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A WOLFRAM IN SHEEP'S CLOTHING: U.S. ECONOMIC WARFARE IN SPAIN,
1940-1944

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ABSTRACT

One of the most sustained uses of economic warfare by the United States occurred in Spain during WWII. We provide an overview of this episode based on the secondary literature and new research in the Spanish archives. We focus on three key battles: (1) an oil embargo against Spain in the summer of 1940, (2) pre-emptive buying of wolfram (tungsten ore) during the middle years of the war, and (3) a second oil embargo in the first months of 1944. The first oil embargo, although launched when Germany was going from victory to victory, was successful in helping keep Spain neutral because it forced the Franco regime to rethink the costs of joining the war. Pre-emptive buying of wolfram was also successful. It forced Germany to pay more for and to consume less tungsten, a material crucial for hardening steel. Ironically, the second oil embargo, undertaken when the Germans were retreating on all fronts, was less successful. The major goal, halting shipments of wolfram to Germany, was not fully realized. Several special circumstances, in particular the naval blockade and the tendency of sanctions and incentives to push the Franco regime in the direction consistent with its long-run survival, help explain the successes.

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A Wolfram in Sheep's Clothing: Economic Warfare in Spain and Portugal, 1940-1944*

I. Introduction

Economic sanctions and incentives have been used increasingly in recent years as a means of statecraft. Indeed, the end of the cold war may have produced an increase in the number and diversity of sanctions. (Elliott and Hufbauer, 1999) They have been used not because of any great confidence in their effectiveness, but rather because the alternatives, diplomatic persuasion and military force, are so unattractive. There is a considerable literature about sanctions including work by Gary Clyde Hufbauer, Jeffrey Schott and Kimberly Ann Elliott (1999), Klaus Knorr (1975), Harry R. Strack (1979), David Baldwin (1985), and many others, exploring various cases, and trying to derive generalizations about the circumstances under which economic sanctions have been or have not been effective. Nevertheless, it is fair to say that the study of economic sanctions is still in its formative stage.

The most intense and sustained use of economic warfare by the United States, at least judged by the variety of means used and the issues at stake, occurred in Spain and Portugal during World War II. A variety of means were used, depending on circumstances: embargos of oil, offers of loans, blacklisting of firms that dealt with the Axis, and even the buying of strategic materials, in particular wolfram (tungsten ore), to keep them out of enemy hands. All of these methods of economic warfare have been used in recent years. The policy of buying strategic materials, for example, has its contemporary counterpart in the efforts to buy Russian

nuclear materials and to hire Russian laboratories and scientists formerly engaged in biological research.

The Spanish experience has been examined by a number of able historians: David L. Gordon and Royden Dangerfield (1947), Herbert Feis (1947), James Cortada (1971), Paul Preston (1993), and Christian Leitz (1996), to cite merely some of the leading treatments in English. Here, in order to draw the attention of economic historians to this episode, we will attempt to create an overall picture of the economic war in Spain by weaving these separate threads together. We are also able to resolve a number of the remaining issues based on new research on wolfram carried out in the Spanish archives. We will focus on what we believe to be the three most important battles in the economic war, all fought in Spain: (1) The first oil embargo of Spain by Britain and the United States, July 27, 1940 to September 7, 1940, (2) the Allied policy of buying wolfram (tungsten ore) to keep it out of the hands of the Germans, mid-1941 to August 1944, and (3) the second oil embargo of Spain, January 22 to May 2, 1944.

The remainder of the paper is arranged as follows. Section II. Describes the first oil embargo. This embargo appears to have been a success. The Franco regime was strongly tempted to enter the war on the side of Germany (the episode is known to Spanish historians as the "Great Temptation"), but partly as a result of the embargo, Franco seems to have rethought his position and decided to remain neutral. Section III describes developments during the wolfram period. Wolfram became crucial during the war because Portugal and Spain became the only source from which Germany could draw supplies. The Allies attempted to prevent Spanish exports to Germany simply by bidding against Germany for the

available supply. This led to an astonishing increase in the price of wolfram in Spain, and generated an income that was of some significance to Spain during this era.

Finally, for a number of reasons, including the cost and the debatable success of the wolfram-buying program, the Allies abandoned the system of competing against the Germans, and instituted a second oil embargo. Ironically, this embargo, described in section IV, launched when the Allied victory appeared all but inevitable, can be considered a partial success at best. Certain political goals were accomplished, but the goal of keeping Wolfram out of the hands of the Germans was not. Finally, section V draws some general conclusions.

II. The First Oil Embargo. ¹

On September 3, 1939, shortly after the Britain declared war on Germany, Britain created the Navicert (Navy Certificate) system to limit the exports of Spain and Portugal (and other neutral countries) to Germany. The intention was for the Royal Navy to control all trade with Europe. The British were especially concerned about oil because even at this early date there was some evidence that Spain had re-exported oil to Germany. Any ship bound for Europe had to have a navicert, a document issued by British consulates that specified the cargo and its destination. If a ship's papers were not in order, the Royal Navy would force it to change its destination. Spain and Portugal complained that the system was a violation of their rights as neutrals under international law, but all they could do was comply.

The fall of France created a new crisis in relations between Spain and Britain. The "Great Temptation" (for Franco to join the war), as Spanish historians know it, reached its peak in the summer of 1940. On June 12, 1940, eight days after the evacuation of Dunkirk,

Francisco Franco, Spain's rightwing dictator, declared that Spain was not neutral, it was "nonbelligerent," the same language that Italy had used before joining the war. On June 14, 1940, Spanish troops occupied the international city of Tangier on the straits of Gibraltar, the most aggressive military action taken by Spain during the war.² A Spanish delegation began negotiating with the German government over the terms of Spanish entrance in the war. Franco may well have thought that this was the moment to greatly expand Spain's empire in Africa. At that time it seemed to many military officers in Spain that the war would soon be over, and that Spain, therefore, had to move fast to join the winning side.

Neither Spain nor Germany thought that Great Britain would have the will to continue the fight, and the United States the will to help Britain. Leaders in Britain and the United States were not much more certain about the willingness of Britain to continue the war. On June 15th Churchill wrote to Roosevelt as follows.

"Although the present government and I personally would never fail to send the fleet across the Atlantic if resistance was beaten down here, a point may be reached in the struggle where the present ministers no longer have control of affairs and when very easy terms could be obtained for the British islands by their becoming vassal state of the Hitler empire. A pro-German government would certainly be called into being to make peace and might present to a shattered or a starving nation an almost irresistible case for entire submission to the Nazi will." Kimball (1984, 49).

Roosevelt replied:

"...we are doing our utmost in the United States to furnish all of the material and supplies which can possibly be released to the Allied Governments." Kimball (1984, 48).

The threat to Britain posed by Spain's entry into the war was clear. If Spain captured Gibraltar, and fortified the corresponding coast of North Africa, the British fleet would have

no way of challenging the powerful Italian fleet: The Mediterranean would become an Italian lake. Hitler had the same thought, and was then in the process of developing detailed plans, code-named Felix, to take Gibraltar.³

With the idea of preventing Spain from joining the war, the Allies embargoed shipments of oil to Spain on July 27, 1940. Embargoes, as a rule, have a bad reputation. The embargo of aviation fuel and other strategic materials to Japan imposed on June 26, 1940, for example, which hardened into a total embargo over the next year, failed to achieve its objectives. But the Spanish embargo is an important counter-example. It was successful, we argue below, mainly because it forced the Franco regime to rethink the constraints it faced.

As Eaton and Engers (1999) have shown, embargoes would seldom be observed in a world in which the costs and benefits of embargoes were known by both sides with perfect certainty. They arise because of misperceptions on one side or both about the costs of embargoes. In this case, the embargo arose because the Franco regime did not recognize a major problem that the Germans already faced, and that Spain would face if it joined the Axis: limited supplies of raw materials. To offset the embargo, and as a reward for joining the war, Spain asked Germany for 400,000 tons of gasoline, 600,000 tons of wheat, 200,000 tons of coal, 200,000 tons of fuel oil, and substantial quantities of other raw materials, including cotton, rubber, wood pulp, hemp, and jute. (Preston 1993, 372).

Although by this time the Germans had begun to appreciate the determination of Great Britain to fight on, the Germans were still not convinced that they needed Spain, and they were not convinced that Spain was in the dire straits that it claimed. But the truth was that Spain had almost no reserves of oil. Its only refinery was in the Canary Islands, so even the

crude oil awaiting processing was not available. Spain was forced to treat with the United States and Britain. The British took the lead in the negotiations (the Spanish preferred the British because of their commercial ties and more conservative government) and an agreement was reached relatively quickly on September 7, 1940. Spain would receive oil and other supplies as long as she remained strictly neutral.

Germany's interest in joining with Spain in an attack on Gibraltar grew steadily in 1940. When the battle of Britain began, Germany was interested in Spain mainly because bases in the Canary Islands might be useful for the war, still far in the future, between Germany and the United States. Immediate Spanish assistance in defeating Britain was not needed. (Goda 1999). By September 1940, the German attitude had changed. The German Navy pointed out the strategic importance of Spain in its continuing war with Britain. Controlling the Straits of Gibraltar, the Canary Islands, and the Iberian Peninsula would be of considerable help to Germany in the Battle of the Atlantic. The German government now tried to reach an agreement with the Spanish government for Spain's entry into the war. Finally, at the end of October 1940, Hitler decided to talk directly to Franco.⁴ Hitler and Franco met at Hendaye, in France on the Spanish border, on October 23, 1940.

There were two tracks to the negotiations leading up to and following Hendaye: the military-strategic and the economic. On the military-strategic side Hitler wanted Franco's help in capturing Gibraltar and pinching off the entrance to the Mediterranean. Hitler also wanted one of the Canary Islands as a base to use against England and, in the long run, against the United States. He also wanted bases in Morocco. Finally, he wanted to keep the final division of French Morocco secret, so as not to raise fears in Vichy France about the future of French

Morocco, and possibly to lead the French forces in Morocco to join the free French. For his part, Franco wanted firm guarantees for all of French Morocco and Gibraltar, and he did not want to cede the bases that Germany asked.

On the economic side, Franco again provided a long list of raw materials he wanted as a precondition for joining the war, including prominently food and oil, in amounts the Germans thought excessive. The Germans, for their part, wanted substantial mining concessions.

It is impossible to say which gap, the strategic or the economic, was the most important to Franco. Indeed, interpretations of the meeting at Hendaye, and what was really at stake, have multiplied to Roshomon like proportions.⁵ Several things, however, are clear. Franco was a fierce nationalist. The idea of ceding permanent concessions to Germany in the Canary Islands, in Morocco, and in the mining industry, would have stuck in his craw. (Weinberg 1994, 177-78). And Hitler's determination to remain vague about what Spain would get in North Africa -- so as not to alarm the Vichy French and the Italians -- undoubtedly made Franco suspicious. On the other hand, recovering Gibraltar would have righted an affront to Spanish pride that had persisted since 1704. A look at the map would say that in square miles and pride of possession, Franco would have gained had he joined the war, and had the Axis won.

In any case, our belief is that the control of raw materials, and especially the oil embargo, a factor largely ignored in most historical accounts, has an equally plausible claim to be the decisive factor that kept Franco from joining the war.⁶ The shortage of oil had played havoc with the Spanish economy. The possibility that a substantial part of the fishing fleet

would not put to sea, for example, was a dire threat for a country that was already hungry. Spanish officials had learned at first hand how difficult it would be for Spain to supply itself with oil in the face of American and British opposition, and how costly a shortage of oil would be. Supplies of wheat for a hungry Spain, moreover, were on their way from Canada and the United States. How certain could Franco be that Germany would make up Spain's desperate food shortage if Spain joined the war? The ability of Germany to supply Spain's needs, Franco had learned, was more circumscribed than might be inferred from Germany's military success.⁷

In theory, Franco and Hitler agreed at Hendaye that Spain would enter the war at an unspecified future date when Spain was ready. In the months that followed Hendaye Hitler continued to press Franco to join the war, specifically to join in an attack on Gibraltar, an operation that Hitler had code-named "Felix." Abundant supplies would be made available, Hitler asserted, once Spain joined the war. But Franco's government continued to claim that it was not ready to join the war. The Allies were supplying wheat and oil. It was far from clear that Germany could or would supply as much if Spain joined the war. A bird in the hand was worth two in the bush.

Proving that the oil embargo was a major factor in the decision to remain neutral is inherently difficult. What can be shown is that the Spaniards themselves constantly brought up the issue of raw material supplies. If the principle that people tend to talk about what weighs most heavily on their minds has any validity, it is clear that the blockade and the potential shortage of crucial raw materials from an embargo was a continuing concern for the Franco regime. It was continually brought up at Hendaye and in subsequent correspondence and face-

to-face negotiations.

Perhaps the last time when the Allies faced real danger from Spain was when the Allied invasion of North Africa (Operation Torch) began on November 7, 1942. Before it was launched, Samuel Hoare, the British Ambassador went to see Franco. Hoare (1946, 164-65) stressed that additional supplies of oil, wheat, rubber, and cotton would be forthcoming if Franco avoided making trouble for the Allies. In his reply, Franco argued that the blockade should be ended. Franco's boast, that the embargo didn't hurt the Germans because they had plenty of everything, as evidenced by their willingness to send 8,000 tons of wheat to Spain -- a mere token, as Franco must have known -- rang hollow.

In 1940 and 1941, the decision to remain neutral merely appeared prudent. Spain avoided a costly oil embargo and received additional supplies of food, but gave up the opportunity of joining the winning side in the war, regaining Gibraltar, and gaining a vastly expanded empire in North Africa. In hindsight, of course, the decision to remain neutral seems nothing less than brilliant. Had Spain joined the war, there was a real possibility that the Allies would have decided to fight their way into Europe through Spain rather than Italy. The loss of human and physical capital under those circumstances would have been enormous. (It has been estimated that in Italy real GDP fell about 68 percent between 1940 and 1945).⁸

As a neutral, moreover, Spain was able to reap enormous profits from the sale of a commodity that had been little noticed before the war: wolfram.

III. Wolfram

Spanish and Portuguese wolfram, tungsten ore, turned out to be critical for the German

war effort.⁹ Tungsten has a high melting point and is one of the hardest of all metals. Steel alloyed with tungsten is extremely tough and heat resistant. In wartime it is used mainly in producing armor, armor-piercing shells, and high-speed cutting tools, although it has a number of other military uses including its use in fireproofing materials and electrical contacts. (Smithells 1952,12-14). The Germans were the first to develop shells with a core of tungsten carbide for piercing armor. It has been claimed that Rommel's early successes in North Africa owed a great deal to the ability of these shells to pierce the armor on British tanks and then explode within to devastating effect. Two years later the United States was using similar shells to stop Von Rundstedt's Panther and Tiger tanks in the Battle of the Bulge. (Li and Wang, 1947, 402). The Germans were also among the leaders in the development of tungsten alloys for use in high-speed cutting tools that were important for sculpting artillery and other munitions.¹⁰

The Demand for Wolfram

Before the war Germany bought wolfram mainly from China, the British colonies in Asia, and to a smaller extent, from Portugal and Spain. In 1938 Germany bought 14,200 metric tons in all, with only 658 tons coming from Portugal, and only 119 tons from Spain. (Table 1). German demands for Iberian wolfram escalated rapidly once the war began. The British naval blockade made it difficult to bring in wolfram by sea, and an overland route to China, the major prewar supplier, was impossible after the attack on the Soviet Union in June 1941. The only other producer of wolfram in Europe was Sweden, but her production barely covered her domestic consumption. Thus, Spain and Portugal became the only places where

Germany could buy wolfram.¹¹

The idea of competing with the Germans for Iberian wolfram originated with the British. Hardened steel seemed to be at the heart of the German war machine. Economic warfare that would reduce the German supply could be as important as destroying German steel plants through strategic bombing, or destroying German units in the field. Initially, however, British purchases were limited, and the Americans were skeptical. The U.S. could easily buy wolfram from the rest of the world: Argentina, Bolivia, Brazil, etc. (See Table 2). The United States also had abundant supplies of molybdenum, which was a good substitute in producing hardened steels. According to Herert Feis (1947, 169), one of the participants, Jesse Jones, the head of the Reconstruction Finance Corporation, whose agency would be the conduit for American finance, thought the idea of pre-emptive buying was “silly.”¹²

Why then did the United States embark on a policy of pre-emptive buying especially given the apparent success of the oil embargo? Why not simply tell Franco that if he didn't cut shipments of wolfram to Germany, further reductions in oil, wheat, and other supplies would be made? Too some extent, to be sure, the oil weapon was used. The price of oil was raised, and the flow was diminished in response to particular situations. Eventually, a second oil embargo would be launched to try to force a complete cut off in Germany's supplies of wolfram.

But for a number of reasons, it was decided during most of 1942 and 1943 to rely mainly on buying wolfram away from Germany. First, the Allies were afraid that if they pressed too hard they might drive Spain into the hands of the Germans. Second, the structure of the industry that had sprung up in Spain (it was a highly competitive "cottage industry")

meant that it would be extremely difficult to monitor compliance. In addition, there is a bureaucratic story. In the United States the Bureau of Economic Warfare ran pre-emptive buying. This agency, initially headed by Henry Wallace, was only loosely controlled by the State Department, and was conducting similar buying campaigns in other parts of the world. It was natural for this agency to attack the problem of wolfram in the same way. As it turned out, the oil weapon was directed more toward political developments in Spain (the main concern of the State Department), while pre-emptive buying was used to deal with wolfram.

The British were led to consider the wolfram problem before the Americans because Portugal, a long-time military ally and economic partner of Britain, was the major European producer before the war. American and Portuguese economic relations, by contrast, were rudimentary. The open competition between the Britain and Germany for Iberian wolfram started prices rising. In the second quarter of 1941 Spanish prices averaged about 12,500 pesetas per metric ton (\$1,140 at official exchange rates) at the mine gate.¹³ In the third quarter they more than doubled to 25,900 pesetas (\$2,365).¹⁴ (See Figure 1) The United States did not begin to consider the idea of pre-emptive buying seriously, however, until November 1941, and did not agree to the policy until February 1942.

By that time the Portuguese situation had been resolved, at least temporarily. On January 24, 1942, the Germans managed to sign an agreement with António Salazar, the Portuguese dictator (and former economist¹⁵) that assured the Germans a share of Portuguese wolfram. An order issued on February 3, 1942 created a Portuguese Metals Commission to realize the agreement and control the wolfram trade.

The Portuguese actions were intended to protect Portugal's neutrality and to end a

wolfram boom that Salazar believed would destabilize the Portuguese economy. Foreign countries that owned mines in Portugal (mainly Britain, although Germany owned a few) would be entitled to the wolfram produced in their own mines. "Free" wolfram, wolfram produced by Portuguese owned mines, was to be split. Initially, the Portuguese allocated 75 percent of the free wolfram to Germany, the rationale being that since Britain owned more mines than Germany, the latter deserved more of the free wolfram. Later, under Allied pressure, the split for the free wolfram was changed to 50:50, leaving the British with a larger share of total Portuguese production. The new organization was functioning by June 1942. The Metals Commission bought wolfram from British, American, and German mines at 80,000 escudos (\$3,200) per ton. It resold it to the owners at a price of 150,000 escudos (\$6,000), which included a 30,000-escudo (\$1,200) export tax. Wolfram from the "free" mines was bought at a higher price, 120,000 escudos (\$4,800), presumably because the costs of production were higher at the smaller free mines, and resold to the Allies and the Axis, without adding the export tax, once again at the official price of 150,000 escudos (\$6,000). Kemler (1949, 63).

The agreement with the Germans, and the establishment of the Metals Commission, made 2,800 tons per year available for Germany. In return for the agreement Germany promised to export 60,000 tons of steel and fertilizers to Portugal. For much of the war Portugal would stick to this agreement, despite British and American insistence that the Portuguese government should cease exporting wolfram to Germany. Eventually, the Portuguese, when threatened with an oil embargo, complied, but not until June 6, 1944.¹⁶

Although in principle all exports from Portugal went through the Portuguese

government, there was an extensive black market. Wolfram was blended with other products or exported under another name. At times there was considerable smuggling of wolfram from Portugal to Spain. (Spanish production areas abutted Portuguese production areas.) The Allies were heavily involved in organizing and financing the smuggling operation. William Medlicott (1952, 596) estimates that 818 tons were smuggled across the border between January and August 1943. The Germans purchased 550 tons and the Allies 268 tons. The flow reversed, as might have been expected, when prices dropped in Spain in late 1943. Smuggling appears to have continued until August 1944, when the Germans left the Spanish frontier, and the land route between Spain and Germany was broken.¹⁷

While the Portuguese supply was regulated with a heavy (although not always effective) hand, the Spanish industry was allowed to go its own highly competitive way. Many small producers -- sometimes a farmer with pickaxe -- dominated the industry. The Franco government taxed the industry, and required an export license, but otherwise let it alone. Allowing the industry to develop in this way, as we will see below, proved to be of enormous benefit to Spain and to the Franco regime.

Once the United States was firmly on board the wolfram-buying program in the first quarter of 1942, the boom intensified. Under the pressure of intense competition between Germany and the Allies, prices (figure 1) in Spain increased from 12,500 pesetas (\$1,141) in the second quarter of 1941, to 160,000 (\$14,612) in the second quarter of 1943, a factor of close to 13.¹⁸ Output (figure 2) increased from 159 tons in the second quarter of 1941 to a high of 1,223 tons in the first quarter of 1944.

The competition was organized in a simple way. The British purchased wolfram

through the United Kingdom Commercial Company; the Germans through their own company, Sofindus.¹⁹ The British had already purchased a small amount, 72 tons, in 1941. When the British company reported to its Ministry of Economic Warfare that Spanish production was rising in response to a strong demand from Germany, the decision was made, at the beginning of 1942 to purchase as much wolfram as possible.

In March 1942 the United States created the United States Commercial Company, modeled after its British counterpart, to buy wolfram and other raw materials that might be valuable to the Axis. Initially, a board of directors appointed by the Reconstruction Finance Corporation controlled the Company, although the separate Board of Economic Warfare was influential in decision-making. In July 1943 the Commercial Company was transferred to the Office of Economic Warfare that had succeeded the Bureau. In September 1943, the Office of Economic Warfare was transferred to the newly created Foreign Economic Administration. Despite these peregrinations, the Reconstruction Finance Corporation maintained that the Commercial Company was its subsidiary, and in September 1945, when the Foreign Economic Administration was discontinued, the Commercial Company was returned to the Reconstruction Finance Corporation. The Bureau of Economic warfare operated somewhat independently from the state department and the military. So while it is appropriate to view U.S. economic warfare in Spain as a whole, this does mean that policy reflected the views of a single policy-maker.

Paying for wolfram was not easy even for the Allies. They taxed exports to Spain, especially oil and fertilizers. But they also allowed the Spanish to accumulate regulated dollar balances in U.S. banks, and shipped gold. The Germans had an even harder time. Occasionally

they resorted to looted and counterfeited foreign bank notes. They also shipped gold. Later, as we discuss in more detail below, they were able to raise pesetas by shipping arms and by canceling a substantial part of Spain's Civil War debt.

On the Spanish side there were two main figures: Demetrio Carceller from the Ministry of Commerce (appointed on October 16, 1940), and, Serrano Suñer, from the Ministry of Foreign Affairs (from September 1940 to September 1943). The latter created great difficulties for Spanish relations with the Allies. A Falangist, Suñer strongly favored the Axis. In an article in the Falangist newspaper *Arriba* he argued that Spain had to join the Axis in its war against the communists and the liberal democracies.²⁰ Both the British and American ambassadors were misled in their evaluation of Spanish economic and political conditions by Suñer. On the other hand, Carceller, although also a Falangist, tried to persuade the Allies to ignore the Spanish Foreign Minister. On occasion Spain may have benefited from this nice-guy-tough-guy routine. Nevertheless, trade negotiations were disrupted to some extent in the early years of the war by Suñer's ideologically based opposition to the Allies. When Count Francisco Jordana replaced Suñer, relations with the Allies improved. From then on Spain's main focus was on making sure that what the Spanish regarded as adequate supplies of oil, rubber, and food were forthcoming in exchange for licenses to export wolfram, and that the wolfram boom continued unabated.

The price was so high that the Germans did not buy wolfram in May 1942. For this reason the Spanish government refused to license German stocks of wolfram for export. The German government reconsidered its position, and began buying again in June. The hesitation in prices between the second quarter of 1942 and the third quarter (figure 1) is probably a

reflection of this contretemps.

Wolfram gave Spain a card to play in its battle with the United States over oil. If the United States believed that there was some re-exporting of oil to Germany, they could reduce Spanish imports. The Spanish government now had its own weapon, wolfram, with which to respond. Economic warfare had become a two-way street.

The Spanish government attempted to exploit the situation in another way. On January 7, 1943 it announced an increase in the export tax from \$5,000 per ton to 15,000 per ton. Both sides protested, and managed to scale the tax back to \$10,000 per ton.²¹ Upon first consideration it may seem counterproductive for the side intent on pre-emptive buying to protest a tax which had the effect of reducing German consumption. An infinitely high tax that effectively prohibited both sides from buying wolfram would have served the purposes of the Allies admirably. It could be that in protesting the tax the Allies had simply slipped into a commercial way of thinking that was inappropriate to the task at hand. It is also possible that the Allies were distinguishing among beneficiaries of the Allied purchases. One of the advantages of the wolfram-buying program, from the Allied point of view, is that money spent on wolfram went, for the most part, into the hands of small-scale producers, many of them ordinary peasants and working people. The tax, of course, would strengthen the regime. It was one thing for the Allies to put money into the pockets of poor Spanish miners, a very different thing to put money into the pockets of the Franco regime. The Allies may also have been afraid that Spain would secretly rebate the German portion of the tax.

The Allies, of course, could evade an export tax simply by not exporting the wolfram they bought in Spain. But on April 29, 1943 the tax was made applicable to all production of

wolfram, whether exported or not.

Wolfram prices peaked in second quarter of 1943 (Figure 1), fell slightly, and then tumbled between the third quarter and the fourth quarter of 1943. The production tax may have had some effect. But the main reason was simply that the Germans had run out of pesetas. In response, the Allies abandoned the market as well.²² Spain, however, came up with a clever ploy to keep the game going. The Franco regime owed Germany a large debt incurred for help during the Spanish Civil War. The Germans agreed to cancel the debt in exchange for a peseta balance that they could use to purchase wolfram. They also promised and delivered military equipment in exchange for pesetas. These weapons were valuable to Germany, which was then engaged in a desperate military struggle with the Soviet Union, and are an indication of how important they considered wolfram. The value of the Civil War debt, on the other hand, is debatable. Clearly, if the Germans lost the war, they would have had a hard time collecting. A realistic market value of the Civil War debt must have been below its nominal value. In effect, the Spaniards had found a way, with a veneer of legality, to price discriminate: a way to charge a lower price to the impecunious Germans and a higher price to the well-heeled Allies. Altogether the agreements made about 400 million pesetas available to the Germans, enough to buy and export close to 1,500 tons of wolfram at the prices prevailing in the third quarter of 1943. The rebounds in prices and production, shown in figures 1 and 2, were due to this deal.

Although the Allied-buying program undoubtedly raised the price of wolfram and discouraged German use, the extent to which German consumption was reduced is less clear. Production in Spain increased rapidly. Both the British and the Germans had trouble

sustaining their purchases of wolfram. And among the Americans there was an intense debate over whether the enormous expense of the wolfram program was worth it, that is whether it was really reducing German consumption or simply stimulating production and enriching the Spaniards. To gauge the impact of the Allied buying-program, we need to know the elasticity of supply.

The Supply of Wolfram

The effect of the wolfram-buying program depended on the elasticity of supply. The more elastic supply the less the impact of the Allied buying program on German consumption. In the extreme case, a perfectly elastic supply curve, the Allied buying-program would have no effect.²³ Fortunately, we have the data with which to estimate supply. The Spanish government taxed wolfram production at the mine level prior to the war at the rate of 3% of the total amount sold. (There was also, as we noted above an export tax, later converted into a production tax). For that reason we have data by mine on output, quality of the ore, the price at which it was sold, and the total value of output, by mine during the wolfram boom.²⁴ Although the records appear to be complete for the years 1941-43, there appear to be some gaps in 1944. In addition, there may be some reporting errors due to tax evasion, which probably existed despite the government's reputation for ruthlessness, and also to recording errors made by relatively poor and uneducated miners. For this reason we rely on the mine level data for information on prices, the quality of ore being mined, and other variables that can be estimated from a sample, but on information published by the Banco Exterior for information on total output.

It would appear that the equilibria that we observe during the boom are essentially points along an upward sloping supply curve. Part of the evidence is the discussion in the previous section which shows that demand fluctuated significantly during the boom, rising dramatically during the first phase of the boom, collapsing abruptly when the Germans ran short of funds, rising again when the Spanish government made additional funds available to the Germans, and then collapsing when the land route to Germany was closed.

The assumption of a stable upward sloping supply curve also fits what we know about the structure of the Spanish wolfram industry. It was a highly competitive industry, consisting of a large number of small mines. The industry was concentrated in Northwest Spain where small outcroppings of ore could be found. The miners were generally peasants, or farm workers, who found it more profitable to dig for ore than to work on the land.²⁵ Figure 3 plots the number of mines for which we have reports operating during the boom. The number rose from 6 in the first quarter to a maximum of 124 in the second quarter of 1943.²⁶ Figure 4 plots the average output per mine. Average output plummeted as the small producers came in, but eventually stabilized at 6 or 7 tons per mine.

As the price rose lower quality sites were brought into production. One piece of evidence for this is shown in figure 5, which plots the average percentage of pure wolframite (a material that contains iron, manganese, and oxygen) in the ore being mined. In general, the producers in Germany and elsewhere were set up to use ore that was 65% wolframite; lower quality ores required additional processing. When the boom took hold, however, the average quality of the ore being mined dropped well below the 65% mark.

Figure 6 is a scatter diagram of price on quantity – both measured in natural

logarithms. For the most part, the observations fall along an upward sloping line. The major exceptions are the initial observations, realized before the industry had time to respond. There are also some outliers generated by the price slump in the latter half of 1943, after which production increased, perhaps because of the expectation, or the hope, that demand would pick up again because of the new financial resources being made available to Germany. Nevertheless, this figure again suggests that we may not be going too far wrong if we fit the convenient constant-elasticity supply curve.

$$(1) Q = SP^{\alpha}$$

Or in logarithmic form

$$(2) \log(Q) = \log(S) + \alpha \log(P)$$

Where Q is the total supply of wolfram

S is a shift curve reflecting investment in the industry,

P is the price of wolfram, and

α is the elasticity of supply

Had the boom been expected to continue for years, there would undoubtedly have been additional investment in the industry both private (exploration, machinery, training of workers, and so on) and public (improved highways or railroads into the wolfram mining area) that would have shifted the short-run supply curve to the right. It is even conceivable that the long-run supply curve would have been downward sloping. But given the short-run nature of the boom, and the expectation that it would end with the war – when low cost Asian producers returned to the European market – the assumption that production was moving up

and down a stable short-run supply curve, and therefore that an OLS regression will identify equation (2), seems reasonable.

Estimating equation (2) with quarterly data yields the following.

The Dependent Variable is Wolfram Production (natural logarithm)		
Period 1941:1 1944:4		
Variable	Coefficient	T-Statistic
Constant	-5.50	-1.07
Real Price of Wolfram (natural logarithm)	1.00	2.20
ar(1)	.54	1.82
Adjusted R-squared	0.56	
Durbin-Watson Statistic	1.40	

The supply elasticity is 1.00, the coefficient on price.²⁷ Because of evidence of serial correlation the equation was estimated using a first-order autoregressive correction. Even this adjustment, however, did not completely eliminate signs of serial correlation. If the regression is run on first-differenced data, the result is

The Dependent Variable is Wolfram Production (first difference of the natural logarithm)		
Period 1941:2 1944:4		
Variable	Coefficient	T-Statistic
Constant	-.13	-.73
Real Price of Wolfram (first difference of the natural logarithm)	.64	1.66
Adjusted R-squared	0.18	
Durbin-Watson Statistic	1.38	

The Effects of the Wolfram Program

The appropriate metric for evaluating the effect of the wolfram-buying program is the reduction in German consumption which depended not only on the elasticity of supply just estimated, but also on the elasticity of German demand, about which we know very little. If we make the assumption that Germany would have spent the same amount on wolfram in the absence of the buying program as in the face of it (a demand elasticity of -1) then we can derive the equation for the effect of the wolfram-buying program.²⁸ Unit elasticity is a reasonable assumption because the Germans simply ran out of money in the third quarter of 1943 and stopped buying. It seems likely that in the absence of Allied buying, and hence faced with a lower price, they would have tried to save a bit of their limited financial resources (a demand elasticity greater than -1 in absolute value). So the assumption of unit elasticity probably biases the estimate toward finding a small effect from the Allied-buying program. Assuming unit demand elasticity yields the following expression for the effect of the wolfram-buying program.²⁹

$$(3) \Delta Q_g = - Q_a [1/(1+ \alpha)]$$

where

ΔQ_g = the change in German consumption of wolfram produced by the Allied buying campaign, and

Q_a = Allied purchases of wolfram.

This expression makes intuitive sense.³⁰ Allied purchases reduce German consumption

(as long as the elasticity of supply is positive). But the effect depends on the elasticity of supply. If the supply elasticity is zero, each ton purchased by the Allies reduces German consumption by one ton. But as the elasticity of supply rises, the impact is reduced. In the extreme case, where the elasticity of supply is infinite, the effect is zero. Each additional ton purchased by the Allies is met by an additional ton of Spanish production with no impact German consumption.³¹

Table 5 shows calculations of potential German consumption based on the supply elasticities estimated above. Two extreme cases, perfectly elastic supply and perfectly inelastic supply, are shown by way of contrast. Neither of the extreme cases makes much sense. Perhaps the best estimate is on the “bottom line” of the table. It assumes the mean estimate of the supply elasticity and makes a rough adjustment for the cancellation of the Spanish Civil War debt. In the absence of Allied buying there would have been little reason for the Spanish to agree to a cancellation of their debt, and limited supplies of war material, on terms so favorable to the Germans. As a crude adjustment we assume that in the absence of the Allied-buying program the Germans would have been able to purchase only half of the wolfram they actually purchased after September 1943.

All in all, it appears that the Allied-buying program reduced German purchases of Spanish wolfram by about one third, by about 1200 tons. Our intuition suggests that this was enough to justify a claim of success, at least in reaching the intermediate goal of reducing German purchases of wolfram. Germany used about 350 tons per month in 1939; compared with 160 tons per month in November 1943. Thus in the absence of the Allied buying program in Spain, Germany could have increased her consumption to the prewar level for

about seven months (1287/(350-160)).

How important reaching this intermediate goal was to achieving the ultimate goal of undermining the German war effort, however, is another question. During the war Germany was forced to economize on the use of tungsten. The use of tungsten-carbide cores in some kinds of ammunition had to be dropped, and the use of tungsten in armor plate and high-speed-tools was reduced. German experts interrogated after the war maintained, however, that the reduction in the overall quality of German arms was limited thanks to the use of substitute alloys and alternative production technologies. (U.S. Strategic Bombing Survey 1945, 109-112.) Before the war German steel makers had preferred steel containing about 13 percent tungsten, and smaller amounts of chromium, vanadium, cobalt, and carbon for high-speed tools. But during the war, they were able to produce an alloy that used about 4 percent tungsten, along with increased amounts of carbon, and an addition of molybdenum (2 to 3 percent) that German metallurgists claimed performed even better than the prewar alloy. (Li and Wang 1947, 333).

The buying program in Spain, moreover, deserves only a small part of the credit for the reduction in the German use of tungsten. The naval blockade and the attack on Soviet Union that cut off Germany from her Far Eastern suppliers, and the sharp upward slope of the Iberian supply curve, would have forced Germany to economize on tungsten even in the absence of the buying program. Still, it is far from clear that using the resources employed in the buying program in another way, for example by increasing the intensity of strategic bombing, would have been more effective. Attacks on nonferrous and ferro-alloy metal production facilities in Germany had only limited effectiveness. (*U.S. Strategic Bombing Survey 1945*, 109-112.)

Altogether it has been estimated that the Allies spent about \$170 million on purchases of wolfram in Spain and Portugal, including export fees, bribes, and so on, split about evenly between the U.S. and Britain. In 1944, the peak year, the Federal government spent about \$88.6 billion on the war effort. So the wolfram-buying program added about .1 percent to the cost of the U.S. war effort. Or to put it slightly differently, wolfram-buying was the equivalent of about 8 1/2 hours of federal spending; 17 hours if the U.S. had shouldered the entire burden. It would be impossible to say with any degree of certainty whether the war could have been ended a few days earlier, and more lives have been saved, if those funds had been invested in some other way. But given the manpower constraints that limited the ability of the U.S. to use more equipment, it may well be that this was the most effective use of these resources.

The big winner, of course, was Spain. Table 4 shows the impact of wolfram on Spanish exports. Wolfram grew from an insignificant 0.4 percent of Spanish exports in 1940 to nearly 20 percent in 1943. In 1943 this was about one percent of national income. The export of wolfram is the major exception to Tortella's (2000, 315-319) generally dreary portrait of Spanish economic policy during the war, and the resulting inability of Spain to seize the opportunities economic offered by the war.

IV. The Second Oil Embargo (January 22 - May 2, 1944)

Frustrated by the ever-increasing price of wolfram and by the cancellation of the Civil War debt -- an operation in which, essentially, the Spaniards used the Germans as a shield to pry higher prices out of the Allies -- the Allies began debating a second oil embargo.

Although wolfram was the key issue, "political" and military issues also played a role. These

included: (1) German spies in Spain, (2) favorable treatment of Axis aircraft landing in Spain, (3) the continuing effort to keep Spanish forces on the Eastern front, and (4) the stridently pro-Nazi propaganda in the Franco-controlled press. German spying was a genuine problem. German spies on the Straits of Gibraltar monitored Allied naval movements. The Blue Division, although only a small part of the total forces engaged on the Eastern front, had fought well. Now it was being removed. But a smaller unit, the Blue legion, remained. All of these tilts toward the Axis, the bitter memories of the Spanish Civil War, and the huge profits won in the wolfram trade, set American public opinion against Spain. Feelings ran high, particularly on the left, that in a war to the death against Fascism the United States should not be doing business with a Fascist regime. The U.S. State Department, responding to this pressure and to the realization that American ground forces would soon be locked in combat with the Germans, wanted all wolfram exports to Germany cut off by D-Day, even if a total embargo had to be imposed. Britain, more dependent on trade with Spain, and with long-term financial interests in Spain, was inclined to continue the current policy. But the British were willing, at least initially, to do their part. (Edwards 1999, 4).

Spain was notified of the second oil embargo on January 22, 1944. The Spaniards bargained effectively. They announced a temporary ban on exports of wolfram to Germany while the dispute was resolved. Although some writers have speculated that this ban was turned into fact, it is now clear from evidence in the German archives that Germany continued to import wolfram from Spain during the oil embargo.³² In February 104.6 tons were exported from Spain. There were no exports in March, and this may have reflected the ban. But in April 198 tons reached Germany from Spain. (Leitz 1996, 189). Clearly, the Spanish government

could not or would not comply, even in the face of a painful embargo.

Spain held out for a face-saving formula that would send token amounts of wolfram to Germany. Spain pointed to its rights as a neutral under international law to trade as it saw fit. Officials known to be sympathetic to the Allies argued that their position would be undermined if the Allies insisted on a complete ban on exports of wolfram to Germany. And Spain pointed to the potential for Germany to use force against Spain, if only in the form of air or submarine revenge attacks despite Germany's deteriorating military position.

The division between the Allies increased as the negotiations with Spain dragged on. On February 13, 1944 Churchill explained his view about the second embargo to Roosevelt in this way:

“When a large, strong, healthy elephant (no reference intended to GOP) comes into a garden and tramples down the flower beds some perturbation is natural among the local gardeners. As you know, we have had our own point of view about this....” Kimball (1984, 726).

Roosevelt remained convinced, or so he said, that an oil embargo would force Spain to cut off all exports of wolfram to Germany:

“I believe that as a result of our suspension of tankers loading the Spanish situation is developing satisfactory and that if both our Governments (British and American) hold firm we can obtain a complete and permanent Spanish embargo on the export of wolfram to any country.” (Kimball 1984, 728)

On March 30, 1944, Churchill cabled Roosevelt, prefacing his argument in these terms:

“...we feel entitled to ask you to take our views seriously into account in the Iberian Peninsula, where our strategic and economic interest are more directly affected than are those of the United States.” (Kimball 1984, 768).

Churchill then pointed out the reasons for reaching a quick compromise: (1) the danger that Spain would smuggle wolfram to the Germans (there were thought to be between 700 and 1000 tons of wolfram stockpiled by the Germans in the Pyrenees) while negotiations continued, (2) the potential loss to Great Britain of iron ore from Spain, 42% of Britain's supply, (3) the loss of Spanish potash that was essential for British agriculture, and (4) the long-run loss of Spanish reliance on British financial resources.

The three-cornered struggle among Washington, London, and Madrid continued for another month. Washington and London became increasingly vexed with each other. Washington argued that if the Allies remained firm, they could have a complete embargo. London argued that insistence on complete capitulation was prolonging the negotiations, and harming relations on other important issues. Spain in the British view would resist the humiliation of a total embargo on exports of wolfram to Germany, but would settle for a face-saving formula, with similar practical effects. Finally, on April 25, Churchill told Roosevelt that Britain was prepared to enter a separate agreement with Spain, and to supply her with Oil. (Hayes 1945, 222-23). This threat forced the United States to throw in the towel.

The agreement ending the embargo was reached on May 2. Spain would be allowed to export a maximum of 20 tons per month in May and June, and 40 tons per month thereafter. The U.S. State Department believed that the invasion of Europe, and the control of France, would cut the supplies of wolfram coming from the Peninsula in any case, so that the main point was to reach an agreement that kept wolfram shipments low until the end of June.

Smuggling undermined the agreement on wolfram. With the help of sympathetic Spanish officials the Germans managed to move about 512 tons to Germany in April through

early July 1944 in addition to the 80 tons in May and June allowed under the May agreement³³

The promise to expel German agents from Spain was also evaded with the help of sympathetic Spanish officials. Hoare, the British ambassador, complained repeatedly about the failure of Spain to expel German agents as promised. In his memoir (1946, 270) he complains that two months after the May agreements 201 of 220 German agents on a list the British had given to the Spaniards were still at large. Some political goals were met. The German Consulate in Tangier was closed (although the agents remained on Spanish soil) and the Press, which was controlled by the government, became less stridently pro-Axis (although this would have happened in any case, with the collapse of Germany). But on the whole, the second embargo, although carried out when the allied victory appeared all but inevitable, was a failure.

When the Germans retreated from the Spanish border in August 1944, and it became impossible to ship wolfram to Germany by land, the demand for wolfram collapsed. The price of wolfram, as can be seen in figure 1, tumbled to a level not seen since the German attack on the Soviet Union.

V. A Creative Response

During World War II the United States was forced to deal with a potentially explosive situation in Spain. Spain was neutral, but ruled by a dictator sympathetic to the Axis. In the early days of German triumphs, Spain was tempted to enter the war on the side of Germany, although how great that temptation was is a matter of debate. The loss of Gibraltar to a Spanish-German force and the fortification of Spanish possessions in North Africa, presented a clear danger to Allied forces in the Mediterranean. The question for the United States and

Britain were how to minimize the aid and comfort Spain provided Germany, without driving Spain into the war, and (more for the British than the Americans) without damaging long-term relations with a government that appeared firmly entrenched. The option chosen was economic warfare.

When Franco appeared to be moving toward entering the war on the side of the Axis, the Americans proposed an oil embargo to show Franco what the consequences of joining with Germany would be. The British, although skeptical, went along. This embargo proved to be a considerable, and given the general record of embargos, unexpected success. Spain ran desperately short of oil, and the Germans were unable or unwilling to re-supply Spain. As a result Franco learned how difficult life would be as a full participant in the war, and this appears to have been an important factor in his decision to maintain Spanish neutrality.

This might have been the end of the story, had it not been for the emergence of wolfram (tungsten ore). Spain and Portugal became the only sources of wolfram for Germany after she was cut off from her traditional sources in the Far East. To limit exports from Portugal the Allies reached an agreement with Portugal, which provided that foreign-owned mines would continue to supply their home countries, and that additional supplies would be divided between the Allies and the Axis. This was possible because the Portuguese had a tightly regulated industry. To limit exports from the highly competitive Spanish industry the Allies launched a competitive buying program. This time it was the British who pushed for the policy, and the Americans (at least some) who were skeptical.

The result was a partial success. The Allies managed to buy about 5,000 tons of wolfram in Spain, and over 9,000 tons in Portugal. Germany was forced to economize on

tungsten, and use valuable foreign exchange reserves and even military equipment to purchase the wolfram it did get. But the supply of wolfram proved elastic. Both the Allies and the Germans drew far more wolfram from Spain during the war than they ever had before. And the Spanish government proved adept at milking the wolfram boom for all it was worth. When the Germans ran short of cash in August 1943, Spain accepted a cancellation of the Spanish Civil War debts and military equipment in lieu of cash. In effect Spain found a way to price discriminate -- to charge a lower price to the impecunious Germans and a higher price to the well-heeled Allies. The income generated by the wolfram boom was important to Spain as a whole. In 1944 (the peak year) Spanish exports of wolfram accounted for about one percent of Spanish GDP. Measures adopted in Germany to conserve tungsten, moreover, limited the affect of the buying program on the German war effort.

Nevertheless, our judgment is that the program of competing against the Germans for Spanish wolfram was worth doing. Our estimate is that it reduced German consumption of Spanish wolfram by perhaps a third. Although the cost was high, there do not appear to have been alternatives, even in hindsight, that would have worked better.

The second oil embargo imposed in January 1944 illustrates what might have happened earlier under a more punitive regime. The embargo dragged on for three months while Spain haggled about the terms, and played the Americans, who were intent on forcing a total ban on exports of wolfram to Germany, against the British, who were more inclined to agree to a face-saving formula. An agreement was reached when the British threatened to break ranks and sign a separate agreement with Spain. Smuggling continued during the negotiations and after the agreement ending the embargo was reached. The supply to Germany

was not cut until the land route to Germany was cut by military action.

Another alternative to the buying campaign was more intensive bombing of German production facilities. But this would also have been costly, and on the evidence of the U.S. Strategic bombing survey, unlikely to have been more effective than competitive buying.

The success of the first oil embargo and the partial success of the wolfram-buying program were due to special circumstances that are not likely to be met with in future cases. First, the Allied naval blockade of Europe meant that the United States had to deal with just one other country, Britain, in order to forge a common policy. This, as we have seen, proved hard enough. Normally when sanctions are used, however, there is no naval blockade, and a much larger coalition needs to be maintained to make them effective. If Spain had been free to trade with Latin America, for example, creating an effective oil embargo would have been far more difficult. And had Germany been able to buy wolfram from producers in the Far East, it is unlikely that the Allies could have sustained a successful buying program.

Second, and equally important, the measures used in Spain were pushing the regime in the direction of its own long-run self-interest. Franco remained in power from the end of the Civil War in 1939 until his death in 1975. The decision to remain neutral during the war and the economic boom produced by the Allied-buying campaigns, undoubtedly contributed to that longevity. Unfortunately, the normal case is one in which economic sanctions are being used to try to bring down a regime we don't like. Resistance in those cases will be much stiffer.

The economic war in Spain during World War II illustrates the whole range of possible outcomes. The first oil embargo, although undertaken when things were darkest for the Allies,

provided a useful warning shot. The second oil embargo, on the other hand, although undertaken when the Allies seemed to hold all the cards, proved a frustrating failure. Sandwiched between the embargoes was the attempt to deprive Germany of wolfram by purchasing it competitively in the open market. Although the idea was met with skepticism in some quarters at the time, in retrospect it seems to have worked about as well as could be expected. Sometimes it is useful to "think outside the box."

Table 1. German Imports of Wolfram, 1936-40. (In Metric Tons).

Year	China	India	Portugal	Spain	Total
1936	5,100	900	300	136	8,700
1937	8,037	1,229	304	150	11,400
1938	8,962	1,295	658	119	14,200
1939	4,142	62	638	74	8,000 ^a
1940	800	--	61	394 ^b	NA

Source: Leitz: (1996, 173).

^a Approximate figure.

^b The increase in Spanish exports between 1938 and 1939 appears to be re-exports of Portuguese wolfram.

Table 2. Wartime Production of Wolfram in metric tons.							
Country	1939	1940	1941	1942	1943	1944	1945
China	10,907	8,619	11,334	11,800	8,573	3,184	-----
US	3,217	4,571	6,023	8,422	10,763	9,161	5,055
Bolivia	3,284	4,117	4,284	5,517	6,823	7,810	3,498
Burma (Tungsten)	4,342	4,172	NA	743 ^a	743	743	743
Burma (Tin and Tungsten)	5,593	6,192	NA	1,109 ^a	1,109	1,109	1,109
Portugal	2,932	3,709	5,964	4,049	5,582	3,058	NA
Spain ^b	228	296	504	1,475	3,087	2,416	284
Korea ^c	NA	NA	2,400	2,400	2,900	3,900	1,500
Japan	None	None	667	927	791	650	NA
Siam	341	NA	873	1502	1579	1032	419
Total ^d	36,405	36,413	38,725	44,919	53,422	44,105	19,279
Source: Smithells (1952, 10-11).							
^a Average annual production during Japanese occupation for the years 1942, 1943, 1944 and 1945.							
^b We have substituted our estimates for 1941-44 for Smithell's.							
^c Estimated exports to Japan 1941 to 1945.							
^d The total includes other countries.							

Table 3. Spanish Exports, 1940-1944. In million dollars.

Product	1940	1941	1942	1943	1944
Wolfram	\$0.28	1.00	16.00	63.18	65.61
Oranges	8.93	36.05	35.58	36.88	21.02
Mercury	8.35	8.61	16.26	6.98	0.02
Olives	6.03	5.02	6.13	10.24	12.24
Iron ore	4.69	5.16	8.59	10.63	12.56
Cork	2.75	7.70	9.25	9.42	7.55
Skins, hides, fur.	1.56	6.36	17.43	12.38	8.78
Anchovies	1.28	6.03	11.40	9.00	0.51
TOTAL (Including other items).	75.78	145.50	208.37	318.86	252.57

Source: Leitz (1996, 172). Figures in British pounds were converted into dollars using exchange rates from Friedman and Schwartz (1982, 132)

Table 4. The Importance of wolfram for the Spanish economy,1940-1944					
Year	1940	1941	1942	1943	1944
Wolfram as a percentage of Spanish Exports	0.37%	0.7	7.8	19.81	19.69
Wolfram as a percentage of Spanish GDP	.01%	.03	.32	1.04	1.07
Sources: Exports; Leitz (1996, 172); GDP, Prados (1995).					

Table 5. Estimates of the Effect of the Wolfram-buying Program in Spain on German Wolfram Consumption			
Supply Elasticity	German Purchases in the absence of Allied Buying (Counterfactual German Purchases)	Reduction in German Purchases due to Allied buying	Reduction in German Purchases due to Allied buying
	Metric Tons	Metric Tons	Percent ^a
Zero (perfectly inelastic supply)	8,381	-4,952	-89%
Minimum Estimate (.64)	6,449	-3,020	-63
Mean Estimate (.82)	6,150	-2,721	-58
Maximum Estimate (1.00)	5,905	-2,476	-54
Infinite (perfectly elastic supply)	3,429	0	0
Mean Estimate of Supply Elasticity plus an adjustments for the Cancellation of the Civil War Debt. ^b	4,716	-1,287	-32
Source: See text			
^a The difference between the natural logarithms of the values shown in column (2) and actual consumption, multiplied by 100.			
^b See text.			

Figure 1
Price of Wolfram in Spain
(1941 Pesetas Per Metric Ton of .65-Equivalent Ore)

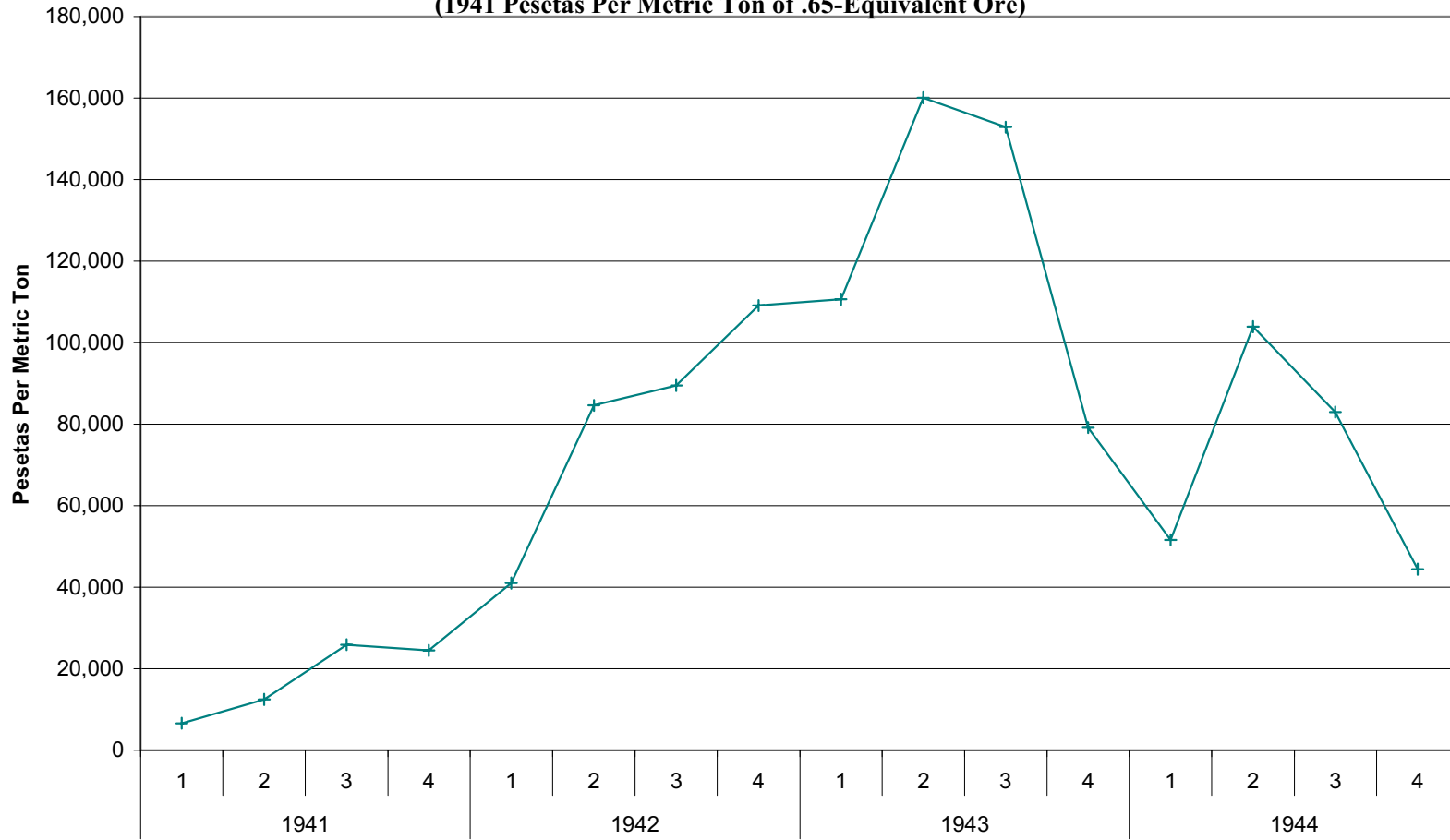


Figure 2
Spanish Wolfram Production
(Metric Tons of .65-equivalent Wolfram)

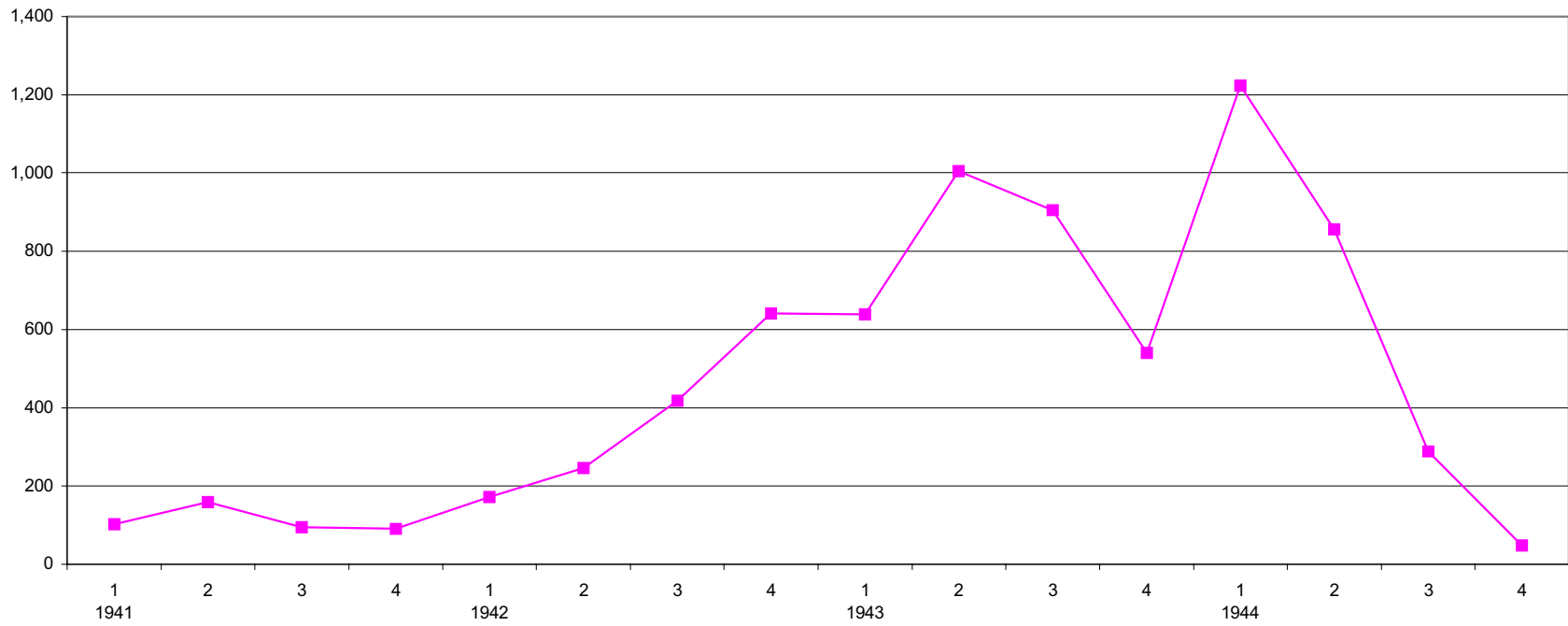


Figure 3
Number of Wolfram Mines

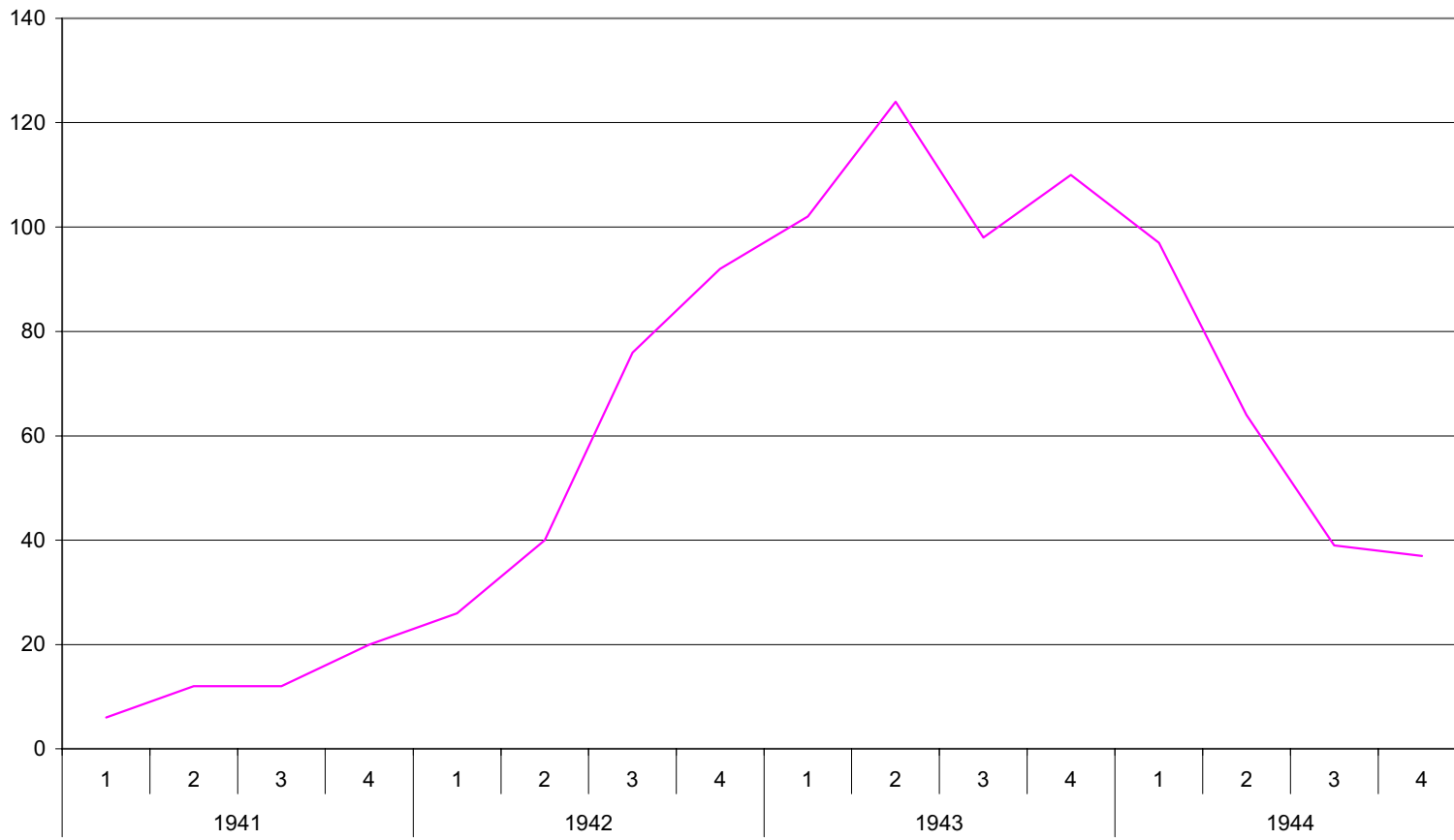


Figure 4
Average Output per Wolfram Mine
(Metric Tons of .65 - equivalent wolfram)

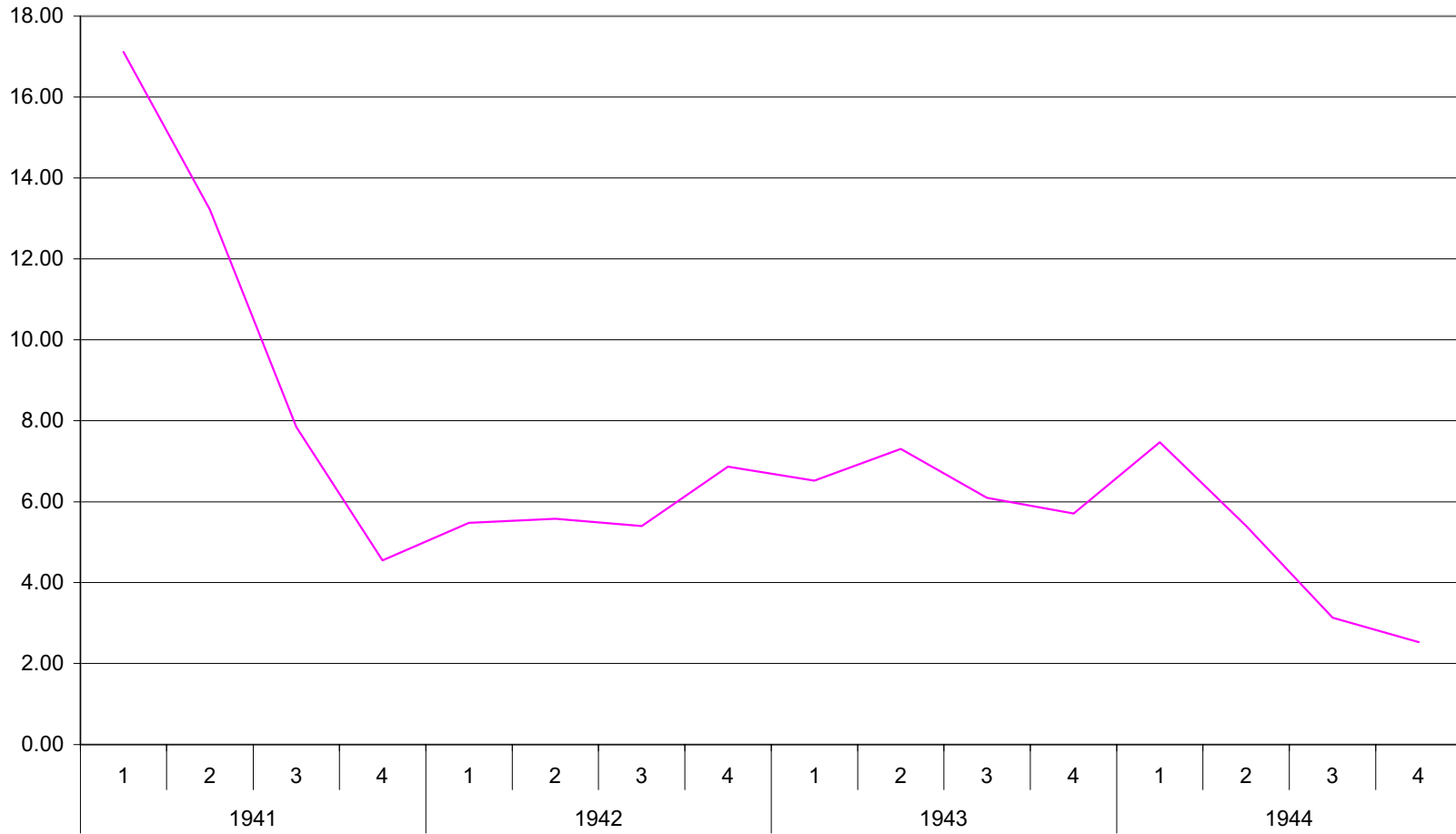


Figure 5
Percent of Tungsten in the Ore

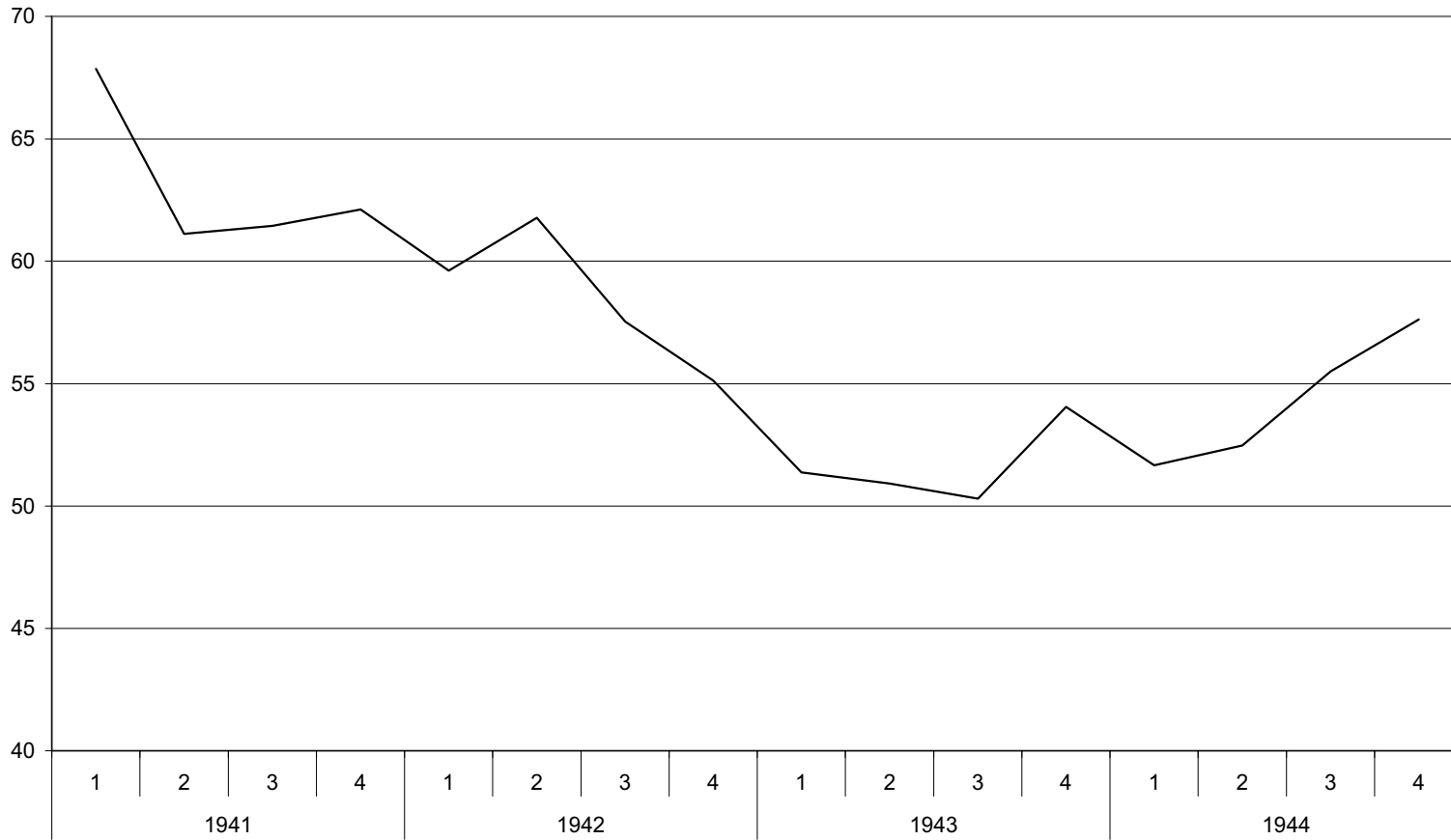
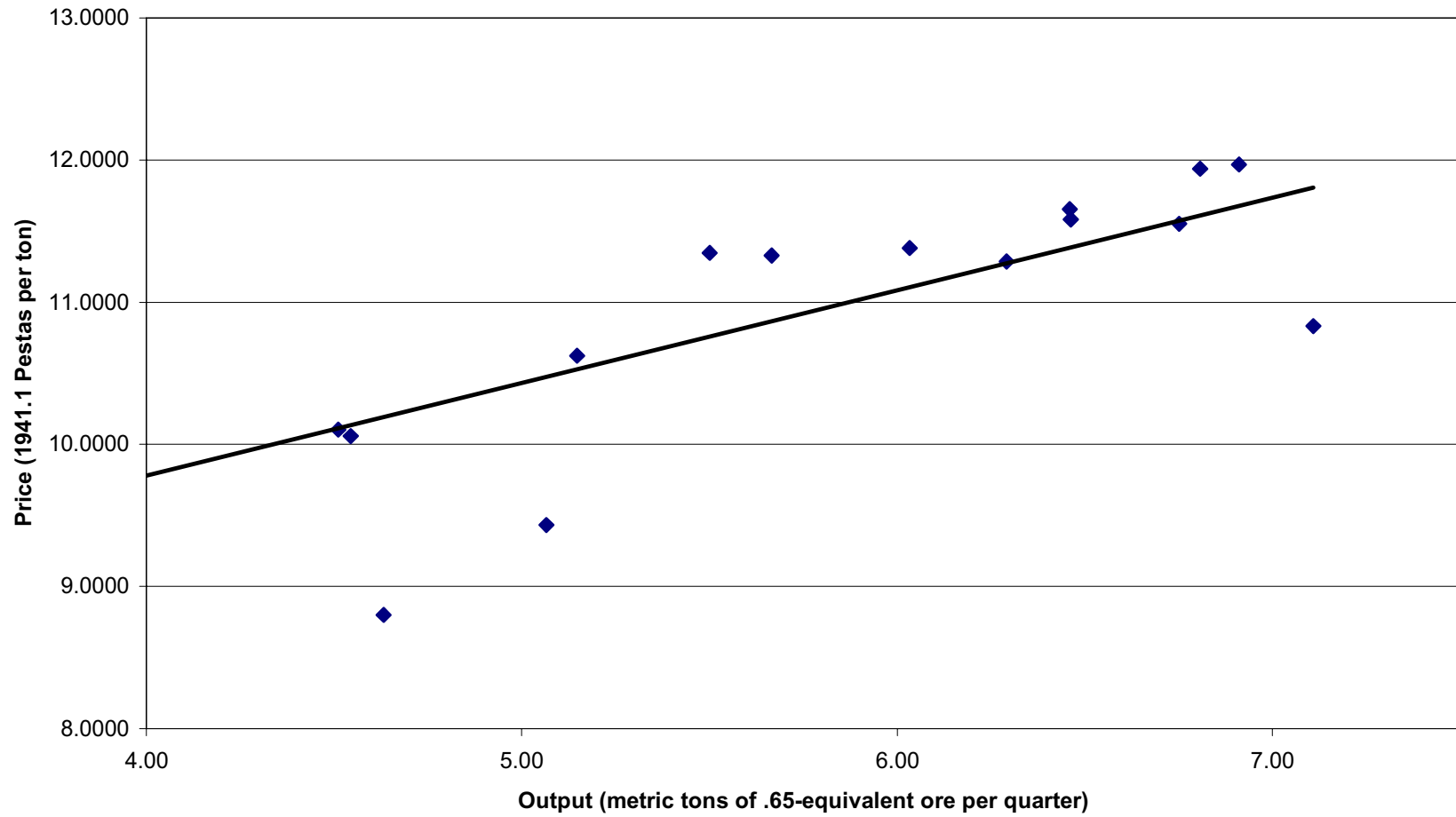


Figure 6
Price and Quantity of Wolfram
(Log Scale)



Chronology of U.S. Economic Warfare in Spain During WWII

1939	April 1	The Spanish Civil War ends with a victory for the Nationalists.
	May 19	Francisco Franco enters Madrid.
	September 1	Start of World War II (Germany attacks Poland)
	September 3	Britain imposes the Navicerts system through which Britain and the United States will regulate Spain and Portugal's seaborne commerce.
1940	May 26 -June 4	Evacuation of British and French troops at Dunkirk. Germany gains control of Western Europe.
	June 10	Italy declares war.
	June 12	Spain declares "nonbelligerency."
	June 14	Spanish troops occupy the International Zone of Tangier threatening British access to the Mediterranean.
	June 19	Spain offers to join Hitler's war against Britain in exchange for economic aid and territories in North Africa.
	July 27 - September 7	The First Oil Embargo. Britain and the United States cut all shipments of oil to Spain.
	September 7	Spain requests a loan from the United States.
	October 23	Franco and Hitler meet at Hendaye. Spain renews its demands for economic aid and all of French Morocco in exchange for joining the war.
1941	July	Spain agrees to end the use of the Canary Islands as bases for supplying German U-boats.
1942	January 24	Germany signs an agreement with Portugal under which Germany will get half of Portugal's "free" wolfram.

	February	The United States begins to buy Spanish Wolfram to keep it out of German hands.
	March 26	United States Commercial Company created to buy wolfram and other war materials.
	September 3	Count Jordana, who is more sympathetic to the Allies, replaces Serrano Suñer, Spain's pro-axis foreign minister.
	November 7	The Allies land in North Africa (Operation Torch). Spanish neutrality is respected, but fears arise in Spain that the Allies may choose to reenter Europe through Spain.
1943	January 7	Spain announces an increase in the production tax on wolfram from \$5,000 to \$15,000 per ton. The increase is later scaled back to \$10,000.
	August 2	Spain withdraws the Blue Division from the Eastern Front, although an element, the Blue Legion, remains behind.
	August 28	Spain and Germany agree on a cancellation of the Spanish Civil war debt, and a transfer of arms to Spain, in exchange for funds with which Germany can buy Wolfram.
	October 12	An Anglo-American force lands in the Azores.
1944	January 22 - May 2	Second Oil Embargo.
	May 2	The "May Agreement." Spain agrees to restrict the export of wolfram to Germany, and to make other concessions.
	August	German troops leave the Spanish frontier.

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Endnotes

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1. This section is based primarily on Caruana (1999).
2. Although its status was unclear, Tangier at the time was an "international" city under Spanish, French, and British administration.
3. Burdick (1967) discusses Hitler's extensive plans for the capture of Gibraltar.
4. State Department. Foreign Affairs, West Europe, microfilm 1244-1.
5. See Preston (1992) and Beulac (1986) for contrasting views.
6. Most accounts do stress the economic weakness of Spain, for example Preston, *The Myth*, p.4. Our claim is only that the role of the oil embargo in bringing home to Franco the ability of Britain and the United States to control the level of deprivation, and the inability of Germany to undermine that control, has been neglected.
7. The best-known use of economic sanctions during the 1930s was the failed attempt by the League of Nations to force Italy to withdraw from Ethiopia. Ristuccia (2000), however, argues convincingly that if the sanctions had included an oil embargo, even one that kept U.S. sales to Italy at their peacetime level, they would have had a good chance of being successful. On the actual sanctions and their effect see Curovic (1997).
8. Sergio Ricorsa, using data developed by the Istituto Centrale di Statistica y del ISCO (*Quadri della Contabilitá* p.4), estimates that in 1940 Italian real income was 123.7 percent of the 1913 level and that in 1945 it was 62.4 percent. (Cipolla 1985, 319).
9. At the time "wolfram" often was used as a synonym for tungsten. Here we use it as the name for the type of ore mined in Spain and Portugal.
10. During the 1930s Gustav Krupp gave his board an example of the importance of his firm's Widia (tungsten-carbide) steel: "... during the 1914-1918 war the turning of a certain grenade with high-speed tool steel required approximately 220 minutes; the introduction of Widia enables the construction of automatic machines which do the work in about 12 minutes. Modern production of grenades without Widia is, therefore unthinkable." (Manchester 1970 [1964], 397-98)

11. The idea that wolfram, and especially Portuguese and Spanish wolfram, would be in great demand during the war could not have been a surprise. There was a similar boom in World War I. Portuguese production rose from 667 metric tons of 60 percent wolframite ore in 1913 to 1,580 in 1918, while Spanish production rose from 169 to 534. The price seems to have risen from under \$10 per ton to over \$90. (Li and Wang 1947, 368-71) If Spain remembered its neutrality and its wolfram boom, it remembered them fondly.

12. Jones was happy, however, to buy wolfram for the U.S. stockpile. In June 1940 he financed the acquisition of Chinese wolfram stored in Indo-China. According to Li and Wang (1947, xiv) this deal was completed within 24 hours after Li first suggested it.

13. Prices were calculated by dividing the total value of ore produced in all reporting mines (probably all mines through most of the period) by total wolframite content of the ore (the sum over all mines of each mine's output multiplied by the wolframite content of its ore), and multiplying the result by .65. We then deflated by the cost of living index set to 100 in the first quarter of 1941. Each mine also reported a price. In a number of cases price times quantity differed from total value, possibly because of recording errors, and possibly because the price represented a modal price, or something similar. The weighted average of these prices, however, is quite similar to the price that we use.

14. There are prices for individual months scattered through the literature. In particular Leitz (1996, 181) cites a number of prices for individual months. In fact, these prices generally agree quite closely with ours (they are generally within one or two percent) once allowance is made for the export tax. (Our prices are pre-tax). This is somewhat surprising because our prices are from a completely different source. The one exception is late in 1944. The value in our series is \$7,691 for the third quarter of 1944 and \$4,922 for the fourth quarter. Leitz gives \$1,826 for September 1944. The sample by this point is small, and some mines are reporting very low prices and sales, similar to Leitz's figure.

15. His background, however, was more in law than economics, as we know the latter discipline.

16. Although Allied pressure to cut off exports grew as D-day approached, the exact timing was a coincidence. (Sweeney 1974).

17. For Portugal the end of the wolfram trade meant losses of more than \$8,000,000 per year, and unemployment of 90,000 to 100,000 persons. But, of course, it was only a matter of time until the war ended, and with it the extraordinary demand for wolfram.

18. The official exchange rate, at which foreign governments bought pesetas, was 10.95 pesetas per dollar. There was also an active black market in Tangier. The black market rate was considerably higher: 1941, 21.49 pesetas per dollar; 1942, 14.99; 1943, 13.25; and 1944, 15.21. Aceña (1989, 391).

19. Sofindus had been organized during the Civil War with the idea of converting Spain into a supplier of raw materials, especially metals, for Germany. Wolfram, however, was not a major focus of attention.

20. *Arriba*, August 15, p. 42. In the September 17, 1940 issue of the same newspaper he said: "The Empire that we announce as our political purpose can not be done alone, it must be done with others," a clear reference to the Germans.

21. Feis (1947, 221), *Foreign Commerce Weekly*, vols. 9-10, 18-19.

22. Whether it was wise to abandon the market at the same time the German's did is debatable. Had Allied purchasing continued, it might have discouraged the Spanish from making the deal that they did make with the Germans, and might have prevented the Germans from buying wolfram at depressed prices when they reentered the market.

23. At one point there were plans to purchase Spanish rabbit fur in order to pre-empt the Germans, who needed warm gloves for the eastern front. The plan was abandoned, however, when it was realized that the supply of rabbits indeed might be perfectly elastic.

24. Spain may also have been influenced by the Fascist idea that data should be collected on the availability of raw materials potentially useful to the military, so that those materials could be directed to their proper use in wartime.

25. Kemler (1949) provides a good physical description of the mining boom. Kemler served on the staff of the United States Commercial Company, and at the U.S. embassies in Lisbon and Madrid.

26. These are mines registered with the government. Some report no sales of wolfram during certain quarters.

27. A back-of-the-envelope supply elasticity -- the percentage change in output from our first observation in the first quarter of 1941 to the production peak in first quarter of 1944 divided by the percentage change in price -- is 1.22, similar, but slightly higher, as would be expected. On the other hand, if the natural logarithm of the price of wolfram is regressed on the natural logarithm of the quantity produced, then the implicit elasticity of supply is higher: 3.85. But it likely that output is measured with greater error because of the omission of some mines so the result from the regression of quantity on price appears more reliable.

28. This assumes a conventional demand curve. Although there were many consumers of tungsten in the German economy, it was possible for the Germany government to set overall price and quantity restrictions. So in the absence of Allied competitors, the Germans could have acted as monopsonists, purchasing less wolfram but at a much reduced cost. The Spaniards, in turn, might have countered, for example by setting a minimum price. When all

was said and done the result might not have been far different from the competitive solution assumed in the text.

29. We ignore the export tax. This would be strictly correct only if it were an ad valorem tax.

30. In the more general case, when German demand is given by $Q_g = DP^{-\varepsilon}$, (3) becomes

(4) $\Delta Q_g = -Q_a [\varepsilon/(\varepsilon + \alpha)]$, which reduces to (3) when $\varepsilon = 1$.

31. In principle one could take another complication into account: the distribution of purchases through time. If the ratio of Allied purchases to German purchases remains steady from period to period, the result will be the same whether separate calculations are made for each sub-period or for the episode as a whole.

32. Feis (1947, 255-261) and Leitz (1996, 189-193). Cortada (1971), who did not have access to the German and Spanish documents, speculated that smuggling was limited.

33. Some of this wolfram appears to have been paid for with gold. Leitz (1996, 192-93).