

Did Swedish Ball Bearings Keep the Second World War Going? Re-evaluating Neutral Sweden's Role[†]

ERIC B. GOLSON[‡]

This paper examines the Swedish ball bearings industry during the Second World War, including subsidiary operations in Germany and the United Kingdom.¹ It determines that these ball bearings were very important to the war effort in both countries, comprising in total about 58% of German supplies and 31% of British. Despite favouring Germany with more exports, the Swedish government allowed the British access to Swedish territory to ensure the delivery of the bearings through the German blockade. In relation to price increases for other exports, prices for ball bearings were time-dependent on the position of the acquiring country. From an overall perspective, the United Kingdom received a discount which Germany did not share. However, with the exception of direct exports, representing respectively about 10% and 15% of total German and British supplies, it would have been difficult for the Swedish industry to withhold all supplies of ball bearings to either belligerent.

Keywords: Second World War, Ball Bearings, Trade, Sweden.

JEL Classifications: N14, N44, N74, N84

[†] The author wishes to thank B. Karlsson and W.P. Howlett for their advice and guidance. The author also benefited greatly from the comments of participants at the Economic History Association (Evanston), Economic History Society (Cambridge), World Economic History Congress (Utrecht), Nuffield College, University of Oxford, the German Historical Institute (Washington DC), and the Economic History Department seminars at the London School of Economics. This version: 23 August 2011. Please do not cite without permission.

[‡] PhD Candidate, Economic History Department, London School of Economics, Houghton Street, London WC2A 2AE. E-mail: e.b.golson@lse.ac.uk

¹ For the purposes of this examination, the term "ball bearings" includes ball bearings, roller bearings and, if applicable, their associated balls and rollers.

Introduction

Just over thirty years ago, Scandinavian Economic Historians were absorbed in a lively debate over the extent to which Sweden aided the German war effort. In the most famous of the articles during this period, Alan Milward demonstrated that denying Swedish iron ore to Germany could not have stopped the war;² eight years later, Martin Fritz's study of ball bearings concluded that Sweden did not provide sufficient aid to the German war effort to change the course of the war.³ Although this debate ended formally in the late 1970s, many questions were left unanswered. The most puzzling is why so much diplomatic effort was put into policies of the international supply of ball bearings if they seemed so unimportant to post-war commentators.⁴ A fresh examination of the ball bearings industry in the Second World War indicates that Swedish-controlled ball bearings were crucial to both the German and British war effort. Of the two, the Swedish parent company supplied more ball bearings and machine tools to the Germans, enough to significantly affect the outcome of the war. But the Swedish government's overall wartime activities were more even-handed than the headline trade statistics might suggest, for example, letting British planes and ships run the blockade from Sweden in 1942. But, although it nominally controlled much of the production of German and British ball bearings, denying either belligerent Swedish-supplied bearings or machines would merely have slowed the war effort, not ended it.

Ball and roller bearings are speciality engineering products which use balls to reduce rotational friction and support loads by separating moving axles. During a war, they are particularly useful in airplane motors, tanks, automobiles, guns, submarine engines and similar war materiel. During the Second World War, ball bearings and the machinery for producing them were among the most sought-after and disputed products. The Swedish company SKF controlled the requisite high-strength raw materials, machine tools,

² Milward, Alan S., "Could Sweden have stopped the Second World War?," *The Scandinavian Economic History Review*, vol. XV, 1967, 127-138.

³ Fritz, Martin, "Swedish Ball-Bearings and the German War Economy," *The Scandinavian Economic History Review*, vol. XXIII, 1975:1, 15-35; partially reprinted in Fritz, Martin, "Swedish iron ore and ball-bearings in the German War Economy" in *The Adaptable Nation: Essays in Swedish Economy during the Second World War*, Ed. Martin Fritz. Stockholm: Almqvist & Wiksell, 1982.

⁴ Fritz, Swedish Ball-Bearings and the German War Economy, 35; National Archives (Kew Gardens, London, UK) [NA] SUPP 14/90, report entitled "Ball, Roller and Taper Roller Bearings," dated 21 June 1951.

intellectual property and patents necessary to produce the highest quality finished product in Sweden and SKF's subsidiary factories in many European countries.

In the case of both Germany and the United Kingdom, there were two different levels of Swedish ball bearings supply: imports and Swedish-controlled local products. The parent company, *Svenska Kullagerfabriken* (SKF), produced and directly exported ball bearings to both the belligerents. SKF also part-owned local manufacturing facilities in both, producing ball bearings which were not limited by Swedish government export quotas and restrictions; although only part SKF-owned and therefore out of the parent company's direct control, these subsidiaries relied on SKF supplies of Swedish-built machinery and technical knowledge transfers. SKF Subsidiaries included the *Vereinigte Kugellagerfabriken AG* (VKF) concentrated in Schweinfurt, Germany, SKF Industries in Philadelphia, Pennsylvania, USA, and the Skefko Ball Bearing Company, in Luton, England, as well as other subsidiaries throughout occupied Europe.⁵ Together with its subsidiaries, SKF held a near monopoly position in the manufacture of high quality ball bearings in Europe. While each country had other domestic ball bearings producers, to paraphrase an American report, none was able to acquire the raw material and requisite intellectual knowledge to produce bearings as robust and durable as those of SKF.⁶

The first and second parts of this article thematically review the relations between Sweden and Germany and between Sweden and the UK. The Swedish company ultimately controlled about 58% of German and 31% of British supplies. Sweden rarely honoured its agreements on ball bearings exports. Changes in quantities delivered and prices depended on the relative strength of the recipients.

The third part of this study concerns the main question: given their control over supplies, could SKF have stopped the Second World War? As this paper shows, had either country's supply chain been interrupted in the early phase of the war, the degree of mechanization and possibly the outcome of the war would for a while have been affected. But ultimately the lack of direct Swedish imports could have been overcome by long-term industrial changes and import substitution programmes; the success of these programmes would depend on the quality of the bearings required and their final industrial application.

⁵ Fritz, Martin and Karlsson, Birgit, *SKF: A Global Study, 1907-2007*. Stockholm: Informationsförlaget, 2006.

⁶ National Archives and Records Administration (Washington DC) [NARA] RG107/160/925, report entitled "The Swedish Ball Bearing Business," draft dated May 1944, in file marked "General Ball Bearings SKF," 9.

How Sweden could have withheld these exports and whether it would have been politically and economically feasible remain very much in question.

Germany

**Table I: German Supplies of Bearings with Swedish Origin
(in millions of nominal Kronor and percentages)**

Year	Swedish Origin Production		Total Swedish Controlled Production for Germany	Total German Production + Imports	Swedish Production as a % of German Supply
	VKF Production in Germany	SKF Exports to Germany			
1937	131	3.9	135	232	58%
1938	155	6.6	162	283	57%
1939	175	7.9	183	324	56%
1940	190	14	204	358	57%
1941	215	24	239	407	59%
1942	249	33	282	478	59%
1943	250	46	-	-	-
1944	195	-	-	-	-

Sources: Fritz, Martin. "Swedish iron ore and ball bearings...," Table 7, "Total German and VKF Ball-Bearing Production 1937-44 (millions of RM); NARA RG242/T-71/108/611492-05, memo entitled "Der Außenhandel Deutschlands 1943," Reichsministerium für Rüstung und Kriegsproduktion; RA UDA/1920ds/HP64Ua/2800 SKF memo dated 10 June 1944. NARA RG107/160/925, "Swedish Exports of Bearings 1943 as Compared with 1942," memo entitled "Ball Bearings" from Neff dated 13 March 1944.

German Imports from Sweden

The growth in German purchases of Swedish ball bearings violated the 1939 Anglo-Swedish War Trade Agreement.⁷ As Table I illustrates, more than 58% of German ball bearings production can be traced to Sweden and SKF. Despite Allied efforts to limit them, direct SKF exports from Sweden provided 10.5% (by nominal value) of all German production.⁸ All Swedish exports were technically controlled by various War Trade Agreements. These Agreements were typically negotiated in parallel by the Swedish government based on British and German lists of acceptable goods. Once quotas were established, Swedish companies received export permits.⁹ The Swedish government was bound by a 1939 agreement with the British to maintain exports to Germany at or below

⁷ NA FO837/897.

⁸ Fritz, "Swedish Iron Ore and Ball Bearings," 28; NA CAB66/49/6, Table I, "Anglo-American Differences over Blockade Measures," dated April 1944, page 2. British figures indicate, with SKF providing 22% of German production, that 1943 saw the most annual imports. This cannot be verified with available German statistics.

⁹ See Calgren, W.M., *Swedish Foreign Policy during the Second World War*. Ernest Benn: London, 1977.

1938 levels.¹⁰ In the area of ball bearings, measured either in nominal or real Kronor, Swedish exports broke this agreement throughout the wartime period.

Most studies suggest exports increased nominally through the war at an *annual rate* of 42%, from 7.9 million Kronor in 1939 to 45.5 million in 1943.¹¹ However, if nominal price increases of 49% from 1938 to 1943 and the changing boundaries of the German trade bloc are allowed for, the *annual increase* in real Kronor of production sent to Germany is 35%.¹²

German Domestic Production

About half the production of German ball bearings, mainly in Schweinfurt, was controlled by *Vereinige Kullagerfabriken AG* (VKF).¹³ Although SKF had no operational control, the VKF factories were almost entirely Swedish in origin, apart from labour and energy inputs: they were developed with Swedish capital, employed Swedish designs/intellectual property and used Swedish machine tools.¹⁴ As Table I indicates, VKF provided approximately 52% of the bearings produced in 1942, the last wartime year with reliable figures.

Machines and supplies for normal operation and increased capacity were provided by SKF. VKF grew proportionately in the run-up to the war, with VKF's Schweinfurt plant capacity increasing by 50% in 1938.¹⁵ In late 1943 it tried to expand again, to make up for decreasing exports from Sweden.¹⁶ Table I shows that VKF increased its nominal production overall by 45% from 1939 to 1943, about 11% *annually*, largely thanks to SKF machines. SKF's provision of machinery to VKF can be described as crucial for maintaining and increasing plant production in this period – 48% of Germany's supplies of bearings were Swedish-related.

¹⁰ NA BT11/140

¹¹ See Fritz, *Swedish Iron Ore and Ball Bearings*, page 28.

¹² RA UDA/1920ds/HP64Ua/2897, table dated 10 July 1943.

¹³ See Table I.

¹⁴ NARA RG107/160/925, report entitled "The Swedish Ball Bearing Business," draft dated May 1944, contained in file marked "General Ball Bearings SKF."

¹⁵ Riksarchivet (Stockholm, Sweden) [RA] UDA/1920ds/HP64Ua/2897, correspondence dated September to November 1944; Fritz, Marin and Karlsson, Birgit, *SKF i stormaktspolitikens kraftfält: Kullagerexporten, 1943-1945*. Novum Grafiska AB:Gothenburg, 1998; Fritz and Karlsson, *SKF: A Global Study, 1907-2007*; RA UDA/1920ds/HP64Ua/2800, 2897-2898, various.

¹⁶ Fritz, *Swedish Iron Ore and Ball Bearings*, p. 29.

Allied Action to Limit German Ball Bearings

Allied pre-emptive attempts to end this Swedish-German trade were only partially successful, given the nature of the supply chain in question. By late 1943, the Allies were treating ball bearings as one of the “choke points” in Germany’s war economy.¹⁷ The Americans and British collaborated to limit both German domestic production and Swedish imports.¹⁸ Germany produced less because of Allied bombings in August and October 1943, which damaged VKF’s factories in Schweinfurt.¹⁹ As Table I indicates, VKF production declined by about 23% in 1944 to a nominal 195 million Kronor. However, although these activities reduced the supply of bearings, their impact came only in late 1944, when Germany had begun to lose the war.

The Allies also pressured the Swedish government, and later SKF, to reduce ball bearing and machinery exports to Germany.²⁰ As part of the Tripartite War Trade Agreement regulating 1944’s trade, Sweden agreed in 1944 to lower its ball bearings exports to the German bloc to 29 million Kronor,²¹ about a third over its 1943 level.²² However, Sweden would not accept Allied request in early 1944 to reduce all exports to Germany.²³ The Commercial Department of the Swedish Foreign Office cited agreements with Germany and the 1944 quotas established in the Tripartite Agreement.²⁴ Such levels remained unacceptable to the Allies, who pre-emptively negotiated directly with SKF to end its already agreed deliveries to Germany. The Swedes did not attempt to stop these Allied activities or enforce the SKF-German contract.

Representatives of the United States Commercial Corporation (USCC) and the United Kingdom Commercial Company (UKCC) were involved in these negotiations. These two companies were responsible for all Allied pre-emptive purchasing operations.²⁵ In April 1944, the American military forces in Europe suggested paying the equivalent of 88 million

¹⁷ NARA RG107/190/925.

¹⁸ NA WO219/2201, documents dated between March and October 1944; RA UDA/1920ds/HP64Ua/2897, documents dated between 22 January 1944 and 22 April 1944.

¹⁹ NA AVIA11/7; NA WO219/2201; NA FO115/4029-4031.

²⁰ NA HS2/267, “Schweinfurt – Bombing of Ball Bearing Installations. Liaison with SKF,” correspondence dated from August 1942 to February 1944.

²¹ NA FO837/897, Tripartite War Trade Agreement dated 23 September 1943.

²² NA CAB6/29/6, although the figure of 29 million Kronor is the most frequently mentioned in Allied and Swedish correspondence and in the agreement, 26 million Kronor is also noted in several places.

²³ RA UDA/1920ds/HP64Ua/2897, documents dated between 22 January 1944 and 22 April 1944.

²⁴ RA UDA/1920ds/HP64Ua/2897, folder marked “1 April-April 30,” Aide Mémoire dated 22 April 1944.

²⁵ NARA RG234/26/19, report “Preclusive Operations in the Neutral Countries in World War II by Blanche Britt Armfield,” section entitled “Swedish Ball bearings.”

Kronor to SKF in exchange for defaulting on German contracts.²⁶ In negotiations with the American and British economic warfare offices and representatives of the USCC and UKCC, SKF agreed to severely limit exports to Germany from 13 April until 12 October 1944 for 22 million Kronor in cash. However, the American government also agreed, among other benefits, to compensate SKF the equivalent of 140 million Kronor for bombing VKF in Germany and to unfreeze SKF assets in the US (where it had been blacklisted as an enemy cooperating company).²⁷ The long list of benefits to SKF to stop exporting to Germany makes it look as though access to a neutral's production goes to the highest bidder, notwithstanding previously agreed trade patterns.

These Anglo-American tactics ultimately prevented the export to Germany of 45.9 million Kronors worth of ball bearings, machinery and other related items, amounting to 74.9% of the 1943 imports.²⁸ The outcome is not clear, but the Allies seem to have taken delivery of 20% of this amount, worth approximately 9.2 million nominal Kronor.²⁹ Sweden suspended exports after the expiry of the Allied-SKF agreement in October 1944, due to transportation problems in the North Sea.³⁰ However, despite their extraordinary costs, these pre-emptive efforts did not curtail German production.

The flexibility in the bearings supply chain meant that Swedish production could be shifted to Germany, by moving machines and steel from Sweden to Germany. In consequence, SKF exports of extra machines and suitable steel increased in 1944, allowing Germany to continue production itself and thus maintain the levels of its armaments manufacturing. After the Allied actions began to limit exports of finished products, SKF and the Swedish government agreed to increase exports of ball-bearing steel; SKF Hofors mining subsidiaries provided 20,820 tons of this in 1944, compared with an average of 12,600 tons from 1941 to 1943.³¹ Exports of machinery in 1944 were also to be 200% of 1943's total.³²

²⁶ NA WO219/2201, memo on "Status of the VKF Ball Bearing Factor and Export Position at Gothenburg, Sweden" from Spaatz (USAFE) to Eisenhower (SAC, ETOUSA).

²⁷ NA FO837/916, memorandum from Economic Warfare Division, American Embassy, London, received by Ministry of Economic Warfare dated 28 November 1944. See further correspondence on Allied-Swedish payments for SKF in NA FO 837/919 and NARA RG234/26/19.

²⁸ NARA RG242/T-71/108/611492-05, memo entitled "Der Außenhandel Deutschlands 1943," Reichsministerium für Rüstung und Kriegsproduktion; RA UDA/1920ds/HP64Ua/2800 SKF memo dated 10 June 1944. NARA RG107/160/925, "Swedish Exports of Bearings 1943 as Compared with 1942," memo entitled "Ball Bearings" from Neff dated 13 March 1944.

²⁹ NA FO836/916, letter from Stockholm to the Ministry of Economic Warfare, dated 21 November 1944.

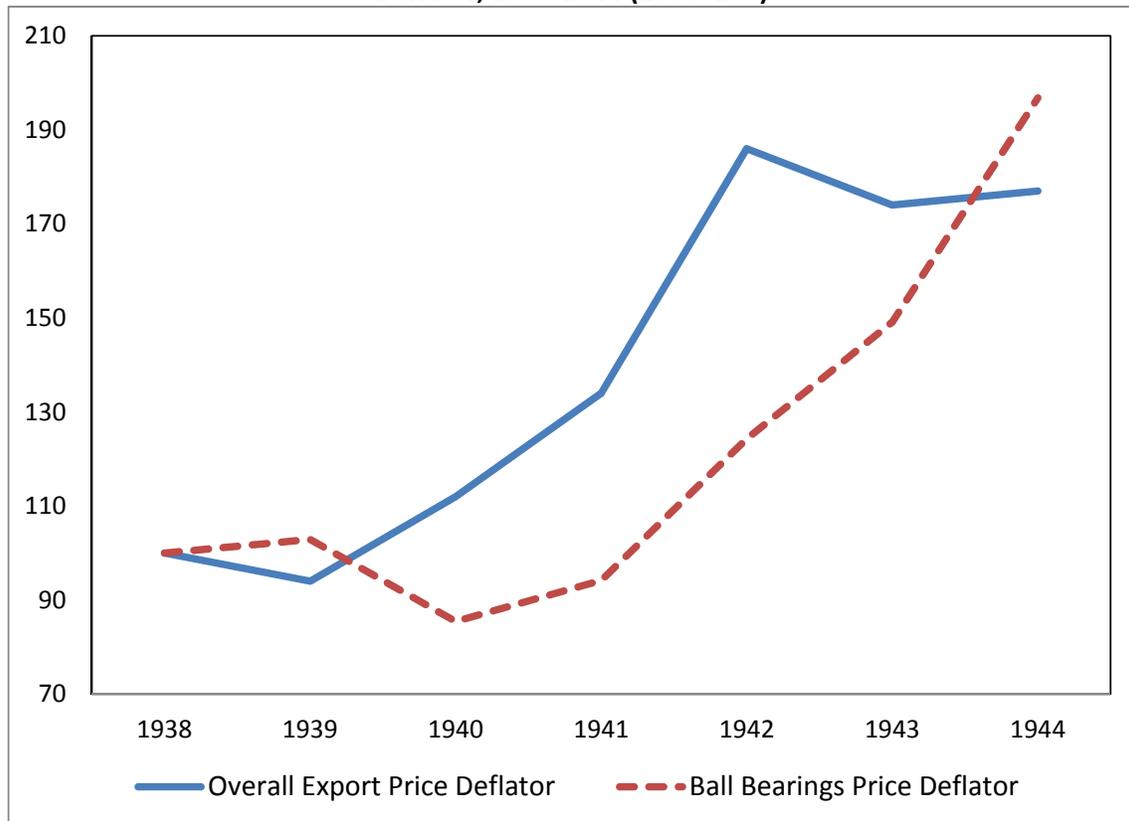
³⁰ NA FO837/916, see correspondence from April 1944 to November 1944.

³¹ Fritz, *Swedish Ball-Bearings and The German War Economy*, 24, table 4.

German armaments, aircraft and tank production continued on average in 1944 at 25% above 1943 levels, in the circumstances, probably depleting some ball bearings stockpiles.³³ Thus, these Allied activities were ineffective in the short term, and possibly too late to materially affect the German war effort.

Preferential Ball Bearings Pricing?

Figure I: German-Swedish Export Trade, Overall Price Deflator versus Ball Bearings Price Deflator, 1938-1944 (1938=100)



Source: Sveriges Officiella Statistik, *Handel Berättelse For År 1938-1945 av Kommerskollegium, 1938-1946*

According to the current political histories, SKF should have been pricing all exported ball bearings in keeping with commercial demand.³⁴ With the long waiting-lists and political pressure for them, prices should have increased significantly, certainly above overall export price index levels. However, the statistics suggest that pricing responded to non-commercial forces – increases for ball bearings do not reflect the overall export deflator for Sweden and

³² RA UDA/1920ds/HP64Ua/2800, correspondence dated between 9 October and 20 December 1943.

³³ Wagenführ, R., *Die deutsche Industrie im Kriege, 1939-1945*. Berlin: Duncker und Humboldt, 1963, 178.

³⁴ Fritz, Martin and Karlsson, Birgit, *SKF: A Global Study, 1907-2007*.

are also not necessarily volume-related. However, as Figure I shows, the export prices of ball bearings lagged behind the overall price index for Swedish exports to Germany. Despite a near 35% rise in the overall price deflator from 1938 to 1941, the export prices of ball bearings were 6% lower than in 1938. It was not until 1944, when ball bearings cost nearly double their 1938 levels that they exceeded the overall export price index, which had increased by only 77% since 1938.³⁵ Although increased quantities of ball bearings were exported, the quantities delivered in any particular year do not particularly correlate with the prices charged.

Table II: Total Exports of Ball Bearings (excluding machines) from 1938-1942 in millions of nominal Kronor; with prices relative to those charged in Germany (in percentages) and excluding transportation, duties, insurance and other ancillary costs.

Country or Countries	1938		1940		1941		1942	
	Kronor (mil)	% of German Price						
Germany	6.464	100	12.281	100	22.959	100	39.916	100
German allied/annexed territories ¹	9.144	113	8.106	114	9.039	111	3.104	99
German occupied territories ²	8.719	124	8.512	127	11.339	136	13.074	133
Neutrals ³	14.428	131	20.261	117	19.841	129	27.267	118
United Kingdom	4.289	74	3.405	70	4.630	76	3.540	68
USSR	5.520	100	2.323	89	5.271	85	1.598	83

Source: RA UDA/1920ds/HP64Ua/2897, file marked "Juli 1943 – Mars 31 1944," table marked "SKF:s Totalexport Exkl. Maskiner och Gångtappar under Aren 1938-1942," dated 19 July 1943.

Notes: Figures do not necessarily match Tables I and II because boundaries and border changes were handled differently in this report.

¹ Includes occupied France, Austria, Bohemia and Moravia, Sudetenland, Slovakia, Poland and Croatia

² Includes Norway, Denmark, Finland, Belgium, Holland, Italy, Bulgaria, Hungary and Romania

³ Includes Switzerland, Portugal, Spain, Turkey, Argentina and Sweden; for the first five, trade conducted with approval of both the Axis and Allied powers.

³⁵ Price index based on statistics from the *Sveriges Officiella Statistik, Handel Berättelse For År 1938-1945 av Kommerskollegium*, 1938-1946; ball bearings categories 1527, 1528 and 1529 included in the ball bearings index. All prices exclude shipping costs. For more information see forthcoming PhD dissertation: Golson, E.B., *The Economics of Neutrality: Spain, Sweden and Switzerland in the Second World War* (2011).

The existing view is also challenged by the preferential pricing for Germany compared with the rest of the German bloc. Table II shows that Germany also received consistent discounts for balls and rollers, compared to both the occupied territories and the neutrals, before and during the war.³⁶ The relative discount to the occupied territories increased in those years. Calculating a straight discount for the Germans, the average difference between Germany's price index and that for the neutrals is 29%.³⁷

From these examples, it is clear that someone tried to ensure that Germany paid less for these much-needed items. If SKF was setting price levels, the discounts suggest the company wanted to ensure that Germany continued to purchase Swedish-made bearings, not shifting all its sources to the German-based VKF. Another could have been a desire to prevent the full nationalisation of the German ball bearings industry. But the destruction of the SKF archives after the war prevents the exact motives from emerging.

The record for this aspect of Swedish-German trade indicates that SKF controlled most of the German ball bearings used in the German war effort; about 58% of them can be traced to Sweden. At least until 1944, SKF provided the Germans with more ball bearings than it had in 1938. This trade exceeded the levels set by the 1939 Anglo-Swedish War Trade Agreement. Allied pre-emptive attempts to limit this trade came too late and were bypassed too easily to affect the outcome. Discounts were provided.

The United Kingdom

SKF also had an important effect on the British war effort, providing some 31% of British ball bearings production, including considerable quantities for aero engines. As with Germany, Sweden's part in the British ball bearings supply chain includes both domestic production and Swedish imports. Although the archives of the British ball bearing control directorate are missing, the UK was dependent on SKF for certain aspects of bearings production. Britain was particularly short of bearings under one inch and over four inches in diameter, all important for tanks, aeroplanes and large motors.³⁸ As late as March 1943, the Controller of Bearings in the Ministry of Supply noted a severe shortage of aircraft bearings

³⁶ RA UDA/1920ds/HP64Ua/2897, file marked "Juli 1943 – Mars 31 1944," table marked "SKF:s Totalexport Exkl. Maskiner och Gängtappar under Aren 1938-1942," dated 19 July 1943.

³⁷ Table II.

³⁸ NA AVIA22/191, report entitled "Reply to the Enquiry from the Minister of Production Regarding the Ball Bearing Industry," points 2 and 3; British Airways Museum and Archive [BAMA] AW/1/6512, "Air Service – Midnight Sun Period," memo dated 26 February 1944.

which materially affected production; it was “in [his] opinion, of the gravest importance to obtain as many bearings from Sweden as possible with the absolute minimum of delay.”³⁹ Moreover, at various points hundreds of British tanks and up to 10% (1,700 units) of all British aircraft production were awaiting Swedish bearings.⁴⁰ Unfortunately it was not possible to compensate with American supplies, since bearing shortages also affected the US and Swedish metric specification bearings did not have suitable American substitutes.⁴¹

It is also significant that ball bearings were among the few items whose supply chains in America and Britain could not be integrated. Because of scarcities in the US, America could supply only 10.6% of total British requirements.⁴² As European and American ball bearings were different, many were produced for the United Kingdom by SKF Industries of Philadelphia or under license.⁴³ The war created continuing transportation problems; some shipments were sent by special military air transport flights to prevent shortages in Britain resulting in production delays.⁴⁴ Because of the poor supply situation among the Allies, The UK had to continue importing ball bearings and raw materials from Sweden. Swedish ball bearings were deemed of “overwhelming importance to our [United Kingdom] war effort” by high-level ministers.⁴⁵ Imports from Sweden were limited by the *Skaggerak* blockade, which at times prevented British access to Swedish ball bearings and to the special steels, lubricating oils and machinery for bearings required to increase Britain’s output.⁴⁶

Imports from Sweden

Direct wartime imports from Sweden provided about 15% of all British ball bearings. Blockade-running ships and airplanes were employed to maintain the British imports from Sweden. This trade was an overt choice by the Swedish government to aid the Allied war

³⁹ NA ADM199/7517, memo “Bearings from Sweden,” dated 5 March 1943.

⁴⁰ NA AVIA38/333; NA AVIA38/381; NA AVIA38/409; NA AVIA38/811; Mark Harrison, “The Economics of World War II: an overview” in *The Economics of World War II*, Ed. Mark Harrison. Cambridge: Cambridge University Press, 1998, 15.

⁴¹ NA CAB115/195, memo dated 27 August 1940.

⁴² NA AVIA22/191, report Entitled “Reply to the Enquiry from the Minister of Production Regarding the Ball Bearing Industry,” points 5 and 6.

⁴³ Due to the lack of any relevant information, no part of these US-produced SKF-related bearings are counted as Swedish bearings for the purposes of this paper.

⁴⁴ NA AVIA38/333; NA AVIA38/381; NA AVIA38/409; NA AVI 38/811; CAB115/195-197.

⁴⁵ NA CAB122/241, Mr. Eden to Viscount Halifax, 1 December 1942.

⁴⁶ See Calgren, *Swedish Foreign Policy during the Second World War*.

effort without German consent. It went against the War Trade Agreement process.⁴⁷ It can even be asserted that these naval and air journeys constituted British military operations launched from Swedish territory. For example, former military officers commanded the boats, while seconded RAF officers piloted the planes. Some carried guns and most used military evasion tactics.⁴⁸ The illicit nature of the trade, not to mention the use, docking and operation of these ships and airplanes in neutral Sweden, exposes it to the charge of being unduly biased towards the Allied cause, but the same could of course be said about supplying the Germans with bearings above the agreed levels. Whatever the circumstances, these naval and airborne exports from Sweden have not hitherto been reported as part of Swedish wartime trade. This is the first study to provide estimates. Transportation problems and shipping losses make it necessary to estimate the value of the deliveries, based on what actually arrived in Britain.⁴⁹

This illicit trade system was very unreliable: purchased ball bearings waited in Sweden for long periods before delivery.⁵⁰ Several hundred thousand bearings, equivalent to a few months' production, were still in Sweden when the war ended.⁵¹ The energy devoted to these services demonstrates how acute the British shortages were of ball bearings and similar specialised Swedish products.⁵²

⁴⁷ *Ibid.*

⁴⁸ NA BT60/68/2; NA HS7/191; NA HS8/769; Churchill Archives, University of Cambridge [CAC] BINN/1; CAC BINN/2; CAC BINN/3.

⁴⁹ Åmark, Karl, *Kristidspolitik och kristidshushållning* Statens Offentliga Utredningar: Handelsdepartment: Stockholm, 1952; Rockberger, Nicolas, *Göteborgstrafiken: Svensk lejdtrafik under andra världskriget*. Stockholm: Allmänna Förlaget, 1973, 272.

⁵⁰ NA FO954/23, for discussion of transport problems during the war, see memo "From Foreign Office to Washington," dated 13 November 1942.

⁵¹ For the final inventory of Allied bearings held in Sweden, see NARA RG107/160/225, memo from E. E. Gloss, Anti-Friction Bearing Branch, on "Supply Purchase of SKF Bearings from Sweden" dated 30 March 1945.

⁵² NA CAB122/241, memo Mr. Eden to Viscount Halifax, dated 1 December 1942; NA ADM199/7517, memo "Bearings from Sweden," dated 5 March 1943.

Table III: Illicit Swedish Trade with the Allies versus Regular Trade, 1940-1944 (in millions of nominal Swedish Kronor, as indicated)

EXPORT TRAFFIC	1941	1942	1943	1944	To May 1945
Illicit - Number of Blockade-running Ships to the UK	5	7	13	14	0
Illicit - Number of Roundtrip Flights to/from UK (bypassing the Skagerrak blockade)	0	174	320	727	369
Authorized Traffic - Number of Vessels Inbound	32	58	46	77	13
Authorized Traffic - Number of Vessels Outbound	35	62	44	78	6
EXPORTS BY VALUE	1941	1942	1943	1944	To May 1945
Illicit Exports by Ship (millions of NOMINAL Kronor)	21.1	21.6	14.3	14.3	0
Illicit Exports by Airplane (millions of NOMINAL Kronor)		1.4	6.3	13.6	7.0
Total Illicit Exports	21.1	23.0	20.6	27.9	7.0
Total Illicit Trade as a Percentage of Overall Swedish Exports to the Allies	43.4%	26.0%	85.8%	70.8%	N/A

Sources: Nicolaus Rockberger, *Göteborgstrafiken: Svensk lejdtrafik*, p.246 and p.263; NA HS7/191, report on "The Performance Operation," from Sir George Binney to Sir Andrew Duncan, Dated June 1942; CAC BINN/2, "Operation Performance;" NA BT60/68/2 "Appendix A: List of Materials Shipping from Gothenburg to England in January, 1941," from "Report by George Binney, H.M. Legation, Stockholm;" and CAC BINN/1, "Operation Rubble."

Three different militarily-supported naval operations tried to bring Swedish exports to Britain from January 1941 through late 1943. To make them harder to detect, the boats set out in the long Scandinavian winter nights. Operation Rubble, the first, used Norwegian ships piloted by British captains to transport approximately 18,600 metric tons of Swedish iron, ingots, ball bearings, machine tools, spare parts and steels of various qualities.⁵³ Operation Performance in March 1942 had to bring over approximately 19,000 metric tons of iron and steel materials, machinery and ball bearings, with 5,500 metric tons of similar material bought by Russia possibly intended to be sent on.⁵⁴ However, only seven ships of

⁵³ NA BT60/68/2 "Appendix A: List of Materials Shipping from Gothenburg to England in January, 1941," from "Report by George Binney, H.M. Legation, Stockholm;" and CAC BINN/1, "Operation Rubble."

⁵⁴ NA HS7/191, report on "The Performance Operation," from Sir George Binney to Sir Andrew Duncan, Dated June 1942; CAC BINN/2, "Operation Performance".

Operation Performance, carrying 4,838 metric tons of cargo, finished their journey.⁵⁵ The total combined value of these imports was some 42.8 million Kronor.⁵⁶

Table IV: Sweden-United Kingdom North Sea Smuggling Operations, 1941 to 1945, Exported Materials by Type

Description	% of Total	Metric Tons
Bar Iron, Pig-iron and Ingots	53.4%	26,166
Rolled Steel	26.1%	12,789
Ball Bearings & Ball Bearing Steel for SKF Luton (Skefko)	11.3%	5,437
Machine Tools for SKF Luton (Skefko)	0.2%	98
Spare parts for engines	1.2%	588
Ferro Chrome	5.6%	2,744
Other	2.2%	1,078
Total – all materials from all shipments	100%	49,000

Sources: RA UDA/1920ds/HP64Ba/2800, draft memo dated 6 December 1944; RA UDA/1920ds/HP73Ba/3314, undated table marked “Export till Storbritannien med kurirflyg under 1942;” RA UDA 1920ds/HP73Ba/3311-3317, reports marked “Översikt över flygtrafiken mellan Sverige och England under tiden...,” various dates from 1942 to 1945, and reports marked “Statistik över visa uppgifter i lastningsbeskeden för de utgående brittiska kurirflygplanen,” various dates from 1943 to 1945; BAMA AW/1/6512, “Air Service – Midnight Sun Period,” memo dated 26 February 1944.

Notes: Does not include passengers or passenger luggage. Based on data available from Operation Performance; probably understates ball bearings supply, since Swedish raw materials were given priority during this period. See limited available import statistics from FO837/905.

Less detailed figures are available for the remaining operations, but their net returns can be estimated. Operation Bridford, between October 1943 and March 1944 used British Motor Gun Boats (MGBs), manned with British crews (most seconded from the military), to carry consignments to Sweden and return with supplies of ball bearings, speciality steels, machine tools and other items.⁵⁷ In their six return voyages these boats carried an estimated 24-26,000 metric tons of material urgently required for British war production, the greater part connected with ball bearings.⁵⁸ Based on the per ton value of the Rubble

⁵⁵ NA HS7/191, page 55.

⁵⁶ *Ibid*; and RA UDA/1920ds/HP64Ba/2800, folder marked “1944, Nov 21-Dec 19,” draft memo dated 6 December 1944 to Sveriges Riksbank.

⁵⁷ NA H58/769, report on “Operation Bridford,” page 10ff; CAC BINN/3, “Operation Bridford.”

⁵⁸ *Ibid*: precise manifests do not exist - based on ships’ carrying capacity and associated notes in these reports.

and Performance cargoes, Bridford's cargoes are estimated to have been worth approximately 28.6 million Kronor, between 1943 and 1944 (calendar years).⁵⁹

On the basis of statistics from Operation Performance, the quantities of cargo can be determined by type. As seen in Table IV, Of the 49,000 tons of cargo shipped through the blockade to the UK from 1941 to 1945, approximately 5,437 tons were ball bearings and the steel for them. Some 98 tons of SKF machine tools destined for the UK subsidiary, Skefko, were also dispatched using this smuggling system.⁶⁰

The Swedish government also permitted civilian air traffic from the United Kingdom from March 1942.⁶¹ Three companies ultimately operated services from RAF Luechars in Scotland to various points in Sweden during the war: the British Overseas Airways Company (BOAC), American Air Transport Service (AATS), only from April 1944-1945; and the Swedish A-B Aerotransport (ABA). Most of the freight was carried by BOAC-operated aircraft and converted American Liberators.⁶² The cargo operations were used to transport the high-priority Swedish ball bearings necessary for aircraft production in the UK.

Detailed statistics on the number of flights, cargo and value of this illicit airborne trade can be provided. The Commercial Department of the Swedish government maintained records of the flights and exports, though not reported as part of normal trade through the Skaggerak.⁶³ As Table III shows, Swedish reports suggest that, excluding passenger luggage and similar cargo, the total goods flown to the UK increased steadily for most of the war: from 46 tons in 1942 to 448 metric tons in 1944. The air cargo consisted of very high value materials needed for the British and Allied war effort, including ball bearings, machinery and high-speed steel.

As seen in Table V, the airborne traffic resulted in a total of 725 metric tons of commercial freight. Table VI shows that of the 725 total tons shipped in the air smuggling operation, 399 tons is estimated to have been SKF ball bearings materials with an additional 43 tons of machines destined for Skefko. The remainder included American, British

⁵⁹ NA BT60/68/2; NA HS7/191.

⁶⁰ NA CAB115/197, cipher telegram dated 10 October 1942.

⁶¹ RA UDA/1920ds/HP73Ba/3311, folders marked "1940-1941" and "Jan-Feb 1942"

⁶² RA UDA/1920ds/HP73Ba/3312-3317.

⁶³ RA UDA/1920ds/HP73Ba/3311-3317, reports marked "Översikt över flygtrafiken mellan Sverige och England under tiden...", various dates from 1942 to 1945, and reports marked "Statistik över visa uppgifter i lastningsbeskeden för de utgående brittiska kurirflygplanen," various dates from 1943 to 1945.

Diplomatic, Norwegian Diplomatic, Russian, Polish and other commercial cargo.⁶⁴ These official statistics probably omit some of the more covert export operations, including possible smuggling in the nearly one metric ton of British diplomatic cargo per week, and the expropriation by Britain of the bearings meant for the USSR.⁶⁵ Unfortunately, the lack of archives for the British ball bearings control organization means these possible additions cannot be easily assessed.

Table V: Sweden-United Kingdom Air Operations, Cargo by Nationality, March 1942-May 1945 (in Metric Tons)

Year	American Diplomatic Cargo	British Diplomatic Cargo	Other Diplomatic Cargo ²	Unclassified Commercial ³	Total
1942	862	24,324	9,254	11,869	46,309
1943	0	32,845	5,810	170,119	208,774
1944	478	42,494	6,411	398,736	448,119
1945	0	17,003	0	144,684	161,687
Total	1,340	116,666	21,475	725,408	864,889

Sources: RA UDA/1920ds/HP64Ba/2800, draft memo dated 6 December 1944; RA UDA/1920ds/HP73Ba/3314, undated table marked "Export till Storbritannien med kurirflyg under 1942;" RA UDA 1920ds/HP73Ba/3311-3317, reports marked "Översikt över flygtrafiken mellan Sverige och England under tiden..." various dates from 1942 to 1945, and reports marked "Statistik över visa uppgifter i lastningsbeskeden för de utgående brittiska kurirflygplanen," various dates from 1943 to 1945; BAMA AW/1/6512, "Air Service – Midnight Sun Period," memo dated 26 February 1944.

Notes: ¹Losses accounted for on a percentage basis (see BAMA AW/1/6512); ²Includes Norwegian (11,067 MT), Russian (10,393 MT) and Polish Diplomatic Cargo (15 MT); ³Unclassifiable commercial cargo included Swedish manufactures in transit to UK intended for either the UK or Russia.

Table VI: Sweden-United Kingdom Air Smuggling Operations, 1941 to May 1945, Exported Materials by Type

	% of total	tons
Atlas Diesel Motors	6%	36
SKF Machines	6%	43
SKF Bearings	55%	399
USSR – Priority Commercial Materials	33%	239
Total Unclassified Commercial	100%	725

Sources: See Table V.

⁶⁴ *Ibid*, all dates.

⁶⁵ *Ibid*; RA UDA 1920ds/HP73Ba/3312-3317, reports marked "Statistik över visa uppgifter i lastningsbeskeden för de utgående brittiska kurirflygplanen," various dates from March 1942 to 1945;

Finished bearings from Sweden constituted a significant fraction of the UK's ball bearings supply. According to a post-war report, average annual British wartime ball bearings supplies amounted to £16 million, resulting in production from 1941 to May 1945 equivalent to 1,120 million Kronor.⁶⁶ In total, the United Kingdom imported some 5,300 tons of ball bearings from Sweden between 1941 and May 1945. Using the 1942 air shipment value of 30,393 Kronor per ton, the value of the imported bearings totals 161 million Kronor.⁶⁷ Thus, Sweden directly supplied approximately 15% of Britain's ball bearings supplies. As previously noted, they included the valuable small precision and large bearings necessary for important parts of the British war effort.

Domestic Production

Exports of machinery and similar equipment from Sweden allowed Skefko to maintain domestic production during the war. Machines and equipment sold by SKF were used at the Skefko Ball Bearings works in Luton. Although Skefko was not owned by SKF at the start of the war, SKF and Skefko had a 30-year agreement for the supply of high-speed steel, interchange of finished products, pooling of patents, designs and technical information within the group controlled by the SKF Company.⁶⁸ This arrangement continued throughout the war. Skefko's machines were dependent on imported SKF parts and materials for continued production. There are clearly documented cases of Skefko waiting for machines and machine parts from Sweden.⁶⁹ British attempts at import substitution led to increased rejection rates and mechanical wear which ultimately damaged other parts.⁷⁰

As this suggests, the lack of SKF machines and machine parts would not have stopped production but would certainly have progressively slowed it as equipment aged. No

⁶⁶ NA SUPP 14/90, report entitled "Ball, Roller and Taper Roller Bearings," dated 21 June 1951.

⁶⁷ RA UDA/1920ds/HP73Ba/3314, folder marked "1943 Febr.-April," table marked "*Export till Storbritannien med kurirflyg under 1942.*"

⁶⁸ NA CAB24/246. In 1936, SKF sold 55% of the company to British investors in what was probably a defensive measure against the perceived risk of the state seizure of arms and weapons manufacturing; after a Royal Commission had checked the feasibility of prohibiting the private manufacture of arms in 1935-1936; see "Royal Commission on the Private Manufacture of and Trading in Arms (1935-1936)." By 1943, SKF holdings were further reduced to approximately 36% of the share capital; see NARA RG107/160/925, file marked "General Ball Bearings SKF," report entitled "The Swedish Ball Bearing Business," draft dated May 1944, page 12.

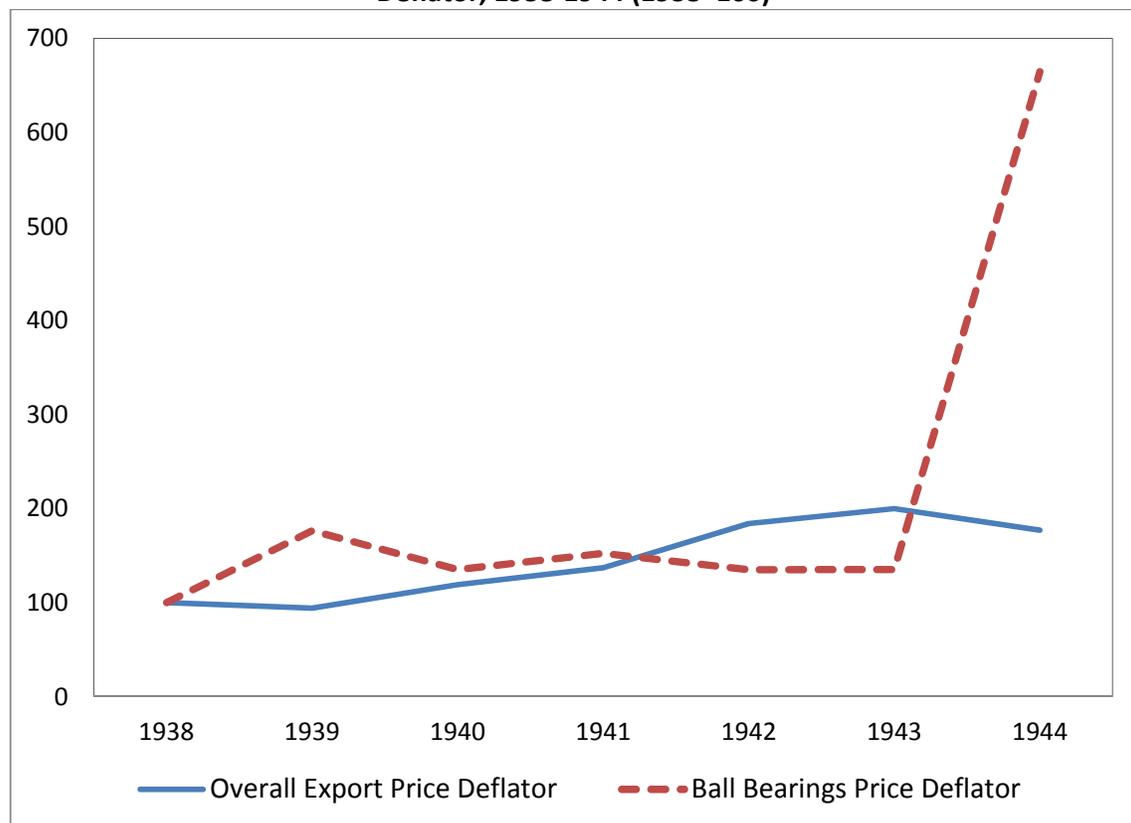
⁶⁹ NA BT60/68/2 "Appendix A" from "Report by George Binney, H.M. Legation, Stockholm;" NA AVIA11/8, Correspondence from Skefko Ball Bearing Company.

⁷⁰ NA AVIA22/1171, memos regarding the efficiency of new ball bearings installations in British dated between 1943 and 1944.

complete list remains of the materials provided, but they are believed to have included *inter alia* much needed dies, stamping machines, lathes, grinding machines, balls and rollers. According to government memoranda in 1942, Skefko had approximately 16% of the United Kingdom bearings market,⁷¹ equivalent to all a 1941-May 1945 revenue of approximately 193 million Kronor.⁷² Hence, Swedish-dependent wartime production amounted to at least 31% of British bearings supplies.

Discounts Provided to the United Kingdom?

Figure II: Anglo-Swedish Export Trade, Overall Price Deflator versus Ball Bearings Price Deflator, 1938-1944 (1938=100)



Source: Sveriges Officiella Statistik, *Handel Berättelse For År 1938-1945 av Kommerskollegium, 1938-1946*

For the direct Swedish ball bearing exports to the UK, SKF price negotiations seem to have clearly depended on political forces. Figure II reveals the prices for imported ball bearings rising faster than Sweden’s overall price index for exports to Britain. But with

⁷¹ NA AVIA22/191, report entitled “Reply to the Enquiry from the Minister of Production Regarding the Ball Bearing Industry.”

⁷² NA SUPP14/90, report entitled “Ball, Roller and Taper Roller Bearings,” dated 21 June 1951.

deliveries by plane (1942-3), prices fell below this index. The rapid rise in prices seen in 1944 is not an error, but rather the effect of British commitments under the Allied pre-emptive purchasing programme. This dramatically increased the overall cost of ball bearings to the UK, whatever the volume.

It should be noted that SKF provided even more substantial discounts to Britain's ball bearings purchases than Germany's.⁷³ Table II shows that in 1938, SKF charged the British 74% of the price to Germany for the same material, and by 1943 this figure dropped to 68%. Such discounts off list prices were commercial decisions agreed to as part of the trade negotiations.⁷⁴ Their rationale remains unclear but it may be argued that it derived from the convertibility of the Pound versus other currencies received. However, SKF set the prices and retained only Kronor earnings so under-pricing gave them no advantage.⁷⁵ The discounts could have been an attempt, notable at the time, by SKF to maintain favour and to quash Allied blacklisting and other threats against itself and its British and American subsidiaries.⁷⁶ Unfortunately, when the SKF archives perished, they probably put the precise reasons for these discounts beyond discovery.

The statistics show the Swedish bearings industry, specifically SKF, worked more for the German war effort than the Allies' and settled prices according factors beyond normal business considerations. But it should be remembered the Swedish government violated the established trade rules for both sides, as the over-supply of Germany and Britain's blockade-running make clear. Moreover, the Americans and British were allowed to pre-emptively contravene Sweden's previously agreed and contracted trade terms with Germany. This does not absolve the industry from working more for the Germans than the British, but does demonstrate Sweden's active role in ensuring access to the industry for both belligerents.

Conclusions: Could Sweden Have Stopped the Second World War?

The previous sections have provided an overview of the supply of Swedish ball bearings to Germany and Britain during the Second World War. This section is designed to deal with the counterfactual scenario of effects if the Swedish government had chosen to

⁷³ RA UDA/1920ds/HP64Ua/2897, file marked "Juli 1943 – Mars 31 1944," table marked "SKF:s Totalexport Exkl. Maskiner och Gängtappar under Aren 1938-1942," dated 19 July 1943.

⁷⁴ RA UDA/1920ds/HP64Ua/2897-2898.

⁷⁵ RA UDA/1920ds/HP64Ua/2800.

⁷⁶ See relevant documents in RA UDA/1920ds/HP64Ua/2800, 2897-2898; Fritz and Karlsson, *SKF i stormaktspolitikens kraftfält: Kullagerexporten, 1943-1945*.

suspend SKF's exports of ball bearings, in particular, machinery to SKF's subsidiaries in Germany and the UK. Withdrawing all Swedish ball bearings as well as the raw materials and machines for making them locally would have blunted mechanization and adversely affected both belligerents' war efforts for a period. But the long-term results, once the import substitution programme took effect, are harder to assess.

The short-term effects of suspending the export of Swedish ball bearing exports seem fairly easy to understand: Germany and the UK would immediately have lost 10.5% and 15% respectively of the bearings supply available to them. They would have had to increase domestic production to compensate, a not impossible process which would have taken several months' investment. But, as the extreme cost to Britain of maintaining its economic links to Sweden suggest, the process would have been difficult. Both countries would at first have been exposed to shortages in particular areas, as shown by the British example of a shortage of aircraft bearings leading to production problems with 1,700 aircraft.⁷⁷ These shortages could obviously have jeopardised fighting capability in the short-term. Britain clearly decided that it was more efficient to bring these bearings to the UK by air than to risk an import substitution programme.

One of the reasons for this choice was the quality of domestically produced bearings. A post-war British government report on the bearings industry maintains that ball bearings were difficult to replicate, citing a 1940 to 1941 attempt to rapidly expand the industry to supply the shortfall created by the blockade of Sweden. The same as presumably applies equally to the Germans.⁷⁸ Ball bearings have to be exactly sized and perfectly round, without any defects to ensure long-term use in high stress applications such as engines. The metallurgy, machinery and machine processes are difficult to reverse engineer; it is virtually impossible to produce an identical ball bearing which will wear in the same way. Skilled labour was particularly scarce and training unskilled labour risked higher levels of rejected bearings entering the supply chain.⁷⁹ Because of the pressure and heat surrounding them, even the slightest defect renders the bearing useless. The loss could cost significantly more in economic and military terms than the bearing itself. For example, if a bearing fails, an engine can explode; the consequent crash destroys everything.

⁷⁷ NA AVIA 38/333; NA AVIA38/381; NA AVIA38/409; NA AVIA 38/811.

⁷⁸ NA AVIA22/1171, memos regarding the efficiency of new ball bearings installations in Britain dated between 1943 and 1944.

⁷⁹ NA AVIA 22/1171, memos between July 1942 and 1943.

A July 1943 memo demonstrates how slowly the British bearings industry adapted to producing Swedish-quality bearings. While virtually all Swedish-imported bearings went to designated priority aviation and tank uses, by July 1943 only 34% of British production was suitable for aircraft engines and similar applications. The quality was expected after a year to improve by 3%, making 37% of British bearings aircraft-worthy by June 1944 that 41% would be aircraft-worthy by December 1944.⁸⁰ By contrast 100% of Swedish imported bearings were aircraft worthy. Swedish machinery was used to obtain these UK production rates. Without the Swedish machinery, successful production rates would probably have been even lower, suggesting that a long-term process was needed to build a suitable replacement ball bearings industry in Britain.⁸¹ The same likely holds for Germany. For both countries, no doubt, suspending Swedish exports would have extended the shortage of ball bearings and blunted mechanisation.

But, while Sweden could theoretically have mitigated the losses of the Second World War, it is unclear how it would have been possible to suspend ball bearings and the related exports. Such a suspension would have seemed unreasonable given the Swedish position. Several recent commentaries on neutral European countries in the Second World War have implied that their neutrality should be equated with isolationism,⁸² but strict isolationism, including suspension of trade, was then impossible for neutrals.⁸³ Sweden depended on imported food and fuel to sustain its population. Suspending ball bearings exports would have led to trade retaliation and probably involved some kind of military action against it. SKF subsidiaries, already harassed because of their neutral affiliation, could have been expropriated by the belligerents. This helps to explain the behaviour of SKF and its government. The policies discussed above were specifically designed to maintain exports to both belligerents. Because they were so difficult to replace, the belligerents' need for access to Sweden was unappeasable.

⁸⁰ NA AVIA22/1171, memo dated 30 July 1943.

⁸¹ NA AVIA22/1171, memos regarding the efficiency of new ball bearings installations in Britain, dated between 1943 and 1944.

⁸² See Levine, Paul A. *Sweden in European Neutrals and non-Belligerents during the Second World War*, Ed. Neville Wylie. Cambridge: Cambridge University Press, 2002; Aarons, Mark and John Loftus, *Unholy Trinity: The Vatican, the Nazis, and the Swiss Banks*. New York: St Martins Press, 1993; Ziegler, Jean, *The Swiss, the Gold, and the Dead*. New York: Harcourt, 1998; LeBor, Adam, *Hitler's Secret Bankers*. New Jersey: Pocket Books, 1999.

⁸³ See Calgren, *Swedish Foreign Policy during the Second World War*.