in Coventry's shadow factories both hindered production and threatened the structure of wages – particularly the fixing of rates – in factories elsewhere in the country. Llewellyn complained that, "It is increasingly evident that the ordinary industrial negotiating machinery is powerless to remedy a situation such as has developed there."⁸⁰

Conclusions

In this essay it has been suggested that to understand the similarities and differences between the war economies of Second World War combatants it is necessary to look, first, at the underlying economic problems all countries had to deal with, and, secondly, at the particular national solutions each country found for these problems. Applying this analytical approach to the history of shadow factories in Britain and Germany yields some surprising results. Despite diverging ideological and political systems, the governments in both countries shared a common goal to build up additional capacity for producing armament goods before the outbreak of war. Their common problem was that the relevant private firms in both countries judged an investment in additional or new armament factories as very risky and unprofitable in the longer run; consequently, they declined to use their own funds for these investment projects. Given a choice between establishing either state-run shadow factories, or state-funded shadow factories operated by private operators under a lease or agency agreement, both governments opted for the second solution. This decision was driven by the

⁷⁶ *Hornby*, *Factories and Plant*, p. 254.

⁷⁷ *Zeitlin*, *Flexibility and Mass Production*, pp. 50 f.; *Penrose*, *British Aviation*, p. 178.

⁷⁸ *Stone*, *Rearmament*, p. 194.

⁷⁹ *R. Croucher*, *Engineers at War 1939-1945*, London 1982, pp. 77 f.

⁸⁰ TNA, AVIA 15/853, copy letter, John (Jay) Llewellyn to Sir Andrew Duncan, 19 May 1942.

belief, again shared by both governments, that in contrast to the state, the traditional armament and vehicle manufacturers, rather than the state, had the technological know-how to commission and operate these new factories.

By mostly locating shadow factories far away from traditional industrial centres, Germany's policy on shadow production contrasted with Britain's approach, at least before the outbreak of war. British policy led, of course, to advantages and disadvantages that were diametrically opposite to the German ones. The German solution had two, main advantages: first, the shadow factories could be hidden in rural areas, or even forests, reducing their vulnerability to attack from French and British bombers; secondly, the local authorities welcomed rather than opposed the investment, which often promised to take the form of a modernisation programme for their underdeveloped regions. There was, however, a major shortcoming in the German strategy: the large geographical distance between parent company and new subsidiary, as well as the insufficient supply of skilled workers in rural regions, might have impeded knowledge transfer and, in turn, reduced labour productivity in shadow factories in comparison to the armament manufacturers' established works.

Despite the differences in the British and German shadow schemes, the fundamental solution to the underlying economic problem – how to utilise the know-how of private armament and other manufacturers who were unwilling to invest – was the same in both countries. Armaments policy was driven less by ideological objectives and rather more by economic exigencies. In a broader perspective, the task of preparing to fight a material-intensive modern war, such as the Second World War, may have led to very similar, national solutions for internationally shared, economic problems.

Nevertheless, the part played by ideological factors in determining how successful Britain and Germany were in implementing the respective schemes was far from insignificant. In setting out to create an effective, British compromise solution, Lord Weir may have achieved his objective: a detailed analysis of the shadow factory scheme suggests that, by the end of the 1930s, Britain's progress in preparing for war was both rapid and extensive. At the same time, Weir's hopes that in producing armaments a democracy ought to have been able to compete on equal terms with a dictatorship were severely tested. A democracy, by its very nature, provides mechanisms for the representation and reconciliation of a diversity of interests. The peacetime British state was not politically disposed to intervene in industry, or to direct labour, or to acquire land for factory construction by exercising compulsory powers. In making Bristol aero engines the priority for shadow production, Britain's new factories were placed in the immediate geographical neighbourhood of the parent motor company. But the planning and execution of this policy was carried out only after the interests of the relevant aircraft manufacturer had been taken into account and after frequently lengthy and tortuous negotiations had been undertaken with the motor companies.

The coming of war demanded a vast increase in productive capacity and Britain's shadow factory scheme was expanded accordingly. Yet, under the conditions of the phoney war, local authorities continued to guard jealously their rights related to local autonomy and accountability; this added a layer of complexity to decision-making and acted to retard the progress of the scheme. There was no sense that Britain's potentially dire geo-strategic predicament required drastic remedies. However much the British public supported the central government in an unified effort to engage in fighting a long conflict, local interests did not always

sit easily with the more immediate dictates and demands of the war. The constraints and limitations imposed by democracy on the mobilisation of resources put the British state at a comparative disadvantage in the race to re-arm against the Nazi dictatorship.

Neil Forbes: Democracy at a disadvantage? British rearmament, the shadow factory scheme and the coming of war, 1936-40.

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Abstract

This essay focuses on a problem confronting most advanced, industrial states as they prepared for and then engaged in fighting a material-intensive, modern war: how to produce armaments and synthetic products in peacetime but also establish capacity to satisfy a future and uncertain level of demand during wartime. In establishing "shadow factories" which were state-owned but built and operated by risk-averse, private-sector firms, Britain and Germany appeared to produce very similar national solutions for internationally-shared, economic problems. Rearmament policies were driven much less by ideological objectives and far more by economic exigencies. However, this essay examines how a combination of economic, political and strategic factors structured the operation of the shadow factory scheme in Britain. In contrast to interpretations that emphasise Britain's readiness for conflict, the evidence offered here suggests that the constraints imposed by democracy on the mobilisation of resources placed Britain at a disadvantage at the outset of the Second World War.

Keywords: Britain, Germany, Second World War, Democracy, Rearmament, Shadow Factories

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