Government Institutions and Economic Development in Tokugawa Japan: A Tale of Systems Competition

by

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Abstract: This study focusses on the influence of the government institutions of the Tokugawa regime (1600-1867) on economic development. The Tokugawa shogunate is of interest in that, a) it coincides with the lead-up to and start of the Industrial Revolution in Europe, and b) Japan was considered by visitors to be a relatively advanced country at the start of the Tokugawa shogunate, and would later become the first non-western country to industrialise. Another reason to study the Tokugawa shogunate is that its government institutions were quite different from both those in use in Europe at the time, as well as those of the pre- and post-Tokugawa Japanese regimes. Where Europe can be described as a States System with both internal and external competition between states, the Tokugawa system was aimed at minimising competition of any kind. Shogunate institutions included strict controls on the warrior class, occupational mobility and international contact.

There are therefore compelling questions on how to view the role of the Tokugawa regime: Was it a hinder to economic development? Did it help create the circumstances for later industrialisation? These questions are approached from the viewpoint of government institutions and through the concept of Systems Competition.

The Tokugawa regime did have certain strict regulations and substantial expenses toward preserving peace and stability. On one hand, the resulting increasing isolation made Japan miss out on certain technological and institutional advances, as well as trade opportunities. On the other hand, the Tokugawa regime did provide circumstances for peace and economic growth and involved commoners in the administrative process down to the village level and below.

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Introduction

In 1844, shortly after the conclusion of the First Opium War, King William II of the Netherlands wrote a letter to Tokugawa Ieyoshi, shogun of Japan. This communication was an unprecedented step between the rulers of these nations. William II advised Japan to move away from its traditional trade restrictions, given the danger of being drawn into a trade war, likely with England. It read in part:

> *"The number of all sorts of vessels sailing the Japanese seas will be greater than ever before, and how easily might a quarrel occur between the crews of those vessels and the inhabitants of Your Majesty's Dominion! The thought that such quarrels may end in war fills us with solicitude."*[2]

- William II (Greene 1907, part IV, p. 112)

The reply from Shogun Ieyoshi's advisers was polite but dismissive. It contained the line:

> *"Now since the ancestral law has been once fixed, posterity must obey."*

- The Gorōju of Japan (Greene 1907, part IV, p. 122)

A few years later – after a famous and onerous confrontation between US Navy Commodore Matthew C. Perry and the shogun's forces in Tokyo Bay – Japan had to give up its "ancestral law" and shortly afterwards its ruling dynasty. This was a distinct difference with the balance of power at the beginning of the Tokugawa dynasty (1600-1867), when it could decide without hesitation which countries' traders to admit to its shores. In the intervening years not only had Western technology improved significantly, the reach of Western empires over the world had also grown by a considerable amount.

When Japan opened in the second half of the 19th century it was set on a course of modernisation that led to it becoming the first non-western country to industrialise and once again be on equal footing with western powers. Japan is an idiosyncratic case in economic history, and its government institutions are a significant part of that. Did the old Tokugawa regime hold Japan back from modern economic growth? If so, what were the particular elements that might have prevented Japan from modernising? In this paper I will explore the way in which Japan's economic development was influenced by the institutions of the Tokugawa government.

2 "Het zwerven van allerlei schepen in de Japansche zeeen zal menigvuldiger dan vroeger worden, en hoe ligtelijk kan er twist ontstaan tusschen de manschap van die schapen en de ingezetenen van Uwer Majesteits staten! De gedachte dat uit zulk een twist oorlog kan ontstaan vervult ons met bekommering." Idem, p. 107.

Chapter 1: Institutions as Cause for Growth: A Review of the Literature

1 Introduction

This thesis discusses the economic development in the Tokugawa period, focusing upon the role of government institutions. This chapter will discuss the relevant theoretical context and definitions for key terms.

The central topic of this thesis is ‘government institutions’. In this case, the term ‘government’ is used in the broad sense of “the system by which a state or community is governed” (Oxford English Dictionary, 2017). Weber’s definition for ‘state’ is: “a human community that (successfully) claims the *monopoly of the legitimate use of physical force* within a given territory” (Weber 1946, pp. 3-4, italics per original). Hoffman argues that few entities in the pre-modern world would be able to claim this monopoly. Instead, he advocates for a definition where a state is a community that meets two requirements: “First, it can employ violence, although it may not have an effective monopoly on its use. Second, it can levy substantial permanent taxation.” (Hoffman, 2015, p. 307). Further, Hoffman suggests that an entity often becomes a state when it gains the ability to “impose and collect significant amounts of tax revenue, not just temporarily during emergencies, but for the foreseeable future” (Hoffman 2015, pp. 306-07).

Thus, ‘government’ includes pre-modern regimes such as the feudal systems of medieval Europe. This definition is more general than others, which include only *modern* governments; those being typified by an extensive system of laws and regulations, a professionalised bureaucracy, specialised organisations and an advanced system of taxation.[3] In the case of early modern Japan (1600-1867), we see not merely a single, unitary government, but rather three distinct levels of government. In descending scale, these levels ranged from the national, through the sub-national to

3 The evolution from the former to the latter type has been extensively described, for instance in these works (Tilly 1992; Bonney 1999).

the municipal level.[4] These three levels of government each had their own implicit powers and active policy areas, not unlike a federal system. The details and workings of this system will be described in the next chapter.

The second definition to make clear is that of institutions. In the words of North, institutions are "humanly devised constraints that shape human interaction." (1990, p. 3). Institutions have been extensively studied in the light of their potential to be key determinants of economic performance, from as far back as Marx and Weber, and more recently in the *New Institutional Economics* (NIE) school of thought, a term coined by Oliver Williamson (1975). The NIE is concerned with the effects of institutions on economic performance, as well as the determinants of those institutions. According to Matthews (1986, p. 903) it is this latter aspect that sets the NIE apart from previous works. In this study I hope to contribute to both these endeavours.

The remainder of this chapter continues discussing the topic of government institutions, and is structured as follows: first I will focus on the types of government institutions and why they matter; then I will lay out my approach for studying Tokugawa government institutions, including a framework that fits institutions within social and economic fields of study; then I will briefly discuss the determinants of institutions; and, most central to my argument, I will put forward the importance of '*Systems Competition*' – an existing concept that has so far not been used to analyse pre-modern history – to describes dynamic effects that shape the institutions of interacting governments. I will finish the chapter with a discussion of Tokugawa Japan's position in relation to these concepts.

2 The Importance of Government Institutions

2.1 Government institutions

Why should we study government institutions, or any institutions for that matter? Institutions matter because they structure the interactions that take place in society. They shape incentives and economic outcomes (North, 1990). One prevalent explanation for the importance of institutions is based on property rights (Williamson, 1998), for which the commonly held reasoning is that uncertainty in property rights lowers one's expected future value of savings and returns from investments, since that property could be taken away. This creates a disincentive to invest money

4 The national level is known as the shogunate/bakufu, the domain level as daimyate/han, and the municipal level as shichōson (city-town-village)

and energy to, for example, develop and improve businesses as well as innovate. According to this line of reasoning, societies with better protection of property rights invest more, and will consequently have higher economic growth. This line of reasoning can be expanded to include contract enforcement, since an important aspect of property rights is the ability to receive money in exchange for, as an example, selling or renting out property. As such, contract enforcement is a crucial means to facilitate the proper functioning of markets (Acemoğlu 2008, p. 135).

The state often plays a crucial part as a provider of property rights protection and contract enforcement. As far back as 1651, Hobbes ([1651] 1996, p. 222) wrote:

> "The office of the sovereign, (be it a monarch or an assembly,) consisteth in the end, for which he was trusted with the sovereign power, namely the procuration of the safety of the people ... But by safety here, is not meant a bare preservation, but also all other contentments of life, which every man by lawful industry, without danger, or hurt to the commonwealth, shall acquire to himself."

Hobbes' *Leviathan* was written during the English Civil War, and one of the main themes is the importance of a strong and unchallenged sovereign, to prevent internal strife and anarchy ([1651] 1996, pp. 115-122). Modern works in part agree with, and expand on this theme; for instance Olson states that under conditions of "anarchic violence" there can be no guarantee of property rights, but also that the protection of these rights depends on the incentives of the ruler (1993, p. 567). Olson (1993) contrasts the incentives of rulers with different levels of security in their authority. In this framework, insecure rulers become under-investing and over-extracting "roving bandits", while rulers that can expect a long tenure – or even a dynasty – become more growth-oriented "stationary bandits" (1993, p. 568). Here the property rights become two-tiered.

On the first tier, if a ruler can expect many years of tax income (i.e., they are secure in their property) then they will not plunder, but instead invest in their territory to grow their income over the course of what is anticipated to be a lengthy reign. Their subjects will, in turn, be protected from excessively harsh government treatment, and it is in the ruler's interest to provide subjects with certain property rights protection to increase their output. Olson (1993) further argues that enforcement of contracts and a stable currency are essential for making long-term investments. In a theoretical paper, Acemoğlu (2005) arrived at a similar binary model. He presumed that a self-interested leader, trying to maximise tax income for their own consumption, would suffer through either overly weak or overly strong states. A weak state is typified by a lack of ability to tax, regulate and improve the economy, while a strong state does have that ability. When the state is too weak, the future control over the executive is uncertain, and the ruler will under-invest in public goods, in turn hurting economic growth. When the state is too strong, the ruler is able to divert too

many resources for their own consumption, resulting in excessive taxation and slowing down economic activity.

North (1979) also made the case that not only does the state set the “rules of the game” (p. 252), but it has the complementary aim of reducing transaction costs in order to maximise its income. In situations where contracts are costly to negotiate and enforce, this leads to state-provided (semi-)public goods. Similarly, Dixit (2009) considers three governance principles as essential for economic activity: secure property rights, contract enforcement, and collective action. The addition of collective action concerns the management of public goods and ‘bads’, and prevents free-riding. While this is in broad accordance with North, Dixit stresses that, although these conditions are often provided by government, this is by no means the only option. Greif’s (1993) work on the Mahgribi traders’ network is a well-known example of non-governmental contract enforcement, in this case through a reputation mechanism. However, of the institutions in question, Dixit considers property rights to be the area that becomes most problematic without government involvement, for instance for subgroups that fall outside of private property rights protection arrangements.

The fact that states play an important role in economic development does not mean their influence is always positive. Greif (2005) writes that for the proper functioning of markets, two crucial institutions need to be present: contract enforcement and coercion constraints. Coercion constraining institutions protect against the confiscation of property by those in power, including the state. Greif (2005) succinctly states: “This implies a dilemma: a state strong enough to protect rights is also strong enough to abuse them.” (p. 731). According to Greif (2005), whether and how this dilemma can be solved depends on the initial, spontaneously formed contract enforcement institutions, because these in turn determine the potential intentionally created institutions as demanded by economic actors.

An example of the successful balancing of contract enforcement and coercion constraints is given by the influential study on early modern England by North and Weingast (1989). They stressed that the events of the English Civil War and the Glorious Revolution resulted not only in enhanced property rights, but also a *credible commitment* by the ruler to uphold those rights. In their description, during the 17th century the English government moved from an arbitrary and coercive fiscal policy to a practice of bargaining with parliament for its funds. They reasoned that this bargaining is only possible when other economic actors trust the government to keep to its word, which in turn relies on effective limits to political power. In England’s case, this was achieved through the increased power of parliament at the cost of the crown. North and Weingast argue that the successive removals from the throne of Charles I and James II created a *credible threat* that

prevented the crown from breaking its word, resulting in a *credible commitment* to property rights. By co-operating with moneyed interests, the English Government's financial situation improved through low-interest loans and tax income. In exchange, wealthy citizens gained political influence. The effectiveness of this bargain was a further reason for the Crown to respect the new status quo.

2.2 Government types

Depending on its institutions, a government can be classified within one or more categories. In discussing and comparing governments, it may be helpful to define common types of government, and the ways in which these types have changed over the course of history. From a modern perspective, we may have certain expectations from governments that differ from historical government policies. Modern government policies are aimed at e.g. trying to grow the national economy, increasing the tax base, keeping the population content, and keeping the ruling powers in office. Historically speaking, the incentives for governments were often different. In both capacity and intent, modern advanced economies differ substantially from early modern ones. As Lindert (2004) has comprehensively described, early modern governments spent relatively very little money on social programmes such as poverty relief, healthcare and education. In modern times, these have become the dominant spending categories in advanced economies. Within the context of early modern governments, public goods are often limited to more fundamental public goods such as legal systems, (national) security, infrastructure, and so forth.

The transition from feudal and early modern government, to modern government, has of course been extensively researched and described. In general, it is assumed that modern government types are necessary and/or beneficial for higher economic development. Tilly (1992) has constructed a framework for the developmental stages of European states, encompassing the changes in governance, taxation and the organisation of civilian and military functions, from medieval to modern times. At the start of the period that Tilly describes, the mid- to late medieval period, revenue systems consisted mainly of tributes or land rents in kind. The military was made up of retainers, vassals or militia. In pre-modern Europe, the overwhelming majority of state expenditure was expended upon the military (vis. Yun-Casalilla, O'Brien, & Comín, 2012). Tilly shows that, as economies developed and became more monetised, this created opportunities for taxes on transactions and values, such as excise, customs, income or property taxes. In many states, this change coincided with standardisation of taxes and a reduction in their arbitrariness. According to Tilly, in more monetised economies the state was often able to leverage the wealth of its citizens to pay for mercenaries and increasingly advanced weapons. This advantage was augmented by the

development of financial markets – including those for government bonds, especially war bonds – that enabled large revenues to be raised quickly in capital intensive areas. This high-capital, low-coercion model (common within Italian city states and the Low Countries) is contrasted by the low-capital, high-coercion model (as seen in Russia and different Scandinavian states). Similar to what North and Weingast (1989) illustrated for England – but more broadly – Tilly describes an increase in bargaining power for the citizens whenever a state increases its demands and dependency on either people or capital. In Tilly's estimation, most European polities eventually more or less converged as they formed nation states with relatively high capital as well as coercion (1992, p. 132ff.).

Tilly is also often cited for his ideas on the contribution of warfare to state formation. The two-stage mechanism through which states developed was initially through increasing their capacity to extract funds for war and to organise the making of war itself, then subsequently through growing bureaucracies with their own objectives besides war and finance. Whichever group had bargaining power over the state could then use its influence to change government policy. Over time European states also transformed from indirect rule–where much of the power was held by local aristocracy, urban oligarchies, and the like–to direct rule by a centralised government. While indirect rule had the effect of diminishing the chance of large, nation-wide uprisings, it also made it more difficult to uniformly apply standardised national policies. As rule became more direct, people, capital interests and others gained bargaining power with the state. Either through force or to prevent protest, European states amended their objectives to include the interests of other, non-government power bases. By the 19th century, this resulted in growing social programmes in many states and advanced states had become much more financially powerful, and at the same time, government goals had aligned with those of a larger portion of the population, leading to more inclusive government (Tilly 1992).

Another influential scholar who studied the fiscal development of European states is Bonney. Bonney and Ormrod built on Schumpeter's (1991) theory of European development from domain states to tax states. In the Bonney-Ormrod model, there are four stages of fiscal organisation: tribute state, domain state, tax state and fiscal state (Bonney, 1999). Tribute and domain states are based on a feudal organisation that receives its main revenue in the form of tribute, or from lands held by the ruling family. During the early modern period, tax states became more and more prevalent. They are typified by broad taxation on various groups in society, and by the end of the 17th century often had long-term public debts. Through the use of loans, states could meet the sudden and growing spending needs of gunpowder warfare. This also put commercialised areas at an advantage because

of the larger financing capacity of the local population. As a result, the rich citizens of these areas gained in political power (Hart, 1995).

Dincecco (2009) has presented a categorisation for government fiscal organisation that is based on two factors: the level of centralisation and the level of limits upon the ruler's powers. The 'Old Regime' was fragmented and absolutist, while more advanced states are those in which fiscal power is both centralised and limited, as in a fiscalised parliamentary system. In his classification, most European countries had reached this stage by 1913. He also found that centralised and limited governments were able to generate higher tax revenues than those classified as Old Regimes.

Acemoğlu and Robinson (2016) contribute a recent and generalised effort on the theme of coercion in state formation, entitled: 'Paths to Inclusive Political Institutions'. They describe the most successful states as having not only capacity to affect real-world conditions, but also a wide political power base. This 'inclusive' type of government takes into account the wishes and needs of a broad section of society. As Acemoğlu and Robinson (2016) set out, not only does inclusive government provide better circumstances for citizens, it also leads to more citizen support for government, making it more capable. They also give examples of states without a broad power distribution, that become either 'Paper Leviathans' (governments that lack both broad support and power) or 'Despotic Leviathans' (governments that lack broad support, but do possess power). In contrast to these three forms, Acemoğlu and Robinson also give an example of a society that fails to create a state at all. They further reason that societies with inclusive political institutions have sustained economic growth, since incentives of both the state and the rest of society are aligned towards cooperation and the promotion of economic growth.

The different types of government discussed in this section may have distinct advantages and disadvantages to economic performance. North (1979) has described the state as both a requirement for economic growth as well as an impediment to growth. This apparent contradiction follows from the capacity to either provide property rights or to take property away by coercion. The state has other powers as well, such as the provision of public goods. In conclusion, states are in a unique position to affect institutional change since they can design and create new institutions, and have the legal power to force others to respect these institutions (Matthews 1986). In the next section I will discuss the effect of government institutions on economic outcomes.

2.3 Effects of institutions on economic outcomes

Given the theoretical underpinnings discussed above, a reasonable question is: what empirical evidence is there that the supposedly more advanced and beneficial government institutions deliver

good economic outcomes? The dominant claim in the literature is that economic growth is helped by better assurances of property rights. Credible commitments to property rights in turn depend upon a balance to government power, including a credible threat to whomever holds that power. One of the ways to institutionalise that threat is through a democratic system. Following this line of reasoning, more democratic societies should have higher economic growth, through better assurances of property rights. Acemoğlu et al. (2005) noted the correlation of democratic institutions and high income per capita, but found no causal effect of income on democracy after controlling for country-specific factors and applying an instrumental-variables approach to isolate the causal effect of income. They concluded that historical factors were likely the strongest factors to affect both income and political institutions. However, neither could they eliminate the possibility of a positive effect of democratic institutions upon income per capita. Acemoğlu et al. (2014) revisited the subject. Again controlling for country-specific effects, they found a positive effect of democracy upon GDP per capita. Their results and interpretation suggest that the effect of democratic institutions on economic performance works through three channels: economic reforms, lowering unrest, and raising public goods provision (such as public health and schooling).

A portion of research has tested the effect of wars on fiscal institutions, and some even extended this to economic performance. Kiser and Linton (2001) found strong positive effects of wars on tax levels in England and France. Moreover, they found that successive wars had cumulative positive effects on taxes. After a war, taxes did not fall back to pre-war levels. This "ratchet effect" (Kiser & Linton 2001, p. 414) can feed into a process of bureaucratisation, since part of the revenue was expended upon bureaucrats who protected their position after the war. Karaman and Pamuk (2013) investigated military, economic and political interactions in early modern Europe. They found that the level of urbanisation and commercialisation mattered in answering the question of which political institutions achieved higher yields during wartime. Under representative regimes, the more developed areas had higher tax revenues, while under more authoritarian regimes, rural and agrarian areas had higher revenues. Besley and Persson (2010) found that government legal and fiscal capacity are important for economic performance, such that greater capacity leads to higher economic development. Further, they found an increased risk of internal conflicts when government legal capacity is lacking. Dincecco and Katz (2014) revisit the issue of government centralisation and limitation, finding that centralisation – and to a smaller extent stricter government limitations – increased a government's fiscal capacity. In turn, this increased fiscal capacity led to higher economic growth. Dincecco and Prado (2012) used pre-modern war casualties as an instrumental variable to estimate how fiscal capacity affects economic growth. They found empirical support for

their rationale that greater participation in war stimulated the development of fiscal institutions, which in turn benefited economic performance. In these works, a convincing case is made for war as a shaping force in the institutions of (at least) European states, and through these institutions, economic growth is impacted.

On the other hand, the improved economic performance of dictatorships such as South Korea and Taiwan in the decades following WWII raised questions about the possible economic benefits of these systems (Wade 1990). From this perspective, democratic political institutions might not be the root cause for growth; instead, the reverse could be true: economic development could be the cause of improvement in political institutions. Barro (1996) used a 100-country panel running from 1960 to 1990 and found that at low levels of political freedom, democratic developments improve economic growth, but at high levels of political freedom the effect disappears or even becomes negative: in other words, the effect of democratic development upon economic growth appears to be moderated–to no or even negative effect–by political freedom. He notes that a higher standard of living seems to promote democratic institutions, and that from a certain level, these institutions seem to function as a luxury public good. His conclusion is that poor nations have the most to gain from improving property rights and free markets; those from a lower democratic and economic baseline are likely to have the sharpest gains. Glaeser et al. (2004) found that existing research was unable to establish the direction of causality between political institutions and economic performance. They note that political institutions seem to have a second-order effect, after the first order effect is provided by human and social capital. Further, they do not find that democratic institutions and constraints on the government are required for economic growth.

However, this line of reasoning is somewhat at odds with the NIE perspective. Not only does NIE consider beneficial institutions to be the root cause of economic advancement, it sees concepts like technology and human capital as an important result of these beneficial institutions. In the words of North and Thomas (1973): “The factors we have listed (innovation, economies of scale, education, capital accumulation etc.) are not causes of growth; they *are* growth.” (p. 2, italics in original) Therefore, whether institutions affect economic development directly, or through factors like human or social capital, they appear to be an integral piece of the puzzle in explaining economic development. Further, Glaeser et al. (2004) and Barro (1996) all consider democratic institutions desirable in their own right, if not as a driver of growth then at least as a public good.

3 A Framework for Analysing Institutions

3.1 The 5 levels of study

Institutions are a broad concept, as evidenced by the definition introduced in the beginning of this chapter: “humanly devised constraints that shape human interaction.” (North 1990, p. 3). Useful definitions also make clear what falls outside of them, and how their constituents might interact with other concepts. Williamson (1998, 2000) introduced a useful scheme for categorising such concepts. He separated four levels of social analysis that focus on different aspects of institutions in the broad sense (levels 1-4, Table 1, below). These levels are the subject of different fields of research, and work at different time scales.

Table 1: Williamson’s (1998) Levels of Analysis, with Author’s Addition

Level of analysis and main concepts	Field of study	Time scale
4: Resource allocation and employment: (prices and quantities; incentive alignment)	Neoclassical economics/ agency theory	Continuous
3: Governance: play of the game – especially contract (aligning governance structure with transactions)	Transaction cost economics	Years to decades
2: Institutional environment: formal rules of the game – especially property (polity, judiciary, bureaucracy)	Economics of property rights	Decades to centuries
1: Embeddedness/Culture: informal institutions, customs, tradition, norms, religion	Social theory	Centuries to millennia
0: Geographic Endowments: climate, topography, prevalent diseases, natural resources (including plant and animal habitation)	Geography	Millennia and longer

Note. Adapted from Williamson (1998, p. 26, fig. 1). Level 0: author’s addition.

Level **four** in Williamson’s hierarchy is the domain of neoclassical economic decisions, taking certain parameters as given, based on the underlying levels of the model. Where level four is centred around marginal analysis and optimisation of price and output, the other levels are about structural analysis. The division of economic activity between organisations (level three) and markets (level four) is the subject of some of Williamson’s best known works (1979, 1981, 1998).

Most government decisions take place at level **three**. Here, actors are taking place in "2nd-order economizing" based on prevailing institutions as described one level below. (Williamson 1998, p. 26).

Level **two** of Williams' model consists of the formal institutional environment. In Williamson's view, property rights are the most important feature of these institutions. This level is also where the government's political, judicial and bureaucratic institutions are located. Williamson describes deliberate change in these institutions as possible, but only under extreme circumstances. Notably, he mentions the Meiji Revolution as an example of one of these exceptions. (Williamson 1998, p. 28)

The difference between levels two and three can be characterised as the difference between "the formal rules of the game" (level two) and "the play of the game" (level three). Davis, North and Smorodin (1971) describe a similar divide: at level two, the institutional environment codifies the fundamental rules for property rights, elections, and other governmental functions. This is captured – in the American case for instance – by the constitution, its amendments, and its interpretations. Within these basic rules, 'institutional arrangements' (level three) function as co-operations between economic units with more specific goals. For instance, these can take the form of businesses, government organisations or citizen groups.

The institutional level in turn depends on the level below. Level **one** of this classification structure includes deeply held (informal) norms, traditions, and culture. These change very slowly, over the course of centuries to millennia. Such change is generally gradual, and not subject to deliberate manipulation. Economists often take the conditions on this level as given, although there has been more interest in this topic recently. One of Greif's (2006) contributions in this field is that institutions can only persist and be enforced if they are supported by the culture of the society in which they exist. In addition, he views institutions as equilibria that are part of historical processes. Greif describes these equilibria as path-dependent. He stresses that historical events can determine whether an institution changes with its environment, or persists in the face of change. This view is similar to the concept of 'basins of attraction' used by Acemoğlu and Robinson (2016) in their work on inclusive political institutions. They posit that these inclusive institutions depend on supportive informal institutions and social norms.

Institutional economics is generally concerned only with levels two and three. Each level influences the level above it (i.e., those with higher numbers). Effects in the opposite direction (e.g.,

from level four to level three) can also occur, but these are envisioned as secondary feedback effects to the primary causal direction of the model.

Although Williamson's own work is mostly concerned with levels three and four of the model, his framework can be very useful for the purpose of comparative historical economic analysis, as in this thesis. For this same purpose, it might also be expanded with a level below the informal institutions. Williamson himself (1998) suggested a possible underlying evolutionary level zero to describe the path to modern humans starting in the Pleistocene. For the purpose of comparative analysis however, I believe that a level **zero** that includes the geographic condition of a society would be more valuable. The importance of geographic factors for economic development in general is well-established. For instance, Acemoğlu (2008) considers the four determinants of economic growth to be: luck, geography, culture, and institutions. Geographic endowments also affect the higher levels, in keeping with the bottom-up influence direction of Williamson's model. Topography, weather patterns, prevalent diseases, and the availability of specific crops and domesticable animals are all among the factors that influence a population's informal and formal institutions. Diamond (1997) gives a compelling overview of the many ways through which geography influences cultures and outcomes. Wittfogel's (1957) 'hydraulic society' – in which certain geographic circumstances give rise to large-scale water management systems and specific types of government to enable them – is another classic example. Acemoğlu, Johnson, and Robinson (2002) found a significant effect of ocean access (specifically, access to the Atlantic Ocean) on institutional change. Other works have proposed geographical explanations for Europe's long-lasting fractional nature in comparison with other densely populated areas–notably China–that formed unified empires instead (Jones 2003; Ko, Koyama, and Sng 2014). This makes geography a valuable level of analysis, to be placed below the level of culture in the framework.

Together, the five levels of this model (i.e., geographic endowments, informal institutions, formal institutions, governance and resource allocation) provide a comprehensive set of perspectives that allow for explanations of the causes of differences in economic development between states. This model also provides a framework for discussing institutions, their economic effects, and their determinants.

3.2 Determinants of institutions

Of the five levels described above, geography and culture are key circumstances in which (government) institutions develop. These two factors are therefore suggested as important determinants of institutions. In this section we will take a short look at these factors in turn.

3.2.1 Geographic effects

Accidents of geography determine the environment that societies and states face. They set the physical, climatological and biological environment, and by extension the potential trade partners and rivals in its vicinity. In Europe for instance, the subcontinent was and is a series of fertile plains, divided by mountain ranges and water features into medium-sized subregions. This gave rise to a group of small- to medium-sized states, who were at times each other's trade partners, allies, and enemies. Since the Roman times however, no empire rose to dominate the region, partly through shifting alliances to counter any rising powers (Jones 2003). In Asia, on the other hand, the dominant systems that established themselves between 1000 and 1500 are very different. Jones (2003) identifies the primary examples as the Ottoman Empire, the Mughal Empire, and the Manchu Empire. These are all externally-imposed and resource-extracting, military regimes from the Eurasian steppes. Ko, Koyama, and Sng (2014) have sought to explain this structural difference between the European states system and the Chinese Empire system (under its various dynasties) by the size and direction of threats faced. Europeans faced medium-sized external threats from different directions, while China faced mainly a single, large, external threat from the Northern steppes. The latter threat stimulated a unified response, which in turn led to a single empire-sized state. Turchin et al. (2013) have approached the same topic with a different investigative methodology: computer-simulating the spread of complex societies over Afro-Eurasia across time. In their simulation model, they found that agricultural societies develop into more complex forms when exposed to steppes. The steppes function as a source of military technology (e.g., the spread of cavalry-based warfare by nomadic tribes), and the military threat drives surrounding populations to form larger, more powerful, and more complex polities.

This body of research makes a compelling case for the effects of geography on the types and sizes of states that form in a certain region. The size of – and relationships between – states had further consequences for the development of different regions. As argued by Tilly (1992) and others (Rasler and Thompson 1985, Brewer 1990, Bonney 1999, Dincecco and Prado 2012), the frequent European wars between states, and the military revolution, led to rising military expenditure and taxation. In turn, this led to increasing fiscal capacity and growing state bureaucracies. Ko, Koyama and Sng (2014) argue that China's centralisation made it more susceptible to foreign invasion and domestic political crises, since the central regime cannot effectively protect the entire area of the empire.

Besides these effects on government types, geography has been used to claim or explain cultural differences, as is stated in the aforementioned works addressing this topic (Diamond 1997; Wittfogel 1957; Acemoglu, Johnson, & Robinson 2002).

3.2.2 Cultural effects

Moving from geography to culture, Greif (2006, p. 5) makes a distinction between "technological features" (such as geography, knowledge, capital stock) and "non-technological features" (institutions). He underscores the importance of both types of features in explaining economic outcomes. However, he also stresses that formal institutions (e.g., laws) only have impact when they are adhered to. In Greif's eyes, the initial NIE framework falls short in two key aspects. First, it does not take into account the motivation of actors to follow the rules. Second, the framework does not provide tools for the analysis of institutional dynamics. On this latter point, Grief states that the existing literature explains institutional rigidity as the costs of changing formal institutions, or by the unchanging nature of informal institutions (i.e., customs and traditions). Culture plays a big factor in both the implementation and the dynamics of formal institutions, but is often treated as an exogenous factor in traditional NIE modelling. To put it in North's 'game' analogy: the NIE approach describes which game is played in a certain society, but the reason why a society plays a certain game is often left out of the scope of research. Greif aims to get around these problems by analysing smaller units: transactions. He does not look at institutions as equilibria, but as path-dependent, self-enforcing phenomena. According to Greif it is not enough to know the laws; we also need to know how these laws came to be, and which cultural elements evolved to support or undermine them.

3.3 Government institution dynamics, or Systems Competition

While the five-tiered scale set out in the previous paragraph is an attractive way of thinking about the 'state of play', it is a mostly static representation. Interesting cases in economic history, however, often concern more dynamic events, such as wars, trade disputes, and rebellions. I believe the concept of *Systems Competition* is useful in describing these dynamic and interactive events, and adds value to existing models. 'Systems' are defined here as collections of complementary institutions, such as political (e.g., government type, military organisation, and tax system), economic (e.g., property rights, trade policy, and market regulation) and social institutions (e.g.,

occupational mobility, and education systems). Together these institutions fill level two of Williamson's model. Sinn (1990) has used the term Systems Competition in the context of the Cold War to describe the struggle between communism and capitalism. He has also used it in describing the more current practice of a 'race to the bottom' for lower tax levels and less regulation, in order to attract factors of production (Sinn 2008). During the Cold War, the active systems were the coalition of capitalist states and the coalition of socialist states; their competition was over political, military and economic dominance. Currently, most systems are capitalist states of some kind, competing in world markets to improve their economic condition. In other works, similar dynamics are described as 'institutional competition' (Kasper & Streit 1999, pp. 403-04) or 'societal evolution' (Turchin et al., 2013).

Confrontations between states are a widely studied topic in history (economic and otherwise), so what does the term Systems Competition add to existing material? I discuss four ways in which I think Systems Competition contributes to theory. First, it focusses on the differences in the organisation of both the economy and the government of the competing states. It follows then that institutions, particularly government institutions, play a big role in Systems Competition. Government institutions are brought to the foreground as units of analysis, rather than the competing states themselves. Second, Systems Competition encompasses all the ways in which these systems can compete, including and not limited to wars, trade disputes, economic competition, and vying for cultural dominance. Third, it implies that a system has something to gain by outperforming its competing systems. The criteria for any system's success depend on the context of the competition; for example, the criteria for success could be military victory, trade dominance, or faster economic growth. Ultimately, a system can become dominant either through the growth (e.g., economic) of its proponents, or alternatively by the (institutional) conversion of its opponents. It should be noted that the players (i.e., states) are not necessarily conscious of, or actively pursuing the dominance of, their own system; rather, systems are promoted and depressed through the self-interested actions of states. Fourth, by looking at the topic of government institutions and institutional change through the lens of Systems Competition, rather than more narrowly by the impact of war, it accommodates and considers more cases from different time periods and geographic areas for similar analysis. This way, a model can be tested against a larger sample, thereby improving its robustness.

Examples of Systems Competition can be seen in the frequent wars taking place between European states during the early modern period. The pressure on states to compete on the battlefield drove development beyond just weapons and tactics to fiscal and organisational change. European

trade was another important area of competition, where states tried to outmanoeuvre each other through (protectionist) legislation and the application of military force. Those states which were successful could leverage the resulting economic advantage for military spending.

States – or rather their populations – also interacted through migration. Similar cultures, ruled over by differing types of governments and ideologies, made it possible for people to find new places to settle, if their country of birth was unreceptive to their religion, philosophy, or values. This fostered the cross-pollination of ideas throughout Europe, which drove further growth. If emigrants are, for instance, well-connected merchants or leading scientists, this could be a grave loss to any state. The large number of different states gave ideas, and business practices, a good chance to spread and be separate from the restrictions of the countries of origin (Jones 2003).

Looking at individual cases, one salient example of the spread of institutional systems through competition is the conquest of European countries by France during and after the French Revolution. There was a conscious effort on the part of the Revolutionaries and Napoleon to make changes to the local institutions of the invaded countries, and thereby spread the institutional system of Revolutionary France. Among other consequences, this promulgation of institutions meant the removal of special protections for groups such as the aristocracy and the clergy (Acemoğlu et al., 2011). A different but complementary example is that of the Glorious Revolution in England, when the Dutch prince William of Orange ascended to the English throne and brought about changes to many English institutions, especially financial ones, to reflect those of the Dutch Republic. In this case, although William of Orange technically came ashore with an army, the change of regime was not ultimately forced by military conquest, but by British domestic political circumstances (Jones 2003).

These cases are examples of institutional reform through regime change as a consequence of revolution, conquests, and political pressure. However, societies can, perhaps more commonly do, change their institutions within the same regime. This type of institutional modification can also be considered part of the Systems Competition pattern, if it is devised as a copy of – or a counter to – the institutions of a competing state. One example of this copying behaviour is the emergence of trade companies. The Portuguese Casa da India was a frontrunner for this type of organisation, then the English East India Company (EIC) and the Dutch Vereenigde Oostindische Compagnie (VOC) added the innovation of joint-stock financing in the early 17th century. This model was subsequently used by other European states to establish trade companies in France, Denmark and Sweden. These trade companies all shared elements of both state and private enterprise, having a profit motive and a domestic monopoly on wholesale trade of goods from the East, as well as overseas military and

diplomatic powers granted by the state (De Zwart & Van Zanden, 2018). Although operating as a private business, the extraordinary rights (such as the right to wage wars abroad) granted to these enterprises by their respective states clearly make these trading companies a matter of government institutions.

An example of an institution devised as a counter to a competing state would be the Navigation Acts passed by the English parliament in the mid-17th century. These acts restricted the carriers of shipments of goods to England, to either English ships or those of the country of origin of the goods. At the time of their passing, these acts were primarily designed to combat the Dutch shipping trade, which was outcompeting the English in their own colonies (Findlay & O'Rourke 2007, p. 237).

These examples of Systems Competition are mainly from North-Western Europe. This bias is partly a reflection of the quantity and quality of documentation and research available for this region, but also, perhaps, of the vibrancy of institutional innovation that this region exhibited in the early modern period. This intensive mutual influencing between European states can be seen as a kind of 'macro-system' that existed in Europe at the time. It has been described by Jones (2003) as the European "States System" (p. 104), an interconnected web of culturally related countries that compete with each other, yet prevent any one country from becoming dominant. Before that, Wallerstein ([1974] 2011) coined the term "world-system" (p. 5) to describe the economic and political situation in early modern Europe. The social system he defined had certain aspects similar to an empire, such as its size and economic integration. What tied this system together, in Wallerstein's ([1974] 2011) description, was economic integration through trade and division of labour across its geography. This integration was of such a level that it was "largely self-contained, and that the dynamics of its development are largely internal" (Wallerstein [1974] 2011, p. 347). The point of difference between a world-system and an empire is that the first is not a political unit, and taxation and tributes did not flow to one central point, but distributed to the respective national capitals. The world-system encompassed political units of various sizes (e.g., city-states, (proto)nation-states, and empires). According to Wallerstein ([1974] 2011) this world-system developed in and from early modern Europe and subsequently came to encompass most countries of the world. Both Wallerstein ([1974] 2011) and Jones (2003) remark on the fact that this system did not, over all this time, become an empire.

According to Wallerstein ([1974] 2011), the world-system enables the model of capitalism: "capitalism as an economic mode is based on the fact that the economic factors operate within an arena larger than that which any political entity can totally control." ([1974] 2011, p. 348). His

description enables the division of this world-system into core states (mainly Western countries) and a periphery, the former being associated with strong states and the ability to reap the rewards of the system, the latter with weak or non-existent states and a smaller share of economic gains ([1974] 2011 pp. 349-56). Jones (2003) makes a more explicit case that the European ‘States System’ was a key cause of its emergence as the dominant economic region of the world. As has been discussed in this chapter, under the right conditions state capacity can enhance economic outcomes, and Systems Competition has the potential to enhance state capacity. Putting Jones’s argument in terms of Systems Competition, European states competed on two different levels: firstly with the other members of the States System, and secondly with entities outside the States System. There was therefore both high internal as well as external Systems Competition. Empires by contrast are generally set up to minimise internal competition, but are still able to pursue external competition. As I will set out next, I believe Japan can be seen as a special case of an empire.

4 Japan’s Position

In large part, Japan has avoided mention thus far, because the majority of existing theories related to Systems Competition are either generalised, or focussed on the situation in Europe. The Japanese case is quite different from general and the European cases, but its inclusion adds considerable value to the model of Systems Competition. The more data a model explains, the more generalisable and robust it is. For long periods, war between Japan and other states was neither present, nor even a realistic possibility. What did this mean for the development of Japan’s government institutions, and what does this imply about the link between military activity and government institutions?

Japan was relatively isolated from its neighbouring countries during the early modern period, more so when compared to most European states. The shortest distance between the Korean mainland and the nearest main island of Japan is roughly 180 kilometres, which is over 5 times the distance between Britain and France. Over the centuries of Tokugawa rule and those preceding it, there was regular contact with Japan’s neighbours Korea, China, the Ryūkyū kingdom, and the Ainu people (as will be described in the next chapter), but in Wallerstein’s ([1974] 2011) terms Japan was decidedly self-contained. At times, it paid tribute to the Chinese Emperor, but it was not under its political influence. Japan traded with China and over time with Western carriers, but not to such an extent that it became integrated in a larger ‘world system’ (see chapter four for a detailed description). Japan did become internally integrated, from a collection of ‘warring states’ during the

15th and 16th century, into a cohesion of domains of various sizes that were fiscally and politically ruled from one central point, the Shogunate capital (see chapter two for details). The Tokugawa shogunate ruled over 17 million people in 1600 and 32 million in 1850 (Fukao et al. 2015, Table A1.2). This is comparable to France, the most populous Western European country. France had a population of 18.5 million in 1600 and 31.3 million in 1820 (De Zwart & Van Zanden 2018, Table 1.1). Japan's size compares even more favourably to the Ottoman Empire's population of 19 million in 1550 and 21.5 million in 1800 (Karaman & Pamuk 2010, p. 607). By these descriptions, Tokugawa Japan meets all the criteria of an empire as set out by Wallerstein ([1974] 2011) of a large and self-contained economic system. Notably, Jones (2003) deliberately leaves Japan out of his study of the main alternatives to the European States System. He considers Japan too small, non-connected, and atypical for the main population and culture centres on the Asian mainland: China, India, and the Ottomans (Jones, 2003, pp. 157-159).

Tokugawa Japan does arguably present as an atypical example of an empire, but I suggest it is the prototype of a different sort, an Island Empire. Japan's geographical location means that external threats were less severe, but also that there were fewer opportunities for external expansion, at least over land. As a result, there was less natural external competition placed upon Japan, than in the typical empire. If Europe's geographically fractured situation was key to promoting Systems Competition and institutional development, what effect would Japan experience, being possibly on the lower end of the competition scale? What other factors shaped the institutions, if Systems Competition did not play a big role? What does this tell us about the existing theories on state formation? And can we discern an impact of the institutions on economic growth? One of the two objectives of this thesis is to see if the existing Eurocentric theories of state development apply to other situations, specifically, Japan. The other objective is to see how Japan's unique geographic and cultural circumstances may have impacted its economic development. If competition between the European states was indeed key to their institutional and economic development, how did Japanese circumstances impact its institutional and economic development?

In the next chapter I will discuss the relevant circumstances of Tokugawa Japan, how it moved from a collection of warring states to unified rule, and how and in which ways it became isolated. In short: how did Japan become an Island Empire, and how did it develop from there?

Chapter 2: The Tokugawa System or the Making of an Island Empire

1 Introduction

Between 1500 and 1900 Japan experienced two ‘regime changes’: Unification into the Tokugawa Shogunate, and the abolishment of the shogunate through the Meiji Revolution. In between it went through different within-regime institutional changes. In the terms discussed at the end of the previous chapter, Japan arguably went from a States System into an Island Empire System under the Tokugawa, and then it became part of the expanding world-system in the Meiji period.

In this chapter I will discuss the events that shaped these transitions, notably the unification and centralisation process that formed the Tokugawa shogunate. Further, I will set out the governance structure, social controls and international policy used by the shogunate to restrict Systems Competition. I will then focus on some key factors of government policy: the ensurance of property rights and the national finances. Finally I will make a comparison with states that represent other systems.

2 Shaping the Tokugawa State

2.1 Sengoku institutional developments

The political realities of the Tokugawa period were shaped by preceding events during the *Sengoku* or Warring States period (1467-1568) and the Azuchi-Momoyama period (1568-1600). During this period there were frequent battles between warlords called *daimyo*. Several of the most successful daimyo started changing the support structure for their armies and their samurai vassals. Before the Sengoku period, samurai managed their own estates and provided troops to their liege lord in case of war. Competition between houses caused an institutional change that centralised power and increased the scale of the armies. This period is not unlike the periods of frequent warfare and Systems Competition in early modern Europe.

At the start of the Sengoku period, daimyo were able to establish domains in which they had deep control, in contrast to the then existing *shōen* system, which featured extensive estates that were commonly outside of public control. (Morillo 1995). The way daimyo exercised their control changed over time. Hall (1961) has used Ukida Naoie of Bizen province to the west of Kyoto as a

fairly typical example of the institutional evolution of daimyo. Illustrated by this example, Hall has classified this institutional evolution into four stages: *Shugo daimyo*, associated with the pre-Sengoku period and up to the 1490s, *Sengoku daimyo* (up to around 1570), *shokuhō daimyo* (up to the early 17th century) and finally *kinsei daimyo* (the dominant type for most of the Tokugawa period). According to Hall, over these stages the daimyo develop from provincial military governors (shugo daimyo), into independent feudal-style warlords based on personal leadership (Sengoku daimyo), then into leaders of larger, more structured organisations (shokuhō daimyo), and finally into heads of increasingly bureaucratic governments (Kinsei daimyo), their position no longer justified by military might, but by Confucian principles. These stages are similar to those identified by Bonney (1999) and Tilly (1992), insofar as they describe a development from feudal to more bureaucratic institutions.

One of the developments that enabled the more advanced shokuhō daimyo was the monetising of sources of income. Instead of offering land in return for military service, successful daimyo were able to use revenues from their economic base to pay their vassals. The daimyo, being free of levies towards regional or national aristocrats in this period, had an incentive to improve the economic situation in the area under their control (in the way of Olson's (1993) 'stationary bandits'), while their true competition were other daimyo. Among daimyo, those with a better economic base had an advantage over their competitors, and a trend is seen of promoting economic development in their domain. This took the form of establishment of castle town commerce, public works and agricultural productivity promotion (Morillo 1995).

Hōjō Sōun (1432-1519), active in the Ise peninsula and Kantō plain of current Tokyo, is another example of an early Sengoku daimyo that rose up from a samurai to become an independent local ruler. According to Steenstrup (1974, p. 283): "He set up as a Sengoku daimyo, ousting a member of the traditional warrior aristocracy and establishing, with the aid of disciplined and devoted followers, his own rule in a limited area. But in the expanding territories under his control, he introduced a decent administration, the beginnings of cadastral surveying, army professionalization, and various policies aiming at economic growth. Thus his way of rule came to resemble that of the developed *shokuhō daimyo*". The Hōjō present an early case of a phenomenon that would be applied by rival houses and by the three unifiers. Improvements in organisation, taxation and recruitment enabled increasingly large armies. The size of the Hōjō army grew from a few hundred warriors in 1491 to 50 000 during their final stand against Toyotomi Hideyoshi in 1590, who himself had then gathered 200 000 men (Birt 1985, 372).

Hōjō Sōun and his descendants were in an ideal position to disrupt existing institutions, because most of their domain was conquered from enemies. When land was conquered, the Hōjō granted the land rights to loyal samurai, taking care not to create large contiguous sub-fiefs, and to place powerful samurai away from their original power-base, so as not to create internal rivals. The scattering of individual samurai holdings made it difficult for them to organise the collection of revenues themselves, in effect making them dependent on their liege lord for their income and driving another wedge between the samurai and their source of power. Based on surveys of the amount of land they held, samurai were obliged to provide specific numbers of different troops in times of mobilisation. This made it easier to raise and organise an army of predictable size and composition. These same cadastral surveys were used as a base for tax collection expressed in monetary amounts, the so-called *kandaka* system. As the Hōjō faced increasingly powerful adversaries, their mobilisations became broader, drawing in large numbers of commoners to serve as footsoldiers. At the same time, the Hōjō's fiscal and judicial administration gained influence straight down to the village level. Village administrators gained direct access to the daimyo through communication channels provided by the Hōjō bureaucracy, while the influence of samurai at the local level receded. The Hōjō standardised and centralised both the military and civilian aspects of the area they ruled. Power was gradually wrested away from the samurai class and into the hands of the daimyo. They were the last independent power in the central regions of Japan, until their eventual defeat by Hideyoshi in 1590. (Birt 1985)

Besides the daimyo of the more central area of Japan (Bizen and Kantō), their more far-flung counterparts experienced similar, though not identical institutional developments. One example comes from the southern, smallest of the main islands of Japan, Shikoku. Chōsokabe Motochika of Tosa domain had risen to dominate and conquer his neighbours on Shikoku. Despite his success however, when he was challenged by an invasion by Hideyoshi in 1585, the Tosa army proved wholly inadequate. The ‘mainlanders’ were professional soldiers, better trained and better equipped than the part-time farmers under Motochika’s command. Motochika started a transformation on several fronts: Firstly he imposed a new, stricter hierarchy on the top levels of his organisation, although the separation of his men into full-time farmers and full-time soldiers was not completed in his life-time. This eventually happened after the Chōsokabe were replaced by the Yamauchi at the hands of Ieyasu. The second transformation by Motochika was a land-survey – performed on order of Hideyoshi – to support tax collection. Thirdly he tried to establish a prosperous castle town like those being built in central Japan, although sources indicate he had trouble gathering both his

retainers and merchants to the several locations he tried. Fourthly Motochika wrote a 100 Article Code, to guide his retainers as both a moral and a legal document. (Jansen 1963)

The experience of the Chōsokabe is perhaps a clearer example of Systems Competition than those of the more central domains. It demonstrates the effects of the defeat of a militarily, economically and institutionally less advanced competitor at the hands of a stronger opponent – this effect being the adoption by the weaker system of institutions from the stronger system. I think this is a convincing demonstration of the presence of Systems Competition in Japan during the Sengoku period. It also shows some of the limits of institutional alignment. In the case of Tosa some of the institutions (like the separation of farmers and soldiers) took time to be completed, others (like the establishment of a large castle town) may have lacked supportive circumstances. Jansen (1963) does not give definitive reasons for the failure of the castle towns, but the geographic placement of the town (the distance to sea trade routes) seems to have been a factor for the attraction of merchants at least. The retainers seem to have been reluctant to leave their rural holdings behind, for whatever reason. Putting it in terms of the five-level model of analysis described in Chapter One, this may have been a case of institutions going against either custom (culture) or economic interest (resource allocation).

2.2 Unification

Without wanting to stray too far into the 'Great Men' type of history, three figures loom exceptionally large in the events of this time: Oda Nobunaga, Toyotomi Hideyoshi and Tokugawa Ieyasu.[5] Together they are known as the 'unifiers' that transitioned Japan from separate warring chiefdoms to (again) come under a single ruler. The first unifier was Oda Nobunaga, who through brash tactics grew in short time from a minor to a prominent warlord. In 1568 he made a play for national power by marching a substantial army on the imperial capital of Kyoto and installing a new *shogun*, Ashikaga Yoshiaki, as the head of the Ashikaga shogunate. Although the title of shogun officially included the power to command armies in name of the emperor, the Ashikaga shogunate had been unable to enforce national peace. Nobunaga's re-establishment of the shogunate was short-lived however, as Yoshiaki objected to the dominant position of Nobunaga and formed an anti-Nobunaga league of daimyo. Nobunaga then spent several years quashing both this opposition and several militarist religious sects. While his power grew, Nobunaga's ideology and politics did make him enemies, and he was assassinated in 1582 by Akechi Mitsuhide, one of his vassals. According to Asao (1991), Nobunaga's assassination was motivated by resentment for his modernising

5 The names are listed in Japanese order here, family name first. However, these three figures are commonly referred to by their given names, what would be their first names in English name order.

decisions to establish free markets, remove toll barriers, introduce Western medicine, construct castle towns and make the previously independent warrior class into stipended retainers.

Nobunaga's death was avenged by Toyotomi Hideyoshi, who subsequently took over Nobunaga's mantle as unifier. Hideyoshi pacified the remaining independent warlords through battle and diplomacy. Once the country was suitably unified, Hideyoshi quickly set his sights on the invasion of Korea in 1591, presumably in order to fulfil his vassals' need for taxable land and prevent infighting. The assembly and transport of an invasion force of more than 150 000 is a testament to Hideyoshi's organisational capability. The invasion stalled after initial success, but the peace terms were not sufficient for Hideyoshi. A second invasion also stalled when Hideyoshi suddenly died, and the troops were then withdrawn. After Hideyoshi's death, control over Japan was contested between two camps, each side supported by various daimyo and their armies. The two sides came to a head at the Battle of Sekigahara in 1600. The confrontation was won by Tokugawa Ieyasu and his allies and this made him the de facto ruler of the country. (Asao 1991)

2.3 The role of guns versus institutions

Nobunaga is known for having placed emphasis on the use of firearms in his armies, as well as the requisite production of both guns and gunpowder (Asao 1991). The timing of the introduction of firearms to Japan by the Portuguese (1543) and the use of these new weapons by the unifying armies, has caused Jansen (2000, p. 7) to call them "the instrument of the unification of Japan". This view has persisted in the study of Japanese history (see for instance Brown (1948)), although it has been challenged by others (Morillo 1995, Conlan 2010) who point out that changes in institutions, military tactics, army size and geographical consolidation were well underway before the arrival of these new instruments. There is a similar debate on institutional changes in Europe being caused by the introduction of gunpowder and the 'Military Revolution'. However, in Japan the case for institutional changes predating the technological changes is much stronger, since the exact time of technological transfer is known (Morillo 1995). Conlan (2010) suggests that changes in military organisation were more important than technological advancement, based on detailed study of battlefield reports and wounds per weapon type over the 14th to 16th centuries. He describes how the increasingly improved organisation of armies made large and cohesive pike formations possible, and that this was a more important change for military outcomes than the adoption of firearms. Consequently, he places the emphasis on army organisation as the key attribute necessary for military power, as well as political power.

Both Japan and Europe went through institutional and technological advancements during their respective pre- and early modern periods. Where Japan unified into a single empire during this time, Europe did not however. How remarkable is either of those facts? I have noted that Wallerstein ([1974] 2011) and Jones (2003) both found the continued disunity in Europe exceptional. One can wonder if this is a rare chance in history, and with slightly different strategic or tactical choices Europe could have ended up under one empire. One factor that must be play a part in the difference between Japan and Europe is that of size and geography. As has been noted, Japan is more isolated, but is is also obviously much smaller than the whole of Europe. In terms of landmass it is more comparable to the British Isles. Japan should be easier to bring and keep under single control, since a ruler only has to conquer so much before they can dominate the rest of the area.

2.4 Centralisation

Hideyoshi himself, arguably the biggest institutional transformer of the three unifiers, formalised and expanded upon local centralisation efforts such as those of the Hōjō. He ordered a national land survey (*taikō kenchi*) that registered land tenure, production value and tax revenue of all agricultural land. The registered yield was expressed in *kokudaka*, a quantity measure of rice, over which taxes and other patrimonial dues were calculated. This system became the basis for most of the tax revenue, not just under Hideyoshi, but also under the Tokugawa shogunate. In some domains similar systems were already in place before Hideyoshi's survey. However, his system for tax collecting was more advanced than earlier ones, taking into account different yield rates, and an improved administration system from the villages to the top level. On the other hand, large differences remained between the situation in the central area and the periphery, where some daimyo still used diverging systems. (Makihara 2014)

Besides taxation, Hideyoshi made changes to improve national stability. He instigated several institutions aimed at securing peace between all social classes. One important act was the so-called 'sword hunt' edict in 1588, whereby Hideyoshi confiscated swords and other military weapons from farmers. At the same time he prohibited fishermen from taking part in piracy. Hideyoshi had recently pacified Kyūshū, the home base for many *wakō* pirates that harassed particularly the Chinese coast and disrupted trade relations between Japan and China. (Asao 1991, 49)

Another decree by Hideyoshi, known as *heinōbunri*, separated the warrior class and the farmer class. It sharply differentiated the rights and obligations of these classes, and prohibited switching between classes. All samurai had to be organised under a daimyo. Daimyo and samurai were not allowed to own or work farmland, but they did have the right to taxation of farmland. Wives and

family members of daimyo were forced to live in Kyoto as hostages, while daimyo themselves were required to serve Hideyoshi there. Daimyo could also be transferred to different domains at Hideyoshi's will. For farmers, it was made illegal to own weapons or to leave their land. They were, however, the only group who could own farmland. Farmers were only obliged to pay taxes to one lord, and the village was made responsible for collecting lord's taxes. In a sign of his supremacy over the daimyo, the patrimonial right to peasant labour was reserved for the national hegemon, Hideyoshi. These measures were directly aimed at preventing rebellion by warriors and peasants alike, as well as to standardise tax collection. (Asao 1991)

This division of labour strictly regulated people's role in society, and also freed up manpower for the military. Asao (1994) describes situations where a powerful local family, previously exempt from duties, was split. The first son was forced to start a new family as a samurai in a different area, and the second son took over the family farm. This way, Hideyoshi not only created new samurai, he also made sure they could not give their former family preferential treatment. Both the tax and the social regulations served to put more control in the hands of the central authority and the daimyo below it.

2.5 Significance

The events described above are generally viewed as important turning points for Japanese government institutions and the way the holders of power justified their positions. However, there is less agreement on the characterisation of the situation before and after. Part of the debate among historians of Japan is about the extent to which Nobunaga's time was a continuation of the old Ashikaga feudal system, or the beginning of a new, early-modern system. Asao (1994) splits the difference by separating Nobunaga's time of dominance into three periods. Asao notes that at first, although his power was virtually unrivalled, the administration system was still in the hands of the Ashikaga shogunate. The second period of Nobunaga's reign started with the building of Azuchi Castle, which guarded the entry to Kyoto from potential rivals and secured the capital. In the third period Nobunaga consolidated his economic power base, and became the de facto 'defender of the realm'. Asao's view is that in the beginning Nobunaga was focussed on gaining power whatever it took. In the latter stage, Nobunaga began to envision a new system, although his plans were cut short by his assassination. At Azuchi he began a sort of deification of himself, to demand loyalty from the other lords, and as a justification of his power. This was a new phenomenon.

In more recent studies the view has persisted that the change from feudal to early modern times was quite gradual. Makihara (2014) writes that even in the early sengoku period villages already

had a degree of independence from the warrior class, and some separation between soldiers and farmers was also present long before Hideyoshi. Tokugawa in turn used Hideyoshi's system of taxes and social controls as a starting point for his own policies, making for an arc of change that extended from the early Sengoku to the early Tokugawa period.

2.6 Justification

A second subject of debate is the justification used by the three unifiers for their power. As mentioned, in his last years Nobunaga started to glorify himself in a manner similar to a deity. Besides that, he began to be referred to as the *kōgi*. This was an evolving term, increasingly used during the sengoku period to refer to the ruling authority of the men or offices of power, such as the shogun or daimyo. Nobunaga claimed the authority of kōgi based on the assertion that he acted for the common good, and despite not holding the title of shogun. (Asao 1994)

Nobunaga used deification and an appeal to kōgi authority to claim the right to power, but as of the time of his death he had not taken an official title. Hideyoshi on the other hand legitimised his power by taking on the rank of *kanpaku* (imperial regent) – the highest court rank save that of emperor. However, the obedience he demanded from the daimyo was not necessarily tied to the imperial throne, but to Hideyoshi himself as the kōgi. According to Nakano (2014), Hideyoshi succeeded in making the Toyotomi clan the centre of government, and himself the focal point. Hideyoshi's son Hidetsugu took over his position as kanpaku when Hideyoshi retired to become *taikō* (retired imperial regent). This was more an attempt at putting his son in a position to eventually succeed him than an actual abdication of power.

Ieyasu also used an official title to justify his position of power, but he chose the office of the shogun. He also prepared his son as successor by taking on the title of retired shogun himself. Like the other two unifiers, Ieyasu claimed kōgi authority and was revered as a deity.

The concept of kōgi is reminiscent of Hobbes' descriptions of a sovereign, who is given authority (by force or by vote) to act for the good of the commonwealth. The deification of the sovereign also features in his work. He describes the 'leviathan' in the title of his famous work as "that Mortal God, to which we owe under the Immortal God, our peace and defence" (Hobbes [1651 1996, 114). This deification of sovereigns is similarly seen as the 'mandate of heaven' in East Asian countries, and the 'divine right of kings' in the West. Of course these concepts have differences and are applied differently depending on the country and the religion. In Europe the religious aspect was decidedly multinational. In China the 'mandate' was seized by a succession of dynasties. In Japan there was only one Imperial dynasty, and the Emperor was revered as a deity,

but after the sengoku period the military leviathans also became deified. During much of Japanese history the emperor was a powerless figurehead while actual power lay in the hands of a shogun. Did the three unifiers try to break the pattern of dependence on the Emperor for legitimacy, by claiming divine status and authority themselves? According to Hori (2014), this pattern is best described not as a rivalry, but as a mutually beneficial cooperation.

One of the significant differences between Japan and Europe is that, although certain European monarchs tried to use the symbol of the pope to legitimise their own authority, the pope was not a symbol of European unity. A ruler that had the support of the pope did not have dominion over all of Christianity. In Japan however, a shogun with the support of the emperor *could* claim dominion over all of Japan. This situation was obviously confusing for the early European visitors to Japan, who compared the emperor of Japan to the pope. Kaempfer (1733, p. 43), physician to the Dutch East India Company (Vereenigde Oost-Indische Compangie, VOC) in Japan, described the emperor of Japan as its "hereditary religious monarch"[6], the shogun as its emperor, and the daimyo as princes. King William II in 1844 likewise in his letter to the then shogun referred to him as Emperor. (Greene 1907). It should be noted that Hendrik Doeff, head of the VOC mission on Dejima in the early 19th century, strongly disagreed with this reading of the emperor as Japan's religious monarch in his writings (Doeff 1833, p. 6).

3 Social and Governance Structure

3.1 Governance structure

The Tokugawa system of governance is often referred to as *baku-han*, referring to the *bakufu* (shogunate) and the *han* (domains) in allegiance to it, together making up the whole of Japan. Nominally the shogun was a military leader subordinate to the emperor, but in reality during the Tokugawa shogunate, the shogun was in command of all matters of government, and the emperor's power was entirely symbolic.

The top level of power was the shogunate, whose main source of power was the amount of land directly and indirectly under shogunate control. The shogunate had 'granary lands', known as *tenryō*, that it taxed directly. The shogun's granary lands made up about 16% of the total agricultural land by production capacity in the late 17th century. In addition, another 10% of this land was held by shogunate bannermen (*hatamoto*) that were direct vassals to the shogun (Hall 1991, p. 152).

6 In the Dutch source: "Kerkelijken Erf-Monarch"

The han were the domains of local lords, the daimyo. Some of these daimyo descended from – or at the beginning of the Tokugawa period, were themselves – sengoku daimyo (warlords). Other daimyo were created by the granting of land, primarily by the shogunate. When the country was unified, and certainly during the Tokugawa period, daimyo started to function more like governors. To become a daimyo, a domain of at least 10 000 *koku*[7] was required, an amount of land that could support several thousand people. On the other end of the scale, the largest non-shogunate domain was that of the Maeda clan in Kanazawa-han with over one million koku (McClain 1982). Due to the shogunate's prerogative in national affairs such as defence, international relations and national currency, coupled with a high level of autonomy for the domains, the Tokugawa governance system has been described as a federal system (Ramseyer 1996, p. 18).

3.2 Local participation

Although the common description for Tokugawa government is *baku-han*, there was a third level of government that formed an integral part: villages. Villages and other municipal organisations played an important role in society, since well before the Tokugawa period. They performed many tasks that would be considered government functions today, including tax collection, infrastructure upkeep, maintaining local law and order, and small-scale poor relief. Villages were also the unit of account for taxes levied by the shogunate and the domains. Although the taxes could be calculated down to the individual holders of farmland, gathering and paying taxes was a communal affair (Ooms 1996). The internal functioning of villages and neighbourhoods depended on two principles: consensus and long-term relations. The latter was ensured by the fact that official village business took place at *ie* level. 'Ie' means 'household' or 'house', in that time customarily made up of all generations of one family. Especially in the agricultural setting of the villages, a household was also almost synonymous with a family business. In official and unofficial dealings within the village, the long-term nature of relationships between *ie* created a situation conducive to trust and cooperation (Sakane 2011).

City neighbourhoods functioned according to similar principles as villages, reflecting the national governance. As villagers were geographically separated from the city-dwelling classes, so too was the city population separated. Daimyo lived in their castles (in their own domain) or city estates (when they were in Edo on alternate attendance). Shrines and temples had their precincts, as did samurai, and *chōnin* (city commoners such as merchants and artisans). The administration of the

7 In land surveys the officially estimated production capacity of agricultural land was expressed in a rice amount called *koku*, irrespective of the crop grown on the land. 1 koku was equal to 150 kg, supposedly the amount of rice needed to feed a person for a year.

Tokugawa period's cities – some of which were among the largest in the world – evolved into multilayered organisations. In Edo as well as many other cities, the higher offices in these hierarchies were occupied by high-ranking retainers, who commanded a number of samurai that saw to the daily administration. The actual implementation of the policies was mostly done by representatives of the civilian classes, such as merchants acting as city elders and neighbourhood chiefs. This delegation of responsibility down to increasingly smaller local groups is similar to the situation in the villages. In Edo responsibilities were delegated down to the level of *gonin-gumi* (5-family groups). In Kanazawa, one of the largest non-shogunate controlled cities, the lowest level consisted of *jūnin-gumi* (10-family groups). The leaders of these groups were responsible for their members' contributions of taxes and corvée, as well as performing community activities such as leading firefighting squads, settling disputes, maintaining streets and looking after abandoned children. (For a detailed description of the Edo and Kanazawa systems see, respectively, (Katō 1997) and (McClain 1982)). As Katō (1997) remarks, the Edo city governance did what the shogunate required, in that it facilitated implementation of official policy at the family level. At the same time however, it enabled a large degree of self-governance by the civilian population.

Villages and neighbourhoods handled many matters themselves, except when there was an issue that went beyond the bounds of their area, such as a dispute with another village, or some natural disaster that was beyond their capacity to deal with, such as a famine, a fire or a flood. The support that municipalities received from the higher levels of government was mostly in the form of the more substantial judgements and disaster relief. In the opposite direction, villages and neighbourhoods not only provided tax revenue, but also corvée labour. The first went to the domain coffers, but the second was in principle at the discretion of the shogunate, as part of the *kōgi* prerogative. The high level of village self-governance made possible a very small staff of administration officials at the domain level. Han officials worked either in one of the central bureaus in the castle town, or locally as district magistrates (Smith 1959, p. 202). The number of villages and inhabitants overseen by a single magistrate could be very large. Although magistrates did have some support staff, they did not generally have any military forces stationed within their district, other than a few guards. According to Smith (1959, p. 203) "this administrative system was by no means merely a contrivance of the warrior class for its convenience; it had been evolving since prehistoric times. From the beginning of agriculture, the village had a strong corporate life."

There was a relatively elaborate hierarchy between the state at the top and the villagers at the bottom. The local variations were many, but according to White (1995, pp. 87-88) in general the layers looked like the following:

1. Magistrate
2. Intendant
3. Subintendant
4. Village group overheadman (optional)
5. Village headman
6. Household group leader
7. Household head

The first three representatives are from the samurai class, and the first four are appointed top-down by the domain or shogunate. The last three are chosen bottom-up through status, rotation, deliberation or election. The village headman was often assisted by village elders, and accountable to an assembly of village freeholders or farmer's representatives. The intendants and (over)headmen formed the most important articulation point between the village population and the state. White notes the wide range of characterisations given to village governance in the supporting literature, from autocratic to democratic, from co-operative to contentious, and from stagnant to reforming. These may all have been true for different communities at different times, depending on local circumstances. According to White, two generalisations can tentatively be made: The first is that as long as the village fulfilled their duties of taxation and kept the peace, they had a high level of autonomy. The second is that proto-industrialisation, village reform, and village conflict started in the west of Japan and moved east (White 1995, pp. 87-90).

Villages were at times a source of unrest. White (1995) has made an extensive study of the phenomenon known as *ikki*, a type of peasant protest or rebellion. These stopped short of becoming a revolution, but they could have their effect on specific decisions, officials or institutions. This fits the pattern described by Greif (2005) in his work on contract enforcement and coercion constraints. There the example was Qing China, and the focus was the Qing practice of setting a deliberately low tax rate in order to prevent revolt. This choice was made by the central government because the costs of subduing such a revolt would be very high. In Japan by contrast the land tax rates were set at the han level. There is supporting evidence that domains that experienced large protests, subsequently saw larger declines in tax rate than other domains (Paik, Steele and Tanaka 2012). The work by Sng and Moriguchi (2014) supports the view that agency problems were larger for pre-1850 China than for Japan at that time, due to the greater geographical size of China. For the Chinese central government it was more difficult to keep an effective eye on their bureaucrats, which provided an opportunity for corruption. In order to prevent overexploitation, the official tax rate then has to be lower than in the case of more effective monitoring of agents. By comparison,

the smaller size and more localised tax decisions in Tokugawa Japan may have facilitated a higher tax level. Even though this possibly led to the local unrest described by White (1995).

3.3 Social controls

Coming out of the sengoku period and the struggle for unification, stability and control over its subjects was a major concern for the Tokugawa shogunate. The policies introduced by Nobunaga and Hideyoshi to increase stability and control were continued. Several groups in society could potentially threaten national order, or help to control it.

3.3.1 Daimyo

Daimyo where the centres of power for the lands not under direct control of the shogun. Given that many daimyo had openly opposed the Tokugawa clan at the Battle of Sekigahara – and others had switched their allegiance at the last minute – the loyalty to the Shogunate cause of many families was uncertain. Based on their history with the Tokugawa clan, domains were classified as either *fudai* (insider, trusted) or *tozama* (outsider, less trusted), which afforded the rulers of these domains different levels of influence in the administration. A set of rules served to ensure the obedience of all daimyo. In addition to taking oaths of obedience, the daimyo had to ask for permission to expand their castles or to marry. The shogun also reserved the right to confiscate or transfer land. Especially in the early decades of the Tokugawa shogunate, the size and control of domains changed substantially. During the reign of the first three shogun,[8] domain confiscations equalled 41% of the national agricultural production capacity (Hall 1991, p. 152).

In Japan at that time, a liege lord would often demand hostages from his vassal's families. Hideyoshi had done so when he demanded wives and children of daimyo to reside in Kyoto, and the daimyo themselves to also serve him there (Asao 1991). Under the Tokugawa shogunate daimyo were forced to have a residence in the newly established capital of Edo (current-day Tokyo), and to house their family there. Third shogun Tokugawa Iemitsu expanded the rules and defined a compulsory system of alternate attendance (*sankin kōtai*). This meant that daimyo spent part of their time in their own domain and part their time at the shogun's court in Edo.

The alternate attendance system was conducted at a large cost to the daimyo budgets. Large expenses were incurred for the annual processions of the daimyo to Edo, for the one or more

8 1603-1605: Tokugawa Ieyasu (de facto in power from the battle of Sekigahara in 1600, remained in power as retired shogun (*ogosho*) until his death in 1616)
1605-1623: Tokugawa Hidetada (ogosho until his death in 1632)
1623-1651: Tokugawa Iemitsu (died in office)

mansions maintained there, and for the consumption of goods and services by the daimyo and his retainers. For many daimyo the expenses for sankin kōtai were equal to one third of their yearly income (Hall 1991, p. 158).

The institution of sankin kōtai would have cut into the ability of daimyo to rebel against the shogun in at least four ways: First, there was the threat to the hostages. Second, the time spent away from home cut down the time available to organise any rebellion. Third, the time spent in Edo weakened the bond between the daimyo and their domain in favour of a personal connection to the shogun (Hall 1991, p. 158). Lastly, the expenses made it more difficult to fund a large army. Sankin kōtai was a major component of government expenditure – if indeed it was as large as the share given by Hall (1991, p. 158)[9] – and one squarely aimed at keeping the shogunate in power.

3.3.2 Social division – status and class

Hideyoshi had set into law the distinction between farmers and warriors. During the Tokugawa period these distinctions developed further into a division of four groups: samurai, peasants, artisans and merchants. While the four groups are generally agreed upon in the literature, there is at least some debate on to which extent the groups represent status or class (see (Howland 2001) for a discussion of this topic). The process of separation of the four groups seems to have taken place gradually during the sengoku period through to the middle of the Tokugawa period. Cases from the Sengoku period are described by (Makihara 2014), while Howland puts the timing of the fully developed system in the 1700s. The process Howland describes seems to have been part organic, bottom-up, and part theoretical and legal, top-down. The latter can be seen in Hideyoshi's edicts separating farmers from soldiers, and in Confucian writing. In Chinese Confucian texts there is the concept of four classes, although these groups were slightly changed in the Japanese Confucian writing of the time to fit the Japanese circumstances. This adapting to the Japanese situation shows that it was not a purely theoretical or legal system, but that it also reflected existing developments in society. However, the theory did influence the thinking on how certain people should behave.

From the vantage point of the state, the most important groups to regulate were warriors and farmers. The warriors were of course important to maintain national security. The farming population was of interest because they were not only by far the largest group, they also contributed the vast majority of the tax income. As a consequence, farmers had a higher social status than artisans and merchants. The prevailing view stemming from the Confucian Mencius was that these latter groups – especially merchants – added less to the production of goods than farmers did

9 Hall does not provide a source, or details about which daiymo spent a third of their income on alternate attendance.

(Howand 2001). Especially for merchants, the relatively low social status was potentially in sharp contrast with their wealth. Conversely, some of the lower ranked samurai lived in relative poverty, as illustrated especially well in the works of Vaporis (2000). The aim of the social system was to keep people from having ambitions outside their station, and particularly to maintain farmers as the source of income to the regime. At times, farmers did resist high tax levels, both through internal revolts (*ikki*) and leaving their land to try their luck in the cities or other domains, despite both actions not being permitted (Paik, Steele and Tanaka 2012).

While for the national stability there may have been certain advantages to restrictions on occupational mobility, for the population it certainly had disadvantages. There are many reasons imaginable why the offspring of a farmer, artisan, or even samurai may have wanted to pursue a different career than what they were born into. In the case of farmers it could be a lack of land (or rather an abundance of siblings), for artisans a lack of ability or opportunity. It seems that such considerations at times weighed heavier than the official decrees. A significant part of the manservant population of Edo, Osaka and Kyoto came from surrounding villages, for maidservants this part was even greater (Leupp 1992, pp. 65-66).

3.3.3 The samurai question

The samurai as a social group were divided in several status levels, from the shogun and his family, down to daimyo, bannermen and retainers. Within these ranks there were further gradations based on the amount of land one controlled, the location of that land etc. Nobunaga and Hideyoshi had increasingly separated the samurai from the farming population, both legally and physically. The latter happened gradually through building projects that increased the size of castle towns. The physical separation reached its peak during the early Tokugawa shogunate, when samurai were ordered to live in castle towns by shogunate and daimyo. Only some peripheral domains failed to institute this rule (Nakai 1991).

During the Tokugawa period the lower ranked samurai where both physically and financially cut off from the farming population, and completely dependent on their lord for sustenance. A new pattern emerged wherein samurai filled positions in the government bureaucracies in return for stipends. The total number of samurai was too large to keep productively employed in this way, especially in daimyo domains (*han*) that were left with a large samurai population relative to the size of the land holdings. The land holdings of many daimyo had been changed by the shogunate depending on their loyalty. In contrast the number of samurai families was relatively fixed. In addition, there was a required number of troops (dependant on the size of the land holdings) that a

daimyo should be able to send to support the shogunate, in case of need. Even at the end of the Tokugawa period, the social class of samurai and low-ranking soldiers and their families came to almost 2 million people – more than 6% of the total population (according to a population survey taken around the end of the Tokugawa period (Tōkyō Tōkei Kyōkai 1882, p. 107)). Given the large supply of samurai for bureaucratic duties, many positions were filled by two or more people. The samurai that received stipends were often only temporarily or partially employed. In fact, when the new Meiji government issued regulations on working hours for civil servants in 1869, they set them from 10:00 to 14:00, reflecting custom in many late Tokugawa domains (Saito 2006, p. 61).

According to Craig (1986), increasing levels of education of the samurai coincided with the development of 'bureaus' within domain governments. Increasingly formalised, paper-based procedures were made possible by education. Daimyo were looking for expertise to handle the administration of their charges, especially in times of fiscal crisis. As Kozo Yamamura put it: “The continued pace of the Tokugawa period gradually changed the shogun's retainers from the samurai of the battlefields into bureaucrats, underemployed soldiers, and unemployed idlers” (Yamamura 1974, p. 70). It is a classic example of Veblen's 'leisure class'. Veblen even mentions feudal Japan as a prototypical example of a society where the warrior class is exempted from productive activity, as the “economic expression of their superior rank” (Veblen 1899, p.7). The employment of samurai in the government – in spite of the small amount of work there was for them – has been explained as an attempt to keep the warrior class occupied in peaceful activities and prevent uprisings and civil war (Howland 2001). The ostensible purpose of the samurai class was national security, but they arguably fell short of this goal. Although soldiers were used as guards in peacetime, during a large part of the Tokugawa period neither their training, their equipment nor their organisational structure was suited for war (Hall 1991).

4 International Policy

4.1 Establishment of Tokugawa trade policy

National trade had first been effectively regulated by Hideyoshi, who had instated a trade permit system. The trade permits, called Red Seals or *shuinjō* allowed Japanese traders to perform international trading missions. When Tokugawa Ieyasu took power, he consolidated Hideyoshi's system, issuing shuinjō, trading on his private account, and controlling the parties Japan did business with. The trading partners that called at Japan's ports during Ieyasu's time consisted of the Chinese, Dutch, Portuguese, Spanish, and English. In addition to the shuinjō trade, Japanese trading

missions were conducted by the Sō clan of Tsushima domain who acted as an intermediary to Korea and the Shimazu clan of Satsuma domain who filled a similar role regarding Ryūkyū (current Okinawa). Lastly there were small-scale trading contacts with the Ainu of Hokkaido (then known as Ezo) (Tashiro 2004, p. 105).

Despite the many different trade partners, the ultimate source and destination for the large majority of trade was China. For long stretches of time, free and direct trade between Japan and China was not permitted by either one or both countries' government. Because of this circumstance, several actors functioned as intermediaries between the two countries. It had been the main reason for the profitable trade of the Portuguese between Macao and Nagasaki. The shuinjō traders travelled mostly to South-East Asia, but often met with Chinese traders there. The same is true for the Dutch, after they lost their trading post on the island of Formosa (Taiwan). The Chinese that were allowed entry to Japanese harbours did so without the permission of their own government. Korea and Ryūkyū also acted as intermediaries, being traditional tributary states to China (Innes 1980, pp. 54, 65).

The shuinjō system was abolished in 1635, when the owning of ocean-going vessels and foreign travel were banned for Japanese nationals by the third shogun Tokugawa Iemitsu. In 1639, all foreigners were expelled from the country except the Chinese and Dutch. The apparent motivation for this decision was to counter the influence of Christianity in Japan, which had the potential of undermining the shogun's power. The edicts severely restricted the number of contacts with the world outside Japan. It also had the result of centralising control over foreign trade even more into the hands of the shogunate, at the expense of daimyo and merchants. The common description of the resulting situation has for a long time been *sakoku*, meaning ‘seclusion’ or ‘isolation’. However, the word sakoku was established much later than the initial trade restrictions. It was coined by Shizuki Tadao in 1801 when he translated the work of Kaempfer, the VOC physician stationed in Japan in the late 17th century (Kamiya and Kimura 2002). Although the term and the concept of sakoku are still often used, from the 1970s the academic discussion has been going in a wider and more nuanced direction, away from a viewpoint of total isolation.

First of all, Nagasaki was not the only point of contact. Diplomatic relations with Korea and Ryūkyū continued as ‘countries of communication’ and some trade also still took place. The contrast with China and the Netherlands was that these were seen as the ‘countries of trade’, having the right to establish trading missions on Japanese soil (Asao 1994). Secondly, Japan was considered more and more in context with the rest of East Asia. The Japanese policy began to be compared with other countries, such as the Chinese policy of trade and travel restrictions. In

addition, the political events and instabilities in neighbouring countries are now seen as relevant to Japanese international policies and attempts to insulate itself from foreign turmoil. These and others points have shaped the discussion of this topic around a different term, *kaikin*, or 'maritime ban'. This concept reflects the notion that the isolation was not complete. Japanese people were banned from seafaring, but foreign goods and – to some extent – ideas and technologies still reached Japan (Kimura 2014). Particularly the foreign trade volume seems to have been undiminished by the so-called sakoku edicts. Innes' work with the telling title "The Door Ajar" shows that the gaps left by the expelled trading groups were quickly filled by the Chinese and Dutch traders. In the early Tokugawa period the Portuguese and shuinjō ships handled most of the trade. During 1604-1638 their trade value averaged a combined 51 tonnes of silver, much more than the Chinese and Dutch. Then the shuinjō trade was ended in 1635, and the foreign trade missions were expelled in 1639. During 1639-1684 the Chinese and Dutch export value averaged a combined 76 tonnes of silver, more than making up for the loss. (Innes 1980, pp. 379-417)

During the 17th century a number of additional trade restrictions were put in place, specifically targeting the trade in metals, the main export commodity. Between 1637 and 1646 restrictions were put on the export of copper, as the bakufu needed the copper for re-minting copper coins (Shimada 2006, p. 12). The dwindling silver deposits caused increasingly tight regulation of the trade of silver. Meanwhile the bakufu tried to depress demand for imported items – which were usually luxury goods – through sumptuary laws (Innes 1980, pp. 302-07). In 1685 limits were set on the value of imports. Chinese traders were restricted to a value equal to 6 000 kanme (22 500 kilograms) of silver. The Dutch could import goods worth 3 400 kanme (12 750 kilograms) of silver, of which 400 kanme was reserved for private trade (Innes 1980, pp. 418-422). In 1715 new, lower quotas were set on the number of Chinese and Dutch ships permitted into Nagasaki, as well as the volume of metal to be exported. In the following years these quotas were at times amended, but the supply of copper was such that in many years these quotas were not met (Gramlich-Oka 2008, pp. 93-97).

These trade restrictions seem to have been primarily motivated by shortages in the supply of export materials. The shogunate was wary of exporting all of its silver and copper supply and hence restricted the export of these commodities. Eventually this led to the decline of all exports, and as the export value had to be equal to the import value, the latter declined as well. Meanwhile, the ban on foreign visitors to Japan and Japanese visits abroad prevented any new trade opportunities to arise. There was little knowledge of any potential trade goods Japan had to offer to the rest of the world, and vice versa. When precious metal availability declined – the one trade category Japan was

famous for on the world market – there was very little opportunity for other trade to take its place. Instead, during the 18th century Japan went in a direction of import substitution, stimulating the domestic production of silk and sugar. Eventually, falling domestic prices of these goods made imports uneconomical (Shimbo and Hasegawa 2004).

4.2 Reaction to new attempts at contact

During the 19th century Western powers increased their reach over many parts of the world. The English and French defeated China in the Opium Wars, Russia consolidated its hold over eastern Siberia, and the United States gained access to the Pacific coast. From all these sides, there were attempts to establish trade relations and gain access to the Japanese market. In 1844 King William II sent the shogun a letter, warning that one of these countries might try to force Japan to open up, and advised a gradual change of its restrictive trade policy. The shogun's advisers were not convinced by these arguments and replied that existing law could not be overturned, writing: "such is the strictness of the ancestral law, that no other course is open to us" and "henceforth, pray cease correspondence" (Greene, 1907, p. 122). This exchange suggests that isolation – sakoku – had by this time become a principle with its own intrinsic value to the shogunate, together with other constructs that were considered "ancestral law". Earlier decisions to restrict trade and travel had been motivated by considerations of domestic stability and commodity supply. In the mid-19th century the shogunate seems to have stuck to its position *in spite of* circumstances, not *because of* circumstances. The shogunate also did not use this opportunity for diplomacy, or to gather information. The request to "cease correspondence" can be seen through the lens of the Japanese principle of 'countries of communication' and 'countries of trade', and the Netherlands was in the latter, less prestigious category (Tashiro and Videen 1982).

Perhaps it is too easy to look back with hindsight and criticise this decision, since we now know that US Commodore Matthew Perry would arrive in Edo Bay in 1853 and force trade concessions, which eventually led to the end of the shogunate. The shogunate was certainly aware of the threat. Long before William II's letter, the number of sightings and attempted visits from foreign ships had been increasing. This had led to an increased study of the reports and books provided by the Dutch through Nagasaki, an interest that became known as *Rangaku*. Among Japanese scholars of the time there was considerable debate, based on varying levels of admiration and contempt for Western culture and science. This debate revolved around on a range of subjects, including: admiration for Western technology, mistrust of overtures for trade, fear of the influence of Christianity, determination to protect Japan's borders, and a realisation that its current defence forces were

insufficient. Some advocated for a gradual opening up of the country, and there were various radical ideas to strengthen Japan's defences. The shogunate and han were not in a position to carry out a military revolution however, as they were short on finances (Jansen 1989). The shogunate's system for controlling the daimyo (such as sankin kōtai) was costly, and prevented the daimyo from forming a military threat to the shogunate. This meant that in case of an outside threat, the principal responsibility to protect the country fell to the shogun. The shogun and daimyo did increase spending on coastal defence in the late Tokugawa period, but with existing financial problems and a samurai class virtually converted to bureaucrats, it was a very tall order to deal with this problem.

These are the circumstances in which William II's letter and later Commodore Perry's ships were received in Japan. Because of the bad financial, technological and organisational position of the Japanese government, the shogunate had a very weak hand to play, and in the end it could not offer effective resistance.

What were the costs to the Tokugawa economy of the restrictive trade policies? Although it can not be determined exactly, the costs have been approached by Bernhofen and Brown (2005) through the following counterfactual: How much higher would income have had to be in the early 1850s in order to afford the consumption that would have been available under free trade? The answer is made possible by detailed data on prices and trade volumes to construct a comparative advantage index. Bernhofen and Brown show, for instance, that cloth was significantly more expensive in 1830s Japan than it was in the 1860s. In terms of the missed income due to trade barriers, they arrive at an upper bound estimate of 8 to 9 percent (Bernhofen & Brown 2005, p. 221). They concede, however that the effect on overall welfare may have been lower, because the estimate strictly concerns real wages of urban workers. While Bernhofen and Brown's estimate applies to *static* comparative advantage (i.e., without structural changes taking place in the economy), Meissner and Tang (2018) have considered the issue of the *dynamic* case (with structural changes). They find that between 1880 and 1910 Japans' exports changed from raw materials to cotton textiles and other manufactured goods, while exports increased in value, and gravitated from Western countries towards Asian neighbours. From both these studies it appears that the Japanese economy was significantly held back in its economic development by its trade restrictions.

5 Property Rights

5.1 Stability

As set out in the first chapter, property rights are an important part of an institutional environment conducive to economic growth. By extension this also requires a certain level of general societal safety and stability, a point made abundantly clear by Hobbes ([1651] 1996).

In terms of safety and stability the Tokugawa government performed very well. Except for certain years at the beginning and the end of the more than two-and-a-half centuries of Tokugawa shogunate rule, Japan was at peace. For most of this time there was no significant external or internal armed conflict. This ‘Pax Tokugawa’ was perhaps one of the shogunate’s highest achievements. A different way to put this, as White (1995) has, is that the shogunate successfully monopolised the legal use of force, a crucial requirement for a post-feudal state. He describes how the shogunate increasingly afforded itself the right to coerce and dictate daimyo affairs. Together with a growing bureaucracy and an increasingly elaborate set of laws and customs, Tokugawa Japan was slowly becoming a more modern state. However, in White’s assessment the shogunate falls short of creating a “rational-bureaucratic Weberian state” with independent bureaucratic organisations and a separation of powers (White 1988, p.3). The system relied heavily on semi-official organisations and village councils. The fairness of any adjudication would have depended on the situation within these organisations and the local standing of the individuals involved. This may have limited the impartiality of the justice system. Nevertheless, over time the adjudication process became increasingly rational and impartial. As part of the Kyōhō period reforms around the 1720s, several changes were made to shogunate legal proceedings in order to standardise sentences, restrict torture of the accused, ban the automatic charging of family members of the guilty, impose statute limitations and improve prison conditions (Tatsuya 1991).

One source of instability during the Tokugawa period that could not be eliminated by the shogun or the daimyo, was unrest among the people. From time to time there were local uprisings, known as ikki. These were often motivated by high local tax rates, famines, or social issues, as described by White (1995). They also tended to increase in number towards the later Tokugawa period. The ikki were locally disruptive, and were often aimed at changing local conditions. Due to this nature they generally did not rise to a national level. Partly because of this the level of disruption caused these ikki was than the disruption caused by wars, such as those that were waged in Europe around the same time.

5.2 Legal protections

As stated above, the Tokugawa justice system was increasingly rational and bureaucratic, but it still had flaws. Property rights require a legal infrastructure that protects from both other civilians and the government. The extent of these protections seems to have been limited, depending on circumstances. Property rights protections were limited in at least two dimensions: locality and subject.

As discussed by Ramseyer (1996), Tokugawa Japan could be considered a federal system, in which the shogunate had "structurally limited but geographically broad regulatory power" (1996, p. 18). Theoretically, local government power was constrained by the fact that the local population could migrate to a different village or domain. The above mentioned ikki served as a similar threat that prevented local governments from regulation that was either too restrictive, or not supportive enough to the people. According to Ramseyer these were good conditions for property rights protection, since the federal (shogunate) government was strong enough to enforce property rights, but too weak to become excessive restrictive:

> "Had the national government enjoyed real regulatory power, it could have caused a regulatory catastrophy - for the ideologically and politically based regulatory plans it announced were disastrous: to end social mobility, to stop real estate transfers, and even to ban interdomainal migration. Fortunately for the country, it lacked the power to enforce any of them." (Ramseyer 1996, p. 18)

These shogunate objectives as described by Ramseyer point to a primary occupation with the regulation of land and labour – an understandable situation in a mostly agrarian country where the vast majority of government tax income came from farming. Consequently, the shogunate tried to control the trade in agricultural land and labour, but only to a certain degree. Permanently selling land was not allowed, but renting/pawning was condoned (Saito 2009). Presumably the shogunate wanted to prevent a concentration of land holdings and a revival of a rural aristocracy. The ban on permanent sale may have worked to protect against this to some extent, but eventually some concentration of land did take place, starting from the mid-17th century. These land transfers often started as loans given by wealthier farmers to poorer ones to enable them to for instance pay their taxes. In return the land was pawned. (Kwon 2002). Different types of peasants emerged from the relative equality of the early Tokugawa period: tenants, owner-cultivators, and landlords. (Saito 2009)

In the case of labour, both trade in humans and coercive labour useded, until Hideyoshi put a ban on it, which was later maintained by the Tokugawa shogunate (Mandai and Nakabayashi 2018). As discussed above, the ‘caste’ system and the resban migration were not in fact absolute. Saito (2009) puts this down to the fact that the main objective of authorities was to prevent the departure of households from their farmland, since households were units of taxation. Individuals were more free to find other professions, even going from farms to the cities, as long as the family farm was continued. According to Saito (2009) the lease market for land and rural to urban labour markets were functional, although relatively limited in scope. The existence of a market for these commodities suggests that the shogunate’s ban on land trade and migration was not absolute, and that property rights protections were working to some extent.

Besides property rights protection also contract enforcement is needed. Mandhi (2018) have researched the Tokugawa period rules around foreclosure. They state that the right foreclosure regulation would allow peasants to borrow money to improve their farm with the land as collateral, without causing a concentration of land holdings if such loans went bad. They also describe the stages the forerules went through during the Tokugawa period. The shogunate went from a ban on farmland trades in the mid-seventeenth century, to a tightening of rules on foreclosures in the early 18th century. When this last step turned out to shrink the market for rural credit, the shogunate reverted to a looser set of foreclosure rules that both allowed discount interest rates for punctual borrowers, and punishments for those in arrears. I think this shows that the shogunate not only concerned itself with the primary market for land, but also the credit market derived from it.

There were other markets – beyond labour and land – that received less interest from government regulators. Tokugawa Japan had a centralised system of courts, however according to White (1995) the rights of subjects were not guaranteed by formal law. Instead, there were certain customary rights that were recognised by government officials, and civilians could and did bring suits before the national courts. The chance of a hearing depended on the type of lawsuit however. Civil lawsuits on monetary matters and contract enforcement had the smallest chance of being accepted. The Shogunate position was that these cases should be settled within an organisation, or by a guild or village head (Okazaki 2005). This relies on social mechanisms similar to the ones described by Greif (1993) for the Maghribi traders. In other words, the shogunate was content with letting merchants and artisans work out their disputes and contract enforcements among themselves. Moreover, the shogunate at times extracted forced loans from wealthy merchants. There is record of this happening in the 1840’s when the shogunate encountered several financial setbacks (Ōguchi 2004).

From these facts a pattern emerges wherein the shogunate pays attention to the types of property rights that impact its own bottom line more or less directly, but not those rights that might be of importance to the economy as a whole, such as disputes among merchants or artisans.

6 National Finances

In this section I will first give an outline of the government budget at the national level (shogunate plus han). Since the land production tax was by far the most important one, and in order to be able to give a land tax rate, I will discuss both the land production and taxation. For this I will synthesize a new estimate of land production.

6.1 An outline of the national budget

At the top level, the Shogunate's finances were based on a 'balanced budget'. Its expenses were determined by its ability to extract revenue. And in extraordinary circumstances extraordinary steps had to be taken, such as re-minting or forced loans. In the view of Honjo (1931) the budgetary considerations of the Shogunate are similar to those of a household, and in fact there was a blurry line between Shogunate and Tokugawa family finances. This family orientation of government finances is an important factor in judging the relative development of a government system. In the terms of the Bonney-Ormrod model (Bonney 1999) the Tokugawa state falls in the category of domain states, dependent on income from the land held by the ruling families. It falls short of the tax state category, because its taxation is not broadly focussed different parts of society, and it lacks the modern tools to finance expenditure through long-term public debt. The spreading out of large expenditures over long periods through government debt was a crucial innovation in the competition between European states. Although lending was available on a smaller, local scale (see for instance Saito and Settsu 2006), a full-fledged financial system capable of providing the central government with sufficient funds did not become available until the Meiji period.

The shogunate, daimyo domains, and villages and city neighbourhoods each had resources of different kinds. By far the most important source of income for the shogunate was the land tax, collected either in the form of rice or as money. The official land tax rate over the primary sector output between 1650 and 1850 hovered around 35% (Asao, Uno and Tanaka 1997, pp. 1332-37). However, as explained below, the official tax rate is likely an overestimation. Recent estimates of agricultural output (Fukao et al. 2015, Appendix 1; Fukao, Nakamura, Nakabayashi (eds.) 2017 p. 37) have come out higher than previous ones. These new estimates assume both higher land

productivity at the start of the Tokugawa period, and smoother transitions to the subsequent Meiji-era productivity. The implication of this is that actual tax levels were much lower than the official rates.

Besides the land tax, the shogunate had other sources of income, although on the whole these were more irregular. The shogunate had the authority to issue currency, and in addition the shogunate levied special taxes and contributions for extraordinary expenses. In the few comprehensive shogunate accounts that survive (1730, 1843 and 1844), we see a big shift towards more extraordinary measures in order to keep the budget in the black. In the 1730 shogunate accounts, the land tax revenue made up 80.1% of total revenue, while special purpose taxes made up 18.9% and a further 1.0% consisted of re-coinage profits. For the year 1844 the accounts look very different. Ōguchi explains the difference as a result of both a gradual worsening of Shogunate finances due to increasing stipends, investments in coastal defence, and other costs, as well as a costly reconstruction of Edo's main keep after a fire. The sudden costs were financed by re-minting profits and a forced loan extracted from merchants in Osaka. As a result, land taxes only made up 43.9% of revenue in that year. Total revenue increased from 1.74 million koku in 1730 to 2.47 million koku in 1844, or a growth of 42% (Ōguchi 2004).

At the han level, daimyo had full authority to tax their own domains. Most domain finances were similar to early shogunate finances, with land taxes making up the vast majority of income. Since taxation was the daimyo's prerogative, the shogunate did not keep records of individual domain tax revenue. Therefore, nationwide estimates of tax levels of the daimyo domains are not available until the early Meiji period when an inventory was made of the production and tax income of the daimyo domains.

6.2 Agricultural production

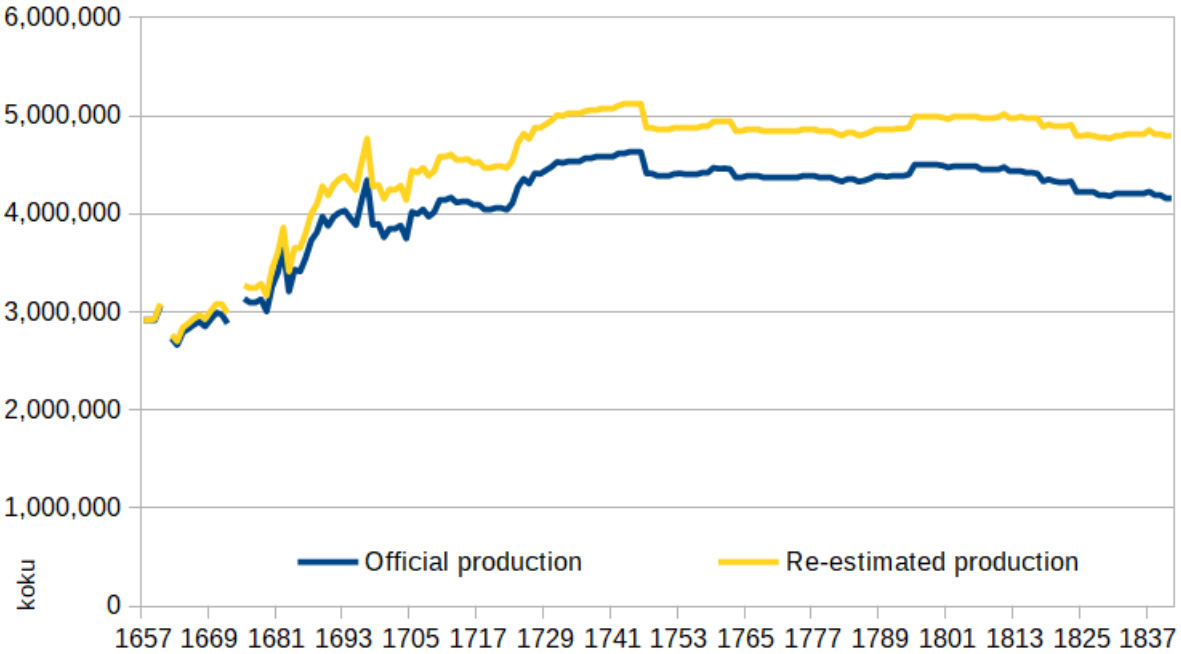
In order to be able to discuss national land tax rates and their development, it is first necessary to get an estimate of total taxable production. The estimation is divided into two parts: production in Shogunate area, and production in other domains.

6.2.1 Shogunate land production

One way of trying to increase the trustworthiness of estimates for the actual production volume is to use the most reliable early estimates as a foundation – since they are based on more reliable land surveys – and then use information on land productivity growth to estimate production growth. Nakabayashi (2008) has done this with a start date of 1716, using an estimate of land productivity

to interpolate the years to 1841. The land productivity data he used is from (Hayami and Miyamoto 1988). I have repeated this exercise with a longer time series of official kokudaka, starting in 1657, from the Kadokawa Nihonshi Jiten (Asao, Uno and Tanaka 1997, pp. 1332-37). According to Nakamura (1968) the kokudaka estimates from a 1645 survey are comparatively reliable. By extension, the 1657 production should still be reasonably close to that estimate. I used land productivity rates (*koku/chō*) from (Bassino et al. 2015, Table 2). These more recent estimates of agricultural output during the Tokugawa period assume a much higher level of production, to increase consistency with the more reliable estimates from the early Meiji period (Fukao et al. 2015, Appendix 1). However, in these estimates the production in the early Tokugawa period is also higher, so that the end effect is a longer but less steep increase in land productivity starting well before the Tokugawa period. According to the estimates of Bassino et al. the land productivity in koku per *chō*[10] (0.99 ha) rose from 13.32 in 1650 to 15.74 in 1850 (2015, Table 2). This results in the re-estimated production in Figure 1.

Figure 1: Official (kokudaka) and re-estimated production on shogunate lands



Source: Re-estimated series calculated by author, for sources see text

10 1 Chō = 0.99 hectares

6.2.2 Domain land production

Nationwide land production data was not being kept very up-to-date by bakufu officials. The measure of kokudaka kept by the bakufu, known as *omotedaka* (表高), was not a very current figure. For many domains it changed only little during the entire Tokugawa period, and then mostly to reflect transfers of land between domains, not newly cultivated land or changes in productivity. A more up to date measure was the *uchidaka* (内高), also called *kusadaka* (草高), that were maintained by the domains. These assessments of the cultivated lands were updated at varying intervals depending on the domain administration. Even the uchidaka was likely an underestimation, however. In case of long update intervals the land survey data would inevitably be outdated. In addition, farmers could try to keep part of their fields hidden from the assessors. A third inaccuracy stems from the tendency to assume a constant land productivity value (Beasley 1960). In a classic study of the assessed yield and tax levels of diverse villages, Smith (1958), shows the remarkably long unchanged use of official production estimates. In most included cases – from the second half of the 17th to the second half of the 19th centuries – the assessment remained unchanged for over 100 years. It is unlikely that actual output would remain so constant, especially considering the high land productivity that at the beginning of the Meiji period, compared to the early Tokugawa period (Fukao et al. 2015).

The actual amount of arable land, the land productivity, and the total agricultural production during the Tokugawa period have been points of of much discussion. A credible approach is to use certain benchmark estimates from relatively reliable sources and use another metric to estimate the path between those two points. Nakamura (1968) used surveys from 1645 and 1867 as production benchmarks, and land improvement projects for the arable land development. This approach has recently been refined by Fukao et al. (2015) by breaking down the data on production and land improvement into 14 regions. In addition, they use an 1874 benchmark instead of the 1867 one, as the difference between those two benchmarks is judged to be implausibly large, and the later one as more reliable. They estimate total national primary sector production (including agriculture, forestry and fishing) of 30.2 million koku in 1600, 69.8 million koku for 1850 and 76.4 in 1874 (Fukao et al. 2015, Table A1.6).

Comparing these figures with the domain uchidaka from the late 1860s it is immediately apparent that there is a sizeable discrepancy. Total daimyo domain uchidaka comes to 22.3 million koku. There are a few domains for which the uchidaka is not known, but their omotedaka only comes to 0.7 million koku. For the domains with known uchidaka, the uchidaka total is 29.2%

larger than their omotedaka. Assuming a similar ratio for the missing omotedaka figures, total daimyo domain uchidaka would come to 23.2 million koku. According to the above estimates of bakufu land production – adjusted to include land productivity improvements – their kokudaka came to about 4.8 million koku in 1841. This is a slightly earlier period than the national estimate for 1850, however, for the last hundred years this estimate was very stable between 4.8 and 5.0 million koku. Besides its granary lands the shogunate's bannermen controlled another 2.6 million koku in 1698. Assuming a similar growth path as the granary lands this would have amounted to 3.0 million koku in 1841. A final small amount of a few hundred thousand koku was held by the imperial family (Hall 1991, 152).

6.2.3 Total land production

Adding all these kokudaka together, the national total would have been in the neighbourhood of 31.1 million koku around the middle of the 19th century, see Table 2. In comparison, the Fukao et al. estimate for 1850 is 2.2 times as large. As explained above, the domain uchidaka figures are based on early Tokugawa surveys and were probably not sufficiently updated. As a consequence, the national estimate based on these uchidaka figures is close to the estimate for the year 1600, with a difference of only half a million koku.

6.3 Tokugawa period national government revenue

The shogunate, han, and villages and city neighbourhoods all had resources of different kinds. The shogunate and han relied mostly on land taxation. In order to be able to consider the national land tax rate it is necessary to combine the numbers of the shogunate domain and the han. In terms of land taxation the shogunate domain was just one of many domains that (together with a small area held by the imperial family) cover the total arable land. In other words, for tax purposes the shogunate was a ‘primus inter pares’ (first among equals). With a total national tax rate it also becomes possible to compare the Tokugawa taxes with those of other, centralised states. Therefore, I will separately calculate the shogunate and daimyo (and imperial family) domain taxes, and then add them together for a national number.

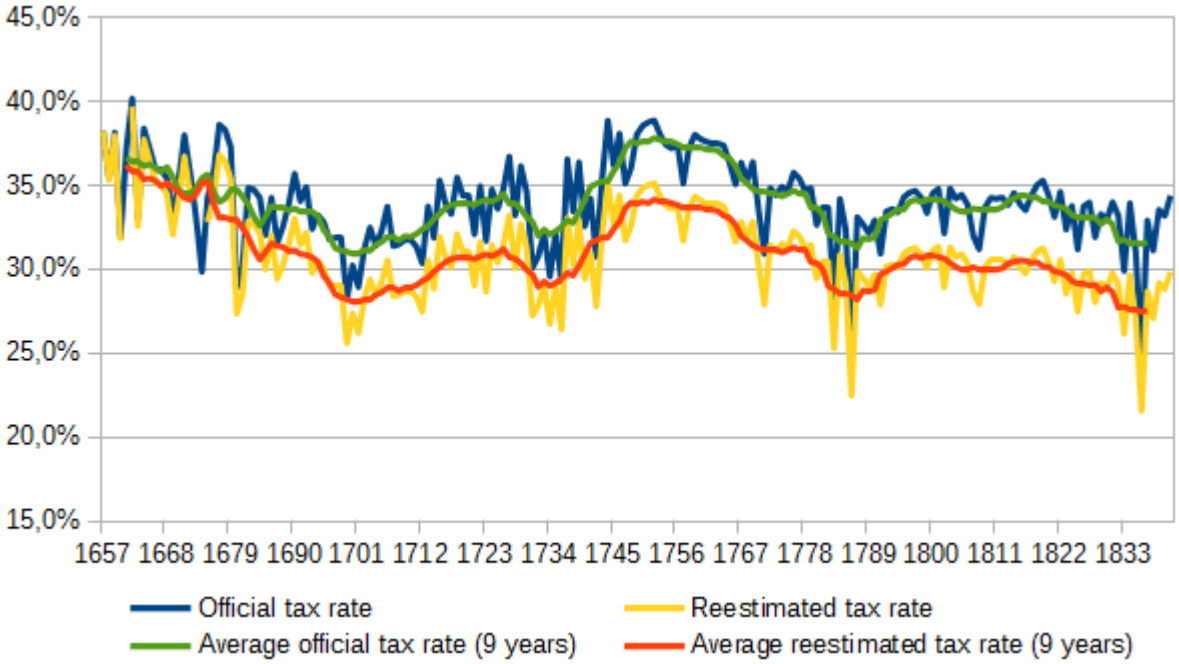
6.3.1 Shogunate

As mentioned above, comprehensive accounts of the shogunate's income and expenditures are only available for a few years, 1730, 1843 and 1844 (Ōguchi 2004). The accounts for the 1840's

contain large irregular revenues due to a re-issue of coin that was carried out in that period. Expenditures are also irregular due to the large costs for the restoration of the shogun's castle in Edo after a fire, and a ceremonial visit to the temple at Nikkō.
According to these accounts – and setting aside the special re-coining revenue – by far the most important source of income for the shogunate was the land tax, collected either in the form of rice or as money. The official land tax rate over the primary sector output hovered around 35% between 1650 and 1850, see the top line in Figure 2 (Asao, Uno and Tanaka 1997, pp. 1332-37). However, it is generally assumed that the official tax rate is an overestimation, due to the actual production being higher than the officially estimated production, which was based on infrequent land surveys.

Dividing the collected tax by the adjusted production estimate yields the adjusted tax rate, see the bottom line in Figure 1. Using these land productivity increases, the re-estimated tax rate drops from almost 38% in 1657 to 28% around 1700, after which it trends up and later down again to around 28%, see Figure 2. At that point the adjusted kokudaka estimate comes to 4.8 million koku compared to the official account of 4.2 million koku, with land tax income of 1.4 million koku.

Figure 2: Official and re-estimated land tax rates of the Shogunate



Source: see paragraph 6.3.1

Besides the land tax the shogunate had other sources of income, although on the whole they were more irregular. The ability to issue coin has been mentioned, in addition the shogunate levied

special taxes and contributions for extraordinary expenses. In the 1730 shogunate accounts the land tax revenue made up 80.1% of total revenue, while special purpose taxes made up 18.9% and a further 1.0% consisted of re-coinage profits, see Table 3. For the year 1844 the accounts look very different. Ōguchi Yūjirō explains the difference as a result of both a gradual worsening of Shogunate finances due to increasing stipends and other costs, as well as a costly reconstruction of Edo's main keep after a fire. The sudden costs were financed by re-minting profits and a forced loan extracted from merchants in Osaka. The size of these schemes is remarkable, making up respectively 26.2% and 21.7% of revenue for that year, compared to 43.9% from the land tax and 8.2% from other special purpose taxes and repaid loans. According to Ōguchi, the 1840s figures were two to three times as large as the 1720s figure (Ōguchi 2004, p. 211). However, that excludes the rice account. Total revenue including the rice account increased from 1.74 million koku in 1730 to 2.47 million koku in 1844, or a growth of 42%.[11] Converting the total revenue to rice amounts has the additional benefit of being closer to 'real' numbers, i.e. corrected for price changes.

Although the increase in revenue was substantial, there are a few significant caveats. Firstly, excluding the special measures of re-minting and forced loans, the regular revenue actually decreased from the 1730 amount (as measured in rice). The annual land tax paid in gold actually increased in nominal terms, but due to a fall in the value of gold coins, this still resulted in a much lower rice amount. Without the special revenues, the tax income was not enough to cover expenditures, even if we exclude the castle reconstruction costs. Secondly, while these special measures were successful in raising revenue, they had possibly adverse effects on the rest of the economy.

First let us discuss the re-minting profits, also known as seigniorage. In the history of Tokugawa money creation there have been distinct periods of active reissue of money, with different degrees of success (see Miyamoto's chapters in Hayami, Saito and Toby 2004). The 1695 Genroku re-coinage achieved significant profits while causing relatively small inflation. This was followed by a succession of re-coinages in the early 18th century that did cause large price rises, which suggests that the money supply growth was outpacing the increase in the trade of goods and services. According to Miyamoto the money issued during the 1820s to 1840s had a beneficial effect on the economy because the re-coinage profits facilitated an expansion of shogunal expenditure. In addition, the growth of the money supply was relatively gradual, preventing the disruptive price

11 1730 and 1844 amounts from Ōguchi 2004, pp. 194–95, 209–10. The accounts are split by medium of transaction, either in rice or in gold. The gold amounts have been converted into rice by use of the average of the Osaka and Edo gold/rice exchange price from Iwahashi 1981, pp. 460–61. Exchanges of rice for gold and vice versa have been excluded as these cancel each other out in the rice and gold accounts. Of loan expenses and income only the net effect has been included.

increases of the early 18th century. However, Shimbo and Saito (2004) are of a very different opinion on this matter, pointing at increasing imbalances in the different coins circulating in Japan at the time. Besides gold and silver coins, there were silver coins with a face value in gold (a quasi fiat money). The exchange rate of gold coins to the other two kinds decreased to around 1:5 by the 1850s, while the ratio on the international market was much higher, which exposed Japan to serious arbitrage exploitation when the ports opened up.

The other measure taken in 1844 was a forced loan extracted from wealthy Osaka merchants for a total value of 1.1 million ryō at 12.5% interest for 20 years (Ōguchi 2004, pp. 210-11). According to Ōguchi, part of the reason for this measure was the difficulty the shogunate had in transferring the castle reconstruction costs to the lords and bannermen. The forced loans were a breach of the merchants' property rights.

6.3.2 Domain revenue

Since taxation was the daimyo's prerogative, the bakufu did not keep records of individual domain tax revenue. Therefore, nationwide estimates of tax levels of the daimyo domains are not available until the early Meiji period, when an inventory was made of the production and tax income of the daimyo domains. A survey was taken of domain governments in 1869, where they were asked to report the average land production and taxation during 1864-1868.[12] This took place before the domains were abolished and the tax system reformed, meaning that in principle the outcome should reflect the situation in the last years of the Tokugawa tax system. In fact, until a national reform of the land tax, the Dajōkan (Council of State) decreed that the old han land tax systems should be maintained (Norman 2000, p. 76). According to the production and tax data the average daimyo land tax as a percentage of their official kokudaka was 49.9%. Compared to uchidaka, the late 1860s land tax rate was 38.6% (authors calculations, based on Kodama and Kitajima 1998, pp. 425-31).

Despite the discrepancies in the land production estimates, the domain revenue from the land tax is a much more reliable figure, since this was much easier for the han administrators to verify. According to the late 1860s survey the total land tax collected by daimyo domains amounted to 9.0 million koku. Other taxes only made up 5.7% of daimyo domain income according to the data included in Beasley (1960), based on the same survey. This adds 540 thousand koku to the tax total

12 The results were published in Tōkei Shūshi (Tōkyō Tōkei Kyōkai 1882). Expanded and corrected data were later released in Meiji Seiran (Hosokawa 1885) and Hansei Ichiran (Nihon Shiseki Kyōkai 1928). This study makes use of the data in Hanshi Sōran (Kodama and Kitajima 1989, pp. 425–31), which is based on the earlier sources.

for daimyo domains. The shogun's land tax income was 1.1 million koku according to the 1844 financial account presented in Table 3. Other regular revenue came to 203 thousand koku. The extraordinary measures taken in that year – an extended re-minting programme and forced loans – increased income by another 1.2 million koku. Assuming similar tax rates for the shogun's bannermen as for the daimyo domain, their total taxes (including non-land taxes) would come to 1.2 million koku. Using the same tax rates for the imperial land holdings, their tax income would only be around 50 thousand koku.

6.3.3 Total national government revenue

The combined total tax income (excluding the shogunate's extraordinary revenue) is given in Table 2 and amounts to 12.1 million koku, of which 11.2 million in land tax and 815 thousand koku from other taxes. This estimate comes with the caveat that the source data reflects somewhat different periods – the 1860s for the daimyo domains and the 1840s for the shogunate tax income.

Given the speculative nature of the above estimate and the unreliability of the production figures from the domain survey, the tax estimate should be checked against other sources for consistency. Fortunately the land taxes were being scrutinised in the early Meiji period in anticipation of a change to the tax system. During 1871-1874, the last years before the land tax was reformed, the range of land tax receipts varied from 10.7 to 12.5 million koku depending on the harvest, with an annual average of 11.67 million koku (Yamamura 1986, p. 389). This is within half a million koku of the above estimate, and an encouraging sign given the different sources and methods. Another estimate uses tax reports by the han and imperial court, shrines and temples for the late 1860s, and tax reports for the shogunate and its bannermen for the late 1850s. The result is a total tax revenue of 13.5 million koku, of which 0.7 million koku is extraordinary revenue for the shogunate (Yamamura 1986). All these estimate through different means are consistent with a total tax revenue of 12 to 13 million koku, excluding shogunate extraordinary revenue. From here on the first estimate will be used of 11.2 million koku in land tax and 815 thousand koku non-land tax.

Based on the materials described above, I have estimated a combined shogunate and domain government tax revenue circa the year 1850. For the shogunate, there are separate estimates for the land tax revenue (last year 1841) and complete accounts for 1843. The daimyo domains' tax income for is based on an inventory of the production and tax income of the daimyo domains during 1869-'70 from ‘Meiji Seiran’ (Hosokawa 1985). Apart from the daimyo domains, there were lands directly controlled by the shogunate (*tenryō*), by the shogun's bannermen, and a small amount under control of the imperial household. There are production estimates for these components for the end

of the 17th century (Hall 1991, p. 152). Based on the rates of growth of production for the daimyo domains between 1698 and 1869-70, and the daimyo domain tax levels in 1869-70, I have extrapolated tax revenues for these additional areas. The total tax revenue arrived at by combining these figures comes in at 12.1 million koku (1.8 million tonnes) of rice, of which 11.2 million koku was land tax revenue. This amount is comparable with the national land tax income during 1871-1874, the last years before the land tax was reformed (Yamamura 1986, p. 389). This consistency suggests that it is a realistic estimate.

7 International Comparison

7.1 Institutions

Comparing Japan with European states in the early modern period, there are a few stark differences. As mentioned in the previous chapter, many descriptions of state development in Europe focus on the role of wars in increasing the organisational and fiscal capacities. Europe endured centuries of competition in the States System. During this time there was not just competition between methods of taxation and warfare, but also of trade regimes, technologies and ideas.

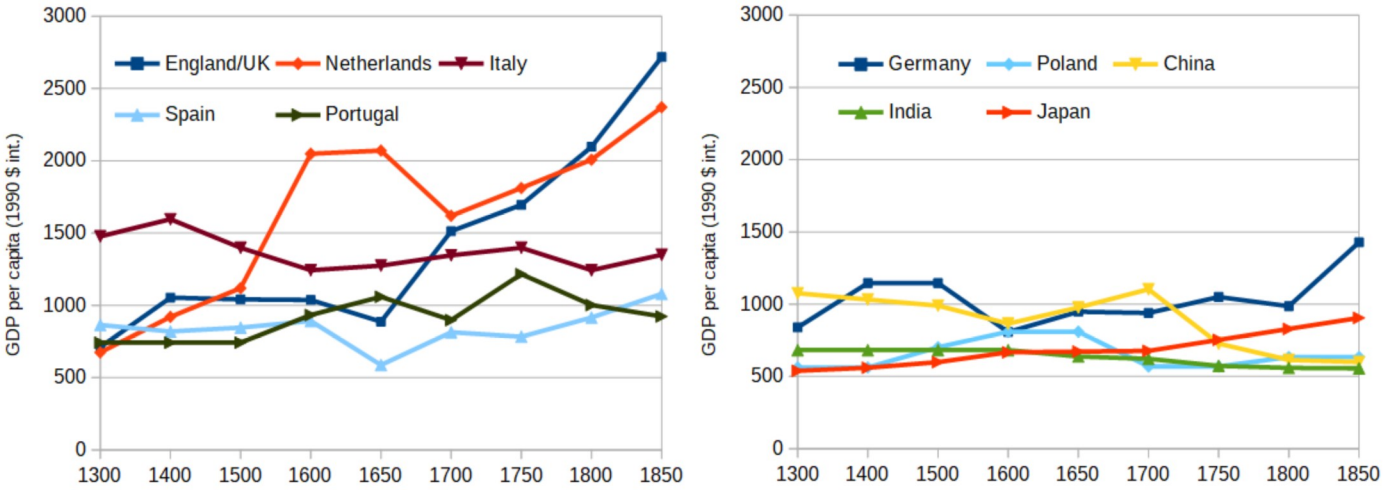
Japan shows a lot of similarities during the Warring States period. Power was centralised from the samurai to the daimyo and the scale of warfare increased through changes to taxation and recruitment. The change and spread of institutions shows clear Systems Competition taking place. Under the Tokugawa regime, however, patterns diverge. During the first few decades of the shogunate competition is restricted at many levels, both internally and externally. Citizens are restricted to their social class, daimyo are restricted to their domains, and outside contacts are restricted to limited visits from the Dutch and the Chinese. Even if trade continued apace in the early years of the trade restrictions, the limited exposure of foreigners to Japan and of Japanese to the outside world meant that there were few chances of new opportunities developing outside the existing trade of precious metals for silk. When the outside world did force their way in, Japan was technologically and militarily too far behind to resist. That is the final level of competition, between the Empire System of Japan and the growing world-system dominated by Western powers, and in this competition Japan was not able to resist.

Japan was unable to defend the sovereignty of its trade access despite having in many regards a well organised government. Comparing the revenue gathering ability of the Japanese government with those of European countries, it is striking how similar it was in some respects. Government revenue around 1850 as a percentage of GDP was comparable to that of Holland or Russia, see below. This is even more remarkable considering that in most European states the military was the main expenditure category, and that Japan had a similar level of expenditure despite being at peace for the last few centuries. One of the factors behind the high government spending in Japan is the employment of samurai in non-productive government positions. The next chapter will discuss this issue in greater detail.

7.2 Economic growth

As laid out in Chapter 1, the causality between institutions and economic growth is a topic of frequent debate. In that debate there is evidence for a causal link from institutions to economic growth (Acemoğlu et al 2014; Besley and Persson 2010; Dincecco and Kats 2014; Dincecco and Prado 2012). There may be caveats to these findings however, especially for countries with already high levels of political freedom and/or economic development. In particular, the strength of property rights remains an influential factor. (Barro 1996; Wade 1990). For the early modern period these issues may be less of a concern, given the relatively low levels of institutional and economic development compared to modern times. In short, the effect of institutional development on economic growth is likely to be positive, although other factors may of course also influence economic outcomes.

Figure 3a&b: Per capita GDP in selected countries (1990 international dollars)

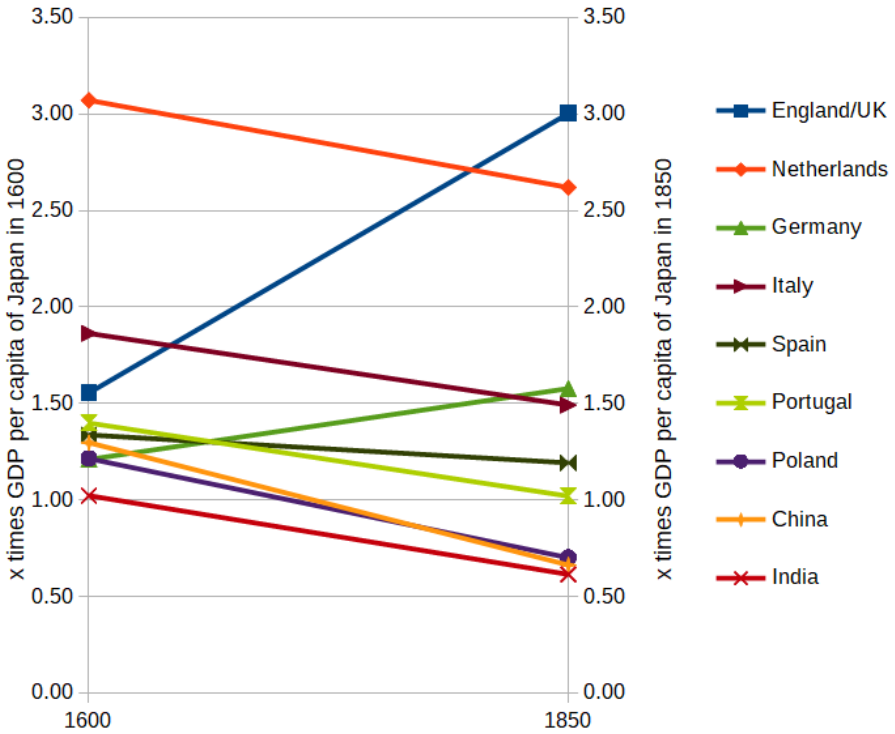


Source: Fukao, Nakamura, Nakabayashi (eds.) 2017 p. 285

Over the past years the historical GDP series of many different countries have been revised, giving us more accurate and reliable benchmarks. See the GDP per capita for selected countries in Table 5 and Figure 3. For Japan much work has been done to expand the GDP estimates with not only better agricultural production statistics by region, but also better production estimates for the secondary and tertiary sector (e.g., Fukao et al. 2015). The result is a GDP per capita estimate for Japan that increases from 539 (in 1990 international dollars) in 1300, to 667 in 1600 and to 905 in 1850. Strongest growth is seen in the 16th century (0.1% per year) and from 1700 to 1850 (0.2% per year). Compared to a selection of other countries Japan starts out in 1300 with one of the lowest GDP's per capita, close to Poland and slightly lower than India. China has a relatively high GDP per capita in 1300 at 1076, only beaten out by Italy in this sample. Both these countries have a lower GDP per capita in 1850 than they do in 1300. The UK and the Netherlands are the two countries clearly outperforming the rest, as regarding both in their level in 1850 and in their growth. Early colonisers Portugal and especially Spain do not seem to benefit from their overseas holdings in terms of national GDP per capita. When it comes to the question of the economic outcome of the Tokugawa period, it seems that economic development was faster in the second half than in the first. But how did Japan fare compared to these other countries? Were its at times restrictive institutions causing it to fall further behind? In Figure 4 I have calculated the ratio of the GDP per capita of the different countries in comparison to that of Japan, both for 1600 and for 1850. We can see for instance that India started in 1600 with a ratio of one (same level as Japan), but by 1850 this had fallen to 0.6 (Indian GDP per capita was only 60% of that of Japan). Seven of the nine reference countries show a downward slope, i.e. Japan was catching up. The exceptions are the UK and

Germany. Three countries fell to a lower GDP per capita than Japan. Perhaps coincidentally, these three are either classic empires (China and India, although the latter became a colony), or regular states outside the early modern world-system (Poland) in Wallersteins estimation (1974). Despite the Tokugawa period's reputation for trade restrictions and technological backwardness, it caught up to some of the countries that were part of the presumably more dynamic European States System.

Figure 4: GDP per capita of selected countries as a ratio of Japanese GDP in 1600 and 1850



Source: Fukao, Nakamura, Nakabayashi (eds.) 2017 p. 285

7.3 Tax rates

Recent estimates of Japanese GDP for the Tokugawa period amount to a value of 111.4 million koku of rice for 1850, of which 69.8 million came from the primary sector (primary sector production from Fukao et al. 2015, Table A1.10; secondary and tertiary sector shares (1846) from Saito and Takashima 2016, Table 2)[13] The tax estimates above result in a tax to GDP ratio for 1850 of 10.9%, and 16.0% for the primary sector alone. This turns out to be a slightly lower percentage than in the early Meiji period (Ohkawa, Takamatsu and Yamamoto 1974). In Table 4 in the Appendix to Chapter 2 these percentages are compared to available estimates of central

13 The primary sector estimate from Fukao et al. (2015) was taken as a base. The secondary and tertiary sector value added were calculated based on this primary sector estimate and sectoral shares from Saito and Takashima.

government[14] revenue for other countries from (Yun-Casalilla, O'Brien, and Comín 2012). The Japanese tax revenue of 10.9% of GDP in the late Tokugawa period turns out to be comparable not only to the early Meiji tax rate, but also to the Castilian revenue in the 17th century, and the British in the 18th century.

In Tables 6, 7 and 8 the tax income is converted from rice to tonnes of silver, and per capita revenue in grams of silver and days of urban unskilled wages. The results are compared to a slightly different set of countries. The results show that total revenue at the disposal of the Japanese government (Japan 1) at 1160 tonnes of silver was a little under half of Chinese Imperial government income, and about 1/10th of English revenue. In per capita terms, England was equally far ahead, while Chinese per capita revenue was only 1/5th of Japanese revenue. However, looking at the days of unskilled labour equivalents, we see that at 35 days the tax pressure was higher in Japan than in England, and much more so than in China.

The high number of working days is striking compared to the less spectacular per capita revenue in silver. This is due to the low silver wages in Japan at the time (or in other words, silver was very expensive). Although Bassino and Ma (2006) find daily urban unskilled wages of roughly 3 grammes of silver circa 1850 (similar to wages in China), I believe the actual pure silver wage is closer to 1 gramme. For completeness, I have given the outcomes using the higher silver content estimates in the "Japan 2" series. Bassino and Ma used a conversion rate of 3.11 grammes of pure silver per *monme* (匁, a Japanese weight unit of nominally 3.75g grammes), however the actual silver content of silver coins had been lowered through several rounds of re-coining. Specifically, the Tenpō re-coinage lowered the silver purity to 26%, or 0.975 grammes of silver per monme. The high value placed on silver in Japan at the time is also reflected in the fact that the gold to silver exchange ratio (1:4.5) in Japan was considerably higher than on the international market (1:15.5) (Ohkura and Shimbo 1978). This situation was only possible as long as Japan's market was relatively closed off from the rest of the world. The important thing is that regardless of the silver content used, the rice value of government revenue and the rice value of daily wages leads us to the same number of urban unskilled working days required of 35. In the international context this is a remarkably high number. It seems to indicate a relatively absolutist state, as well as considerable excess production over bare consistence.

A question naturally emerges from these facts: what was the reason for this high tax pressure? While European countries had high military expenditures, Japan was mostly at peace. One

14 Central government is in the Japanese case interpreted as shogunate plus domains. Since domains had the right of taxation over their own domains, and we are dividing the revenue by national GDP, it seems fair to include the domains. Village and municipal taxes are excluded.

hypothesis is that the employment of samurai drove up government budgets. I will address this question in the next chapter.

8 Conclusion

Comparing Japan with European states in the early modern period, there are a few stark differences. As mentioned in the previous chapter, many studies on state development in Europe focus on the role of wars in increasing the organisational and fiscal capacities. Europe endured centuries of the States System. During this time there was not just competition between methods of taxation and warfare, but also of trade regimes, technologies and ideas. Eventually, this led to the development of strong, centralised states.

Japan shows a comparable level and type of competition during the Warring States period. There was aggressive competition between warlords. This led to centralisation of power, from the samurai to the daimyo, and an an increase in the scale of warfare, through changes to taxation and recruitment. This was partly a consequence of a similar States System that was also taking place in Europe. Under the Tokugawa the process of unification centralised power further and changed Japan into an Island Empire System, withdrawn from both internal and external competition. The Tokugawa regime asserted its power through restrictions on outside contact, strict controls on both civilians and the daimyo, and a relatively high tax pressure, moving in the direction of a ‘despotic leviathan’ (after Acemoğlu and Robinson (2016)). The resulting peace and order created a good environment for economic development, as well as an increasingly specialised bureaucracy. The time away from Systems Competition may have had its advantages. However, over time the Tokugawa system seems to have become constricting. The international policy gradually shifted from controlled interaction in the 17th century, to a system of seclusion by the 19th century. After a period of catch-up through contacts with the West during the sengoku period, Japan’s technology deficit with the rest of the world grew as the Tokugawa period went on. Government finances also started to suffer, partly because of the high cost of the Tokugawa regime’s control system, including sankin kōtai expenses and stipends for a large number of underemployed samurai. The shogunate found itself in an untenable position, unable to respond effectively to outside threats when the world-system spread over the globe.

Appendix to Chapter 2

Table 2: Production estimates and taxation for different holdings, mid-19th century

	Production	**Land tax**	**Other taxes**	**Total**
Daimyo (1864-1868)	23 209	8 968	540	9 508
Tenryō (1841/1844)	4 802	1 085	203	1 288
Shogun bannermen	2 971	1 148	69	1 217
Imperial	161	48	3	51
Total	31 141	11 249	815	12 064

Sources: Daimyo: production (uchidaka) and land tax from (Kodama and Kitajima 1989, 425–431), *non-land taxation from (Beasley 1960); tenryō production and taxation: see paragraph 6.3.1; shogun bannermen and imperial: production based on (Hall 1991, 152) multiplied by development of tenryō production, taxes based on daimyo tax levels.*

Table 3: Shogunate finances, years 1730 and 1844

Year	***1730***	***1730***	***1844***	***1844***
Unit	1000 ryō	1000 koku	1000 ryō	1000 koku
Gold revenue				
Annual tax	509	893	647	490
Kuniyaku	25	44	7	6
Kofushin	27	47	23	18
Yakusho Osame	55	97	71	54
Agemai	29	51		
Forced loans			706	535
Reminting profits	10	18	856	649
Net loan revenue			85	64
Others	10	17	66	50
Total gold revenue	665	1167	2463	1866
Rice revenue				
Tax rice		500		595
Agemai		73		
Other rice submissions		0		11
Total rice revenue		573		606
Total revenue		1740		2472
Gold expenditure				
Stipends/salaries	297	*522*	428	*325*
Household expenses	60	*106*	89	*67*
Administrative costs/bureaus	150	*262*	289	*219*
Reconstruction/repair	69	*120*	68	*52*
Aid	12	*21*	184	*139*
Net loan expenditure	14	*25*		
Nikkō costs			2	*2*
Main keep reconstruction			836	*633*
Others	5	*9*	58	*44*
Total gold expenditure	607	1065	1953	1480
Rice expenditure				
Stipends		151		304
Wages		161		230
Household expenses		11		7
Bureaus		13		27
Local officials		8		41
Others		45		26
Total rice expenditure		390		635
Total expenditure		1455		2115

Sources: (Ōguchi 2004, pp. 194-95, 209-10) Gold amounts converted to koku by average of Osaka and Edo rice price from (Iwahashi 1981, pp. 460-61). Rice purchases and sales excluded, as in principle these cancel each other out in the gold and rice accounts. Loan payments and repayments converted to net revenue/expenses.

Table 4: Central government revenue, % of GDP

	Luxembourg (% of income)	Ottoman Empire	Russia	Castile (crown)	Britain	Holland	Japan
1600-1649							
1650-1699				10	1.3-4.4		
1700-1749					7.3-10		
1750-1799	16.1	3			8-12	13.5	
1800-1849		5-6			23		
1850-1869		5-6	12			11.5	10.9
1870-1889							11.1

Sources: (Yun-Casalilla, O'Brien and Comín 2012); Japan 1850: (Meiji Seiran: Hosokawa 1885); (Hall 1991); (Fukao et al. 2015); Japan 1885: (Ohkawa, Takamatsu and Yamamoto 1974).

Table 5: Per capita GDP in selected countries (1990 international dollars)

Years	England /UK	Nether-lands	Italy	Spain	Portugal	Germany	Poland	China	India	Japan
1300	711	674	1477	864	742	839	562	1076	682	539
1400	1053	920	1596	819	742	1146	562	1032	682	560
1500	1041	1119	1398	846	742	1146	702	990	682	599
1600	1037	2049	1243	892	933	807	810	865	682	667
1650	887	2071	1275	587	1059	948	810	977	638	672
1700	1513	1620	1346	814	898	939	569	1103	622	677
1750	1695	1812	1398	783	1216	1050	569	727	573	753
1800	2097	2008	1243	916	1002	986	634	614	559	829
1850	2718	2371	1350	1079	923	1428	634	600	556	905

Source: Fukao, Nakamura, Nakabayashi (eds.) 2017 p. 285

Table 6: Government revenue, tonnes of silver

		China	Ottoman	Russia	France	Spain	England	Dutch Republic	Japan 1 (0.98g/匁)	Japan 2 (3.11g/匁)
1650	1699	940	248		851	243	239			
1700	1749	1 304	294	155	932	312	632	310		
1750	1799	1 229	263	492	1 612	618	1 370	350		
1800	1849	1 367					6 156			
1850	1899	2 651					10 941		1 160	3 517

Table 7: Per capita revenue, grammes of silver

		China	Ottoman	Russia	France	Spain	England	Dutch Republic	Japan 1 (0.98g/匁)	Japan 2 (3.11g/匁)
1650	1699	7	11.8		46	35.8	45.1			
1700	1749	7.2	15.5	6.4	46.6	41.6	93.5	161		
1750	1799	4.2	12.9	21	66.4	63.1	158.4	170.7		
1800	1849	3.4					303.8			
1850	1899	7					344.1		36	108

Table 8: Per capita revenue in days of urban unskilled wages

		China	Ottoman	Russia	France	Spain	England	Dutch Republic	Japan 1 (0.98g/匁)	Japan 2 (3.11g/匁)
1650	1699		1.7		8	7.7	4.2	13.6		
1700	1749	2.26	2.6	6.4	6.7	4.6	8.9	24.1		
1750	1799	1.32	2	8.3	11.4	10	12.6	22.8		
1800	1849	1.23					17.2			
1850	1899	1.99					19.4		35	35

Sources: (Ma 2011, Table 1) Japan: See text for description of tax level, rice price: (Iwahashi 1981); Population: (Fukao et al. 2015) Wages: (Bassino and Ma 2006).

Chapter 3: The Tokugawa System and Ruling Class Rents

1 Introduction

As described in the previous chapter, the Tokugawa governance system was one primarily aimed at stability and security of the position of the ruling families. This system had potential costs in different forms, one of which was the financial burden on the shogunate and han budgets to maintain it. Several types of expenditures seem to have been contributing to these costs, such as the private expenditures of the shogunate and han families, the expenses of the sankin kōtai (alternate attendance) system, and the stipends for a large number of samurai. This last circumstance was a vestige of the samurai history as landed warriors, which connected the samurai to the control and taxation of land. As these functions of control and taxation were taken from the local warrior and centralised in the hands of the daimyo (see the discussion in the previous chapter), their role also evolved into an administrative one. While their status gave them the right to wear a sword, the Tokugawa system had been designed to keep them from the fights over territory that had characterised the preceding period (Howland 2001). In this chapter I aim to estimate the monetary costs of this system to the taxpayer.

A true accounting of the expenses of these pacifying institutions is not readily available, but some sense of the scale can be gained from Meiji period sources. In the Meiji period the samurai right to stipends was commuted to government bonds of differing financial value, depending on the rank of the samurai. Ohkawa and Rosovsky state that between 1868 and 1876 – before the end of the stipend system – the transfer payments regularly made up over 30% of government expenditures (Ohkawa and Rosovsky 1965, p. 63). According to the 1871 records of stipend expenses, 395 000 people received 6.7 million koku of rice plus miscellaneous transfers with a value of 150 000 koku, at 1850 prices (Crawcour 1979, p. 20). This would be over half of the total national revenue of 12.1 million koku (see the previous chapter for the calculation). During the fiscal year of July 1875 to June 1876 'pensions for meritorious services and hereditary pensions' – terms used to describe samurai stipends – made up almost 18 million yen, out of total government expenditure of 63 million yen (*Japan Weekly Mail* 1877, No. Feb. 3). In 1877 the pensions were commutated to government bonds, worth 172.9 million yen. This ended the pension payments to the samurai class, but increased the government debt to several times the previous size (Ohkawa and Rosovsky 1965, p. 63).

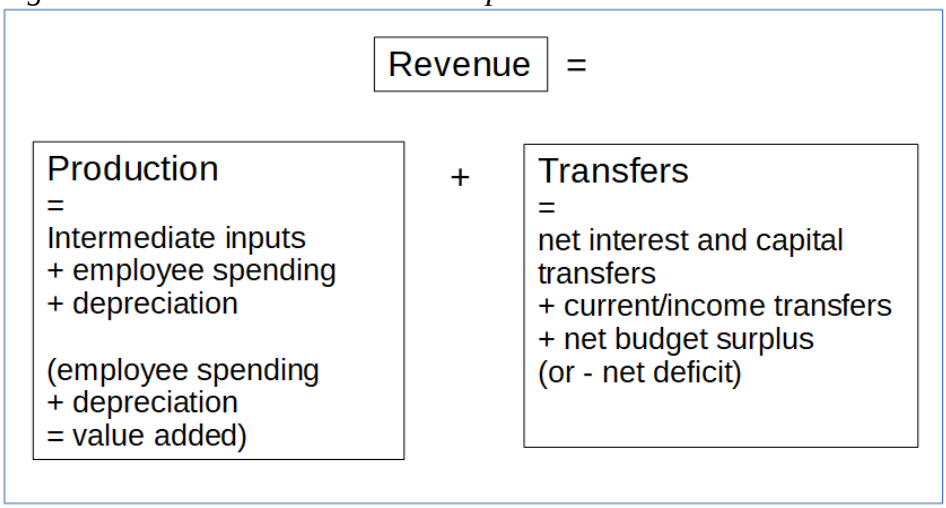
These numbers on the size of Meiji period payments suggest that if the ‘pensions’ paid during the Meiji period were at all comparable in size to the earlier samurai stipends, they would have been a substantial part of the government expenses during the Tokugawa period. Among the financial burdens of the Tokugawa system were the expenses for the shogun and daimyo families. These may also have been represented in the early Meiji pensions, since high ranking samurai received substantial sums during this period. The highest samurai and daimyo ranks even became part of a new official peerage system in 1884 (Jansen 2000, p. 391).

The size of the financial expenses makes this a relevant subject for study. In this chapter I will try to estimate the financial costs of the Tokugawa system that consisted of a large number of stipended samurai, wealthy daimyo and sankin kōtai. Since detailed national spending data are not available for the Tokugawa period, I will take an indirect approach. I will estimate the cost of providing government services in the Meiji period, and compare it with government revenues during the Tokugawa period. Then an adjustment has to be made for the differences in the services provided by the two government systems. The remaining sum represents the higher costs of one system (Tokugawa) over the other (Meiji). In the following paragraphs the method, sources and outcomes will be presented.

2 Estimation Method

The financial costs of the Tokugawa system can be seen through different lenses. As mentioned above, they can be seen as the costs to ensure political stability. In a socio-economic sense they are ruling class rents extracted from the taxpaying population. These rents are equal to the transfer of funds from the taxpayers to those in the samurai class (including daimyo and shogun) receiving stipends or other payments in excess of the value of their work in government service. In a government accounting sense these transfers correspond with the amount of tax paid in excess of the amount used to pay for the goods and services provided by the government.

Figure 5: Government revenue and expenditure in National Accounts



The main distinction within government expenditure is between production and transfers. Productive expenditure is done through personnel expenditure, investment expenditure, and expenditure on intermediate goods and services. Transfers are divided into a budget deficit/surplus, expenditures on loans (interest and repayment) and current transfers. The current transfers are commonly income transfers from taxpayers to those who receive an income subsidy from the state. In modern National Accounts (NA), these transfers are classified as social benefits in the form of unemployment benefits, welfare etc. (United Nations et al. 2009, pp. 441–44) These concepts and their relatedness are represented in Figure 5. In this chapter I will use this framework to calculate current transfers, also known as income transfers. To do this, we first need estimates for all the other elements.

For the Tokugawa period, we do not have reliable estimates for government productive spending, nor for the government transfers. In part this is because we do not know the extent to which samurai bureaucrats were paid for actual work (personnel expenditure in NA) and how much of the samurai income was ruling class rents (current transfers in NA). The approach I have chosen to solve this problem is to estimate a more realistic cost of government production. I do this by looking at government productive spending from a later period. That cost is then converted to Tokugawa prices. That sum is then compared with the actual taxes paid by Tokugawa period taxpayers. The difference represents a type of inefficiency in the Tokugawa government. In theory this inefficiency is an income transfer tot the samurai class, as they were the beneficiaries of the tax payments.

The reference period chosen for the estimate of the more realistic costs of government goods and services, is the Meiji period (1868-1912), and in particular the year 1890. The reason for choosing this year is that in the very beginning of the Meiji period the functioning of the state was still irregular, and therefore not suitable for a benchmark of government production costs. During the 1870s for instance the government still depended in large part on debt for financing its expenditure, including a very large expense for pensioning off the samurai class. Another reason is the availability of data. In the 1880s the government became more organised, and more detailed statistics are available for this period. The first GNP estimation is available for 1885. For the purpose of this research I will make use of the data for 1890 as this year includes even more detailed information, such as expenditure per policy area, which is necessary to make certain corrections in the services that were offered by the Tokugawa and Meiji governments.

Obviously the transition from the Tokugawa to the Meiji government was a major societal shift, wherein the ruling class was replaced and the country was opened up to outside influences. This introduces a degree of inconsistency. However, the different government structure is exactly what is needed to be able to make an estimate of the 'true' cost of providing government services without the inefficiencies of the old system. Despite the societal changes, the technologies used in the provision of many government services will likely not have changed much. There are a few notable exceptions such as the modernised military and the railways that have to be taken into account. On the whole though, there are indications that in most industries fundamental technological change did not come until later in the Meiji period.[15]

The reference period for the Tokugawa expenditures will be the period around 1850. In terms of data availability this is a relatively good period compared to the early and mid Tokugawa. The years around 1850 are also the latest before foreign powers start to impose themselves on Japan and change the economic and political situation.[16] In order to make a good comparison of the 'true' costs, we have to restrict the Meiji period costs to expenditures on government activities that were also present in the Tokugawa government.

15 In the work on regional inequality and industrial structure by Fukao et al. (2015, Table 3.1c) the estimates of labour productivity show a nontrivial yearly growth in the 1874 to 1890 period of around 1% for each sector. In the 1890 to 1909 period however, secondary sector labour productivity growth increases to around 4%. Labour productivity in 'Transport, communication and utilities' grows by an impressive 8.6%, likely as a result of infrastructure investments, including railways. In the rest of the tertiary sector, 'domestic trade and service industries', labour productivity growth stayed under 1%.

16 The years before 1850 saw growing numbers of encounters with the rest of the world, but until Commodore Perry's arrival in 1852, this still happened mostly on Japan's terms. From 1852 the Tokugawa shogunate increasingly lost control over international interactions.

The method I have used is as follows, based on the framework in Figure 5. First a complete overview of the Meiji budget is constructed, including a newly calculated value for the depreciation of government capital goods. This gives us the total production by the Meiji government. Spending on public goods categories not provided by the Tokugawa government in 1850 (e.g. railroads) are then taken out. The next step is a conversion to 1850 prices which gives us the 'true' value or cost of the public goods provided in 1850. The difference between this value and the total revenue of the government in 1850 is equal to the government transfers. These transfers itself are divided over of interest spending, the budget surplus or deficit and finally the current transfers. This final category is considered ruling class rents in this framework. Another way of saying it is that these rents are the amount by which the taxpayers overpaid for the public goods they received. In the remaining paragraphs, firstly an overview will be given of the differences in goods and services provided by the Tokugawa and Meiji governments, secondly the sourcing and calculation of separate elements are explained, and thirdly the results will be discussed.

3 Tokugawa Government Goods and Services

Before calculating the alternative cost of Tokugawa government production, we need to establish the differences the public goods a package in the late Tokugawa period. Especially the productive expenditure, in intermediate inputs, employees and depreciation are of interest at this point, since that is the part we want to translate to Tokugawa levels.

A comparison of the differences between Tokugawa and Meiji period government activities is presented in Table 9. Military spending is a high-value category for which inclusion is debatable. Although the organisation of the Tokugawa period military was suboptimal, it can be seen to have provided some level of national security, both in securing the borders and keeping the national peace. Certain domains also began to modernise and adopt Western military technology in the 1840s and 1850s. However, in 1850 this was not yet a nationwide phenomenon (Norman 2000, p 119). Since military modernisation necessitated large capital expenditures (as well as training) during the Meiji period – and large-scale modernisation was absent in 1850 – military capital spending is excluded from the 1890 expenditure.

At the central level, both employee spending and intermediate input spending are distributed over policy areas using salaries per ministry as a proxy (Emi and Shionoya 1966, Table 15). Spending on railways and education is then subtracted. Payments to the Mint bureau are then added to intermediate input spending (Emi and Shionoya 1966, Table 3). These were excluded in the Meiji accounts as part of the Government Enterprise Accounts among other enterprises like the Imperial

Railway and the Army and Navy Factory. The expenditure for the Mint is added back in at this step because supplying the national currency was one of the important functions of the Tokugawa shogunate.

An interesting data point is the large amount spent on personnel dispatched to the prefectures, equal to a quarter of the total including the military. For calculation purposes this is added to the personnel spending of the ministry for Home and local affairs. In a wider sense the employees dispatched to the prefectures can be seen as evidence that the central government had taken over the responsibilities formerly borne by the han: “it was to resume and expand on behalf of the central government a whole range of functions that had for centuries been performed by feudal lords” (Beasley 1989, p. 643). It is important to note that for comparison purposes the Meiji central government plus the prefectures is best seen as the successor to the Tokugawa shogunate and han. In this the Meiji central government is however not comparable to the Tokugawa shogunate in terms of scope and responsibilities, nor are the han directly comparable to the prefectures. The local level shows more consistency throughout the early Meiji period.

Besides the Home and local affairs and the Army and Navy the biggest spender is the ministry of Justice. The relatively high spending on so-called 'state services', averaging around 55% during the entire Meiji period, has been noted as unusual and unjustified (Oshima 1965, p. 376). This means that the spending levels on which these estimates are based possibly include relatively large inefficiencies. Meiji civil service salaries were considered relatively high compared to the former samurai stipends as well as contemporary private sector salaries (Muehlhoff 2014, p. 209).

At the local level education spending is subtracted from intermediate inputs and employee spending, based on information about total and capital expenditure per policy area and public school teacher salaries (Emi and Shionoya 1966, Table 11, Emi 1971, Table 6, Ohkawa, Takamatsu, and Yamamoto 1974, p. 128). During the Tokugawa period the government did not play a big role in education. The existing schools were run by local temples in most cases. Even though there was an increase in school attendance after the arrival of Commander Perry in the 1850s, by 1873 school attendance was still at 28.1%, compared with 48.9% in 1890 (Emi 1963, 6: p. 126). After public works and administration, education is the third largest local policy area, responsible for 1/5th of the local spending, mostly at the city and village level where it makes up 1/3 of the spending. (Emi and Shionoya 1966, Table 12).

Many of the public goods and services were provided at the local level. Villages were responsible for local administration, tax collection, infrastructure upkeep, resolving smaller disputes

and relief for smaller emergencies. Although the villagers were obligated to provide the labour, there was little or no financial compensation from the daimyo or shogun. The biggest exception to this was the assistance provided to the local population in case of natural disasters (Nakane and Ōishi 1991).

4 Sources and Calculations

4.1 Cost of Meiji government production

Government budget statistics for the Meiji period are available in the Japanese Long-Term Economic Statistics (LTES) series (LTES Vol. 1, National Income: Ohkawa, Takamatsu, and Yamamoto 1974; LTES Vol. 3, Capital Stock: Ohkawa 1966; LTES Vol. 4, Capital Formation: Emi 1971; LTES Vol. 7, Government Expenditure: Emi and Shionoya 1966; LTES Vol. 8, Prices: Ohkawa 1967).

The LTES data makes it possible to divide government spending according to several intersecting classifications. Important distinctions we can make this way are central versus local spending, and current versus capital expenditure. All these items are further detailed into several policy areas, so it is possible to distinguish, for instance, central government current expenditure by the Justice department, or local government capital expenditure for roads and bridges. Using these detailed accounts to exclude the goods and services that were not provided by the Tokugawa government, we can make an approximation of the Meiji period costs for providing a 'Tokugawa public goods basket'.

An important omission from the LTES series is a value for government capital depreciation, which I have calculated separately. Together with personnel expenditure, capital depreciation constitutes government sector value added, and is therefore an important statistic. I have applied the declining balance rate method – used by US Bureau of Economic Analysis (BEA) – to calculate the Meiji government capital depreciation in 1890 (U.S. Department of Commerce. Bureau of Economic Analysis 2003). This method uses depreciation rates that depend on the type of good concerned. The depreciation rates were taken from the BEA, but adapted to the useful lifespan reported for Japan in the LTES (Vol. 3, Ohkawa 1966)[17]. Depending on the availability of the data in LTES, the net government capital stock for each category is either based on net total stock adjusted

17 Infrastructure and buildings: 50 year lifespan, depreciation factor 0.0182
Furniture, equipment, vehicles: 15-20 years lifespan, depreciation factor 0.0825 to 0.11

for non-government capital, or based on historical governmental net capital formation, adjusted for price effects (Ohkawa 1966, Tables 29, 31; Emi 1971, Tables 4-7). In order to separate the prefectural and municipal capital stock depreciation, detailed spending data on capital goods by these levels of government was used (Naimushō [Ministry of the Interior] 1892). This makes it possible to make a split in Meiji period capital spending between the levels of government, as well as a distribution over policy areas, so that specific elements can be excluded. In addition, depreciation of buildings at the central level is adjusted for education related buildings (government education was limited under the Tokugawa regime). To that end, the share for education is subtracted from the depreciation of buildings, approximated by the share of the ministry of education in salaries. For the size of the depreciation by category, see Table 10.

Once depreciation is known, it becomes possible to construct a more comprehensive account of government expenditure for 1890. For the total 1890 budget (including the newly calculated depreciation) see the top part of Table 11. The depreciation presented here raises government value added by 11.5 million yen (or 1.1% of GDP[18]) to 44.5 million yen (4.2% of GDP). Adding intermediate inputs to this result gives the value of total government production at 77.5 million yen (7.2% of GDP).

4.2 Government resources

The main part of the financial resources of the Tokugawa government – its taxes – have been described in Chapter 2. As noted there, in terms of taxation the shogunate and daimyo (and imperial) domains together covered the whole area of Japan. Since the Meiji government had a true national, centralised tax system, it is important to use Tokugawa tax figures on the same national basis. This means taking the total of shogunate, daimyo and imperial domain taxes, which is calculated in Chapter 2 at 12.06 million koku.

The Meiji government also included a local (municipal) level, which can be seen as the modern equivalent of the village and city neighbourhoods of the Tokugawa period. The rest of this section will describe the resources available at this level of government.

Whereas the han and shogunate used land tax as their main income, at the local level the available resources were very different. Villagers had duties both to their lord and to their local

18 In the LTES, GDP is not stated directly. In Vol. 1 Table 8 various measures are provided included NNP, GNP, NDP, Net factor income from abroad and Depreciation. Because of relatively large statistical discrepancies the outcomes are different when calculating GDP either as NDP plus Depreciation or GNP minus Net factor income from abroad. Because of the statistical discrepancies concerning depreciation the latter approach is chosen. This yields a GDP of 1059 Million Yen.

community. The former consisted of taxes as well as corvée. Corvée was often in the form of labour, but could also take the form of money or rice for specific uses. Corvée could be owed to the shogun, the daimyo or the local community. National or domain corvée could consist of construction labour for buildings or infrastructure, and logistical support for tax rice, travelling daimyo retinues and military operations. Examples are the large castle construction projects of the early Tokugawa period, which made use of large amounts of corvée labour. Another big draw on corvée labour – especially for villages along the main trunk roads – was porter duty for daimyo retinues on their way to and from Edo for sankin kōtai (Hall and Jansen 1968, pp. 288, 336). Expenses incurred during the performance of corvée were considered part of the duty. This included administration costs of village officials and meetings for the collection of taxes. Local community duties included the maintenance of local infrastructure (roads, bridges, levies, etc.), the organisation of festivals, temple donations, etc. According to Ooms (1996) the expenses for village communities were high and rising during the Tokugawa period, as daimyo increasingly transferred infrastructure expenses onto villages in order to lighten their own overburdened budgets. This meant that a large part of the village labour and expenses was directed by their overlord. Ooms states that, while these lords were reluctant to increase the land tax, they were more willing to increase local levies. The effect was an increase of village activity in infrastructure maintenance. Since the maintenance took place at the direction of their overlord this also meant a constraint on the village self-governance.

The funding and expenditure of local government goods and services was a self-contained system, where the inputs are immediately and completely used for production. Although part of the goods and services produced were for the benefit of their own community, to a large extent the beneficiaries were the ruling class. This applies to the tax collection activities for the shogun and daimyo, as well as corvée directed by these lords. Part of the goods and services were also consumed by the villagers, such as infrastructure. On the whole there was however a substantial transfer of value from the villages to the ruling class.

The public goods and services produced by the local communities formed an integral part of the functioning of the Tokugawa government. They played a crucial role in tax collection, infrastructure maintenance, dispute settlement and many other areas. At the same time, certain corvée duties – such as the porter duty for daimyo retinues – could be considered onerous and costly transfers of value from the population to the ruling class. The ruling class was able to instruct civilian corvée contributions both towards the public good and to their personal gain. Whereas the line between samurai officials and civilian representatives is fairly strict, the line between locally produced government goods and services on one hand and value transfers to the rulings class on the other, is

not. Because the size of value transfers to the ruling class resulting from corvée duty is unknown, it will not be included in the calculations. The production of local government goods and services through corvée will be assumed to be a closed system – the value of production is assumed to be equal to the costs (both in labour and material). As a consequence the transfers and surpluses from the municipal government level are considered to be zero.

The local corvée labour used for public goods in the Tokugawa government is then assumed to have the same value as the public goods provided at the local level in the Meiji government, minus eduction. This can be seen in Table 11 in the 9.0 million yen of production at the municipal level for the Tokugawa basket (and thus excluding education), compared to 15.4 million for the Meiji basket. A second implication is that when we consider the 12.06 million koku in tax income estimated above for the Tokugawa government, this only goes to pay for central government expenditure, as local government production uses local resources.

4.3 Tokugawa government interest expenditure

Of the central government receipts of the shogunate and daimyo, the part that was not spent on the production of public goods went to transfers and the budget surplus. To estimate the size of current transfers (redistribution) and interest payments it is necessary to get a sense of the financial transactions of the shogunate and daimyo. Both were in a difficult financial situation by the early 19th century, which was exacerbated by famine and other disasters in the mid 1830s. Satsuma domain is said to have had debts equal to 33 times its annual revenue in the 1830s, and for Chōshū domain debts were 23 times the annual revenue by 1840, although these were probably outliers (Crawcour 1989, p. 588). In 1843 the shogunate persuaded Osaka merchants to lend over one million gold coins (each roughly the value of a koku of rice) to the treasury. Although officially the loan was interest bearing and would be repaid, in times of need both the shogunate and daimyo reneged on promises to their financiers. In 1843 shogunate loan costs were 127.7 thousand gold coins (ryō) (Ōguchi 2004, p. 210). The domains and the shogunate both tried to improve their financial situation through reforms, but their success in this respect is questionable (Bolitho 1989, pp. 161–62).

Although comprehensive information about han interest payments is not available, some indication of at least the level of debt is available from the beginning of the Meiji period. When the debts of all han were settled by the new government in 1871, the total came to 78.1 million yen[19]

19 These debt levels may not seem very high considering the tumultuous times and battles around the end of the Tokugawa reign – 78.1 million yen in *han* debt is equal to 13.1 million koku, or 10.2% of 1850 GDP. Besides debt, the shogunate and the *han* issued money to increase their budgets. The shogun had the right to issue legal tender

(Okurashō 1877, pp. 138–39). The source gives some categorisation of different types of debt, including time of issue from 1868 and before 1844. Through elimination of categories such as newer debts and private debts, the total for 1867 would have been 56.3 million yen. Linear interpolation between this number and the 1843 estimate yields a total han debt of 48.0 million yen for 1850. It cannot be denied however that debts may have been repaid or renewed in the intervening years. At an interest rate for daimyo during 1841-1860 of 6.8% (Saito and Settsu 2006, Table 1), yearly interest payments at the han level in 1850 would have been around 3.3 million yen. At the debt total of 78.1 million yen, interest payments would have been 5.3 million yen. At 1871 rice prices (Kin'yūkenkyūkai 1937, p. 15) this equates to 512 thousand koku, or 888 thousand koku at the higher estimate. These estimates have an amount of imprecision due to the turbulent times between 1843 and 1871. As discussed above, fear of foreign intrusion was motivating some domains to invest in coastal defences. Moreover, the country devolved into civil war. This would have caused large fluctuations in han budgets and debt payments. Because of this uncertainty, I will err on the side of caution and use the higher estimate, in order to maintain a lower-bound estimate of the income transfers. In that case, adding the han and shogunate interest payments together yields a total of 1.0 million koku. This outcome can be seen in the results in Table 12 under Interest payments.

4.4 Price and volume adjustments

In order to translate the Meiji period costs of government goods and services production to the situation in the Tokugawa period it is necessary to adjust the results for price levels. The conversion to Tokugawa prices is done by equating the GDP estimates for 1890 expressed in yen to GDP estimates in units of rice as used for the Tokugawa budget (1 koku = 150 kg of rice) (Kin'yūkenkyūkai 1937, pp. 1–18). Based on this data we can convert the yen value of the 1850 Tokugawa public goods production (65.7 million yen in the bottom half of Table 11) to koku of rice (see Table 12).

Another adjustment to be made is to the volume of government production. When we have the cost of the basket of Tokugawa government goods – at Meiji cost levels, in koku – we still may have to adjust for the changes in the size of the country. This is partly a philosophical issue, but in this case quite fundamental for the calculation: Does the level of production (and consumption) of government goods change with the demographic or economic base of a country? The answer has

coins, and many *han* issued local quasi-money called *hansatsu* in order to cover current deficits. It is estimated that the total nominal value of the notes issued during the last years of the Tokugawa period and the early Meiji period was more than 90 million yen (Crawcour 1979, p. 23). Although they played a significant part in han finances, the *hansatsu* do not, however, factor directly into the calculation of the current transfers we are concerned with here.

implications for the expected growth path of Japanese government production between the Tokugawa and Meiji reference periods. Depending on the type of government good or service, it might be expected to stay constant (e.g. national defence) grow with population (e.g. education) or grow with GDP (e.g. infrastructure possibly). When government production is assumed not to change, the yen value from Table 11 is simply converted to koku by the conversion rate. The result is an assumed production value of 11.2 million koku in 1850. When production is assumed to change with population, the production total of 1890 is also divided by the population growth between 1850 and 1890 (from 32.5 million to 41.3 million (Fukao et al. 2015 Table A1.2)). When production is assumed to change with GDP, the production total of 1890 is also divided by the GDP per capita growth (from 904 to 1166 in 1990 international dollars (Saito and Takashima 2016)). The impact of the choice of this assumption, can be seen for each of these three options in Table 12. These results will be discussed in the next paragraph.

5 Results

The results in Table 12 are calculated by taking the known or estimated elements of the Tokugawa government budget circa 1850. most lines are from and converted to koku. Total current receipts (mostly tax revenue, estimated in the previous chapter) minus production (calculated through the Meiji budget in Table 11 and adjusted to koku), minus interest payments leaves the current transfers as the remainder. The current transfers can in this case be considered as income transfers, or ruling class rents. Depending on the assumption for the growth of government production, current transfers made up 10% (if government production was unchanged from the Tokugawa to the Meiji period), 26% (if production grew with the population), or 40% (if production grew with GDP) of total government expenditure. It possible that different parts of government production are more or less impacted by the growth of the underlying population and economy. Therefore it is plausible that the real income transfers were somewhere between the extremes of this range. A reasonable baseline is formed by the middle scenario (production grows with population) and thus current transfers of roughly a quarter of government spending. If true, that would mean represent 3.3 million koku, or 3.0% of GDP. The main results are presented graphically in Figures 6, 7 and 8.

There are three caveats to add to these estimates, besides the speculative nature of the method. Firstly, the current budget surplus for 1850 is an unknown. It is possible there was a surplus, but given the financial difficulties of both the shogunate and the han, it is perhaps more likely there was

a current budget deficit. Deficits could have been funded through the issue of debt or coins and notes. If there was a deficit, this would mean that the current transfers would have been larger by the same amount. Secondly, there is fact that patrimonial services were performed for daimyo or shogun under the system of corvée labour. While some of the services provided by the local government level benefited the local community, the building of castles and porter services for the daimyo trips to Edo probably did not. These services can be considered ruling class rents in kind, but they are not enumerated here. Thirdly, there were also inefficiencies in the 1890 Meiji government. As mentioned above contemporary sources considered the salaries paid to government employees to be above market rate as well as above the level of compensation during the Tokugawa period. These three circumstances combine to make the estimate of 25% of expenditure (and 3% of GDP) likely a lower bound of the actual amount.

In Figure 6 and Figure 7 the difference is shown between the original 1890 budget and the 1890 budget adjusted to the Tokugawa basket of government activities. The first figure shows the allocation of productive spending to each of the levels of government, while the second shows allocation to expenditure categories. Transfers are disregarded since that is what we aim to calculate for the Tokugawa period. The value of total government production drops from 77.5 million yen in the original 1890 budget, to 65.7 million yen for the Tokugawa basket (a drop of roughly 15%). The largest reductions are in the military and municipalities for depreciation and employee spending. This is due to the lower estimated expenses for infrastructure and military investments, as well as wages at the local level for schoolteachers etc.

6 Conclusion

By performing a new estimation of depreciation of government capital goods in 1890 I have calculated a benchmark for government production. I have used this benchmark to estimate a ‘fair’ cost for providing government services, that can be compared with the costs of the preceding government in 1850. After accounting for differences in the types of goods and services provided, and price and volume changes, I estimate the excess costs of the Tokugawa system to be roughly a quarter of government spending in 1850. These excess costs represent ruling class rents in the form of income transfers. These rents took on several different forms. There were the samurai bureaucrats who worked short, possibly unproductive hours for a full compensation. Only the samurai of high rank or those in a high position in the bureaucracy benefited financially. Most samurai had a relatively meagre stipend, and were faced with rising expenses. The more egregious waste was to be

found in higher echelons of the bureaucracy and in the system of alternate attendance, as well as in the private expenses of daimyo on the people's expense.

In the context of taxation and the power of the state, the Tokugawa government could be considered exploitative, able to tax its population to an extent not reflected in the public goods provided. Another way of viewing the system is as a way to keep the county at peace. After all, the institutions devised by Hideyoshi and Tokugawa Ieyasu that are responsible for some of the higher costs were probably at least in part aimed at keeping the different classes from rebelling against their overlord. The alternate attendance system and the incorporation of large numbers of bureaucrats are the obvious examples.

There might be certain secondary effects that show these institutions in a more positive light. Given the fast pace of economic change in after the Meiji Restoration, and the role of the state in this, this might be in part explained by the existing level of state organisation and the ranks of bureaucrats from which to build the new government system.

Appendix to Chapter 3

Table 9: Comparison of Tokugawa and Meiji government activities

1850 Tokugawa Government Budget

By Government Level

- Shogunate
- Domain
- Local/municipal

By Department / Policy Area

- Shogun and daimyo family expenses
- Foreign affairs
- Home and local affairs
- Finance
- Defence and security
- Justice
- Agricultural development
- Infrastructure
- Mining
- Currency
- Others

1890 Meiji Government Budget

By Government Level

- Central
- Prefecture
- Local/municipal

By Department / Policy Area

- Cabinet
- Foreign affairs
- Home and local affairs
- Finance
- Army and Navy
- Justice
- Agriculture and commerce
- Transportation and communication
- Education
- Railway
- Others

Table 10: Meiji Government Capital Depreciation, 1890

Depreciation, 1000 Yen		
Central government	5 954	
- Infrastructure		522
- Military		3 730
- Buildings general		601
- Buildings education and railway		51
- Agriculture		95
- Cultural		113
- Vehicles		38
- Equipment		342
- Railroads and rolling stock		461
Local government	5 516	
- Infrastructure		3 147
- Prefecture buildings		265
- Municipal buildings		349
- School buildings		311
- Equipment		1 444
Total	11 469	

Authors calculation, see text for method.

Table 11: Total Meiji government budget (1890) and 'Tokugawa basket', in million yen.

Meiji package 1890	Municipal	Prefectures	Military	Central excl. military	Total
Production	15.4	12.3	17.0	32.7	77.5
Intermediate input	4.0	3.2	8.6	16.8	33.0
Value added	11.4	9.1	8.4	15.9	44.5
Employee spending	8.7	6.3	4.7	13.7	33.0
Depreciation	2.7	2.8	3.7	2.2	11.5
Transfers				19.0	19.0
Current transfers				6.0	6.0
Interest payments				13.0	13.0
Current budget surplus				16.5	16.5
Current receipts	15.4	12.3	17.0	68.3	113.0

Tokugawa basket (ca 1850)	Municipal	Prefecture	Military*	Central excl. military	Total
Production	9.0	11.1	13.3	32.3	65.7
Intermediate input	2.9	3.0	8.6	18.0	32.5
Value added	6.1	8.1	4.7	14.3	33.2
Employee spending	3.6	5.4	4.7	12.6	26.3
Depreciation	2.5	2.7		1.7	6.9

*Sources: see text. *Military depreciation is excluded from the numbers due to the reasoning explained in the text.*

Table 12: Costs of Tokugawa government (1850) goods and services on Meiji basis, in million koku

Assumed government production level does not change	Municipal	Central+ Prefecture	Military	Total
Production	1.54	7.40	2.27	11.21
Intermediate input	0.50	3.59	1.47	5.55
Value added	1.04	3.82	0.80	5.66
Employee spending	0.61	3.07	0.80	4.48
Depreciation	0.43	0.75		1.18
Transfers		2.39		2.39
Current transfers		**1.39**		**1.39**
Interest payments		1.00		1.00
Current budget surplus	?			
Current receipts	1.54	9.79	2.27	13.60

Assumed government production varies with population	Municipal	Central+ Prefecture	Military	Total
Production	1.21	5.82	1.78	8.82
Intermediate input	0.39	2.82	1.15	4.37
Value added	0.82	3.00	0.63	4.45
Employee spending	0.48	2.42	0.63	3.52
Depreciation	0.34	0.59		0.93
Transfers		4.46		4.46
Current transfers		**3.45**		**3.45**
Interest payments		1.00		1.00
Current budget surplus	?			
Current receipts	1.21	10.28	1.78	13.27

Assumed government production varies with GDP	Municipal	Central+ Prefecture	Military	Total
Production	0.94	4.51	1.38	6.84
Intermediate input	0.30	2.19	0.89	3.38
Value added	0.64	2.33	0.49	3.45
Employee spending	0.37	1.87	0.49	2.73
Depreciation	0.26	0.45		0.72
Transfers		6.17		6.17
Current transfers		**5.16**		**5.16**
Interest payments		1.00		1.00
Current budget surplus	?			0.00
Current receipts	0.94	10.68	1.38	13.00

*Source and methods: see text. Current receipts in red for central+prefecture and military are from total tax presented in chapter 2 (12.06 million). Current transfers (in **bold**) are the remaining sum after confrontation of spending and receipts.*

Figure 6: 1890 Budget and Tokugawa basket by government level

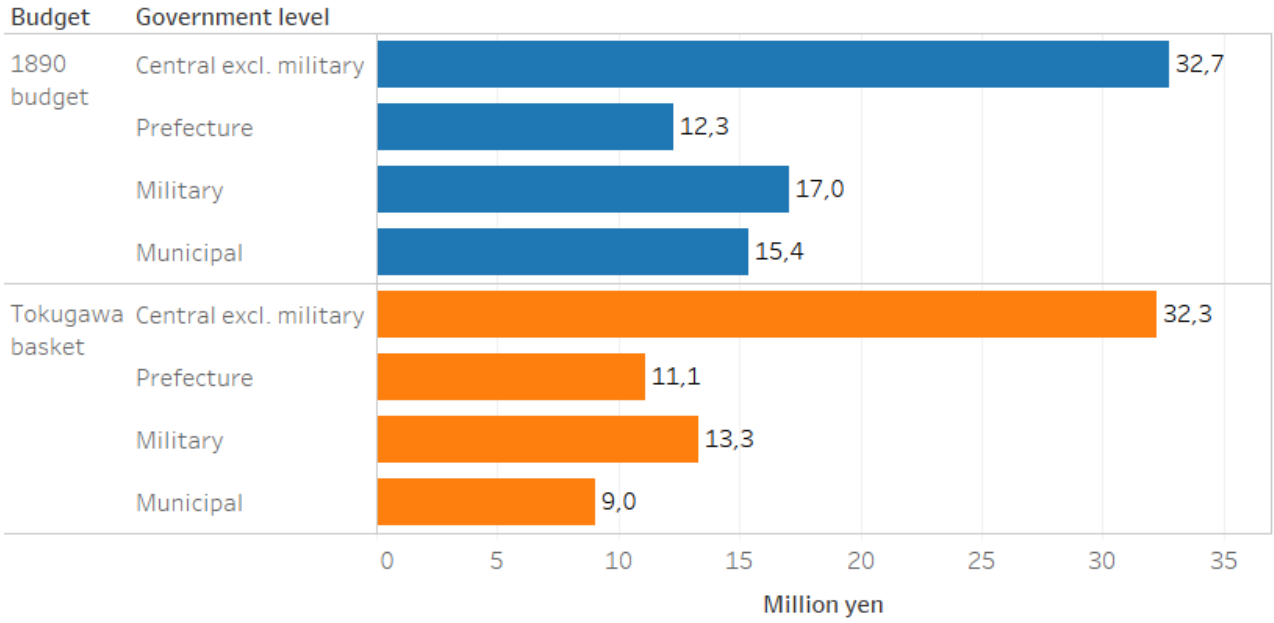


Figure 7: 1890 budget and Tokugawa basket by expenditure category

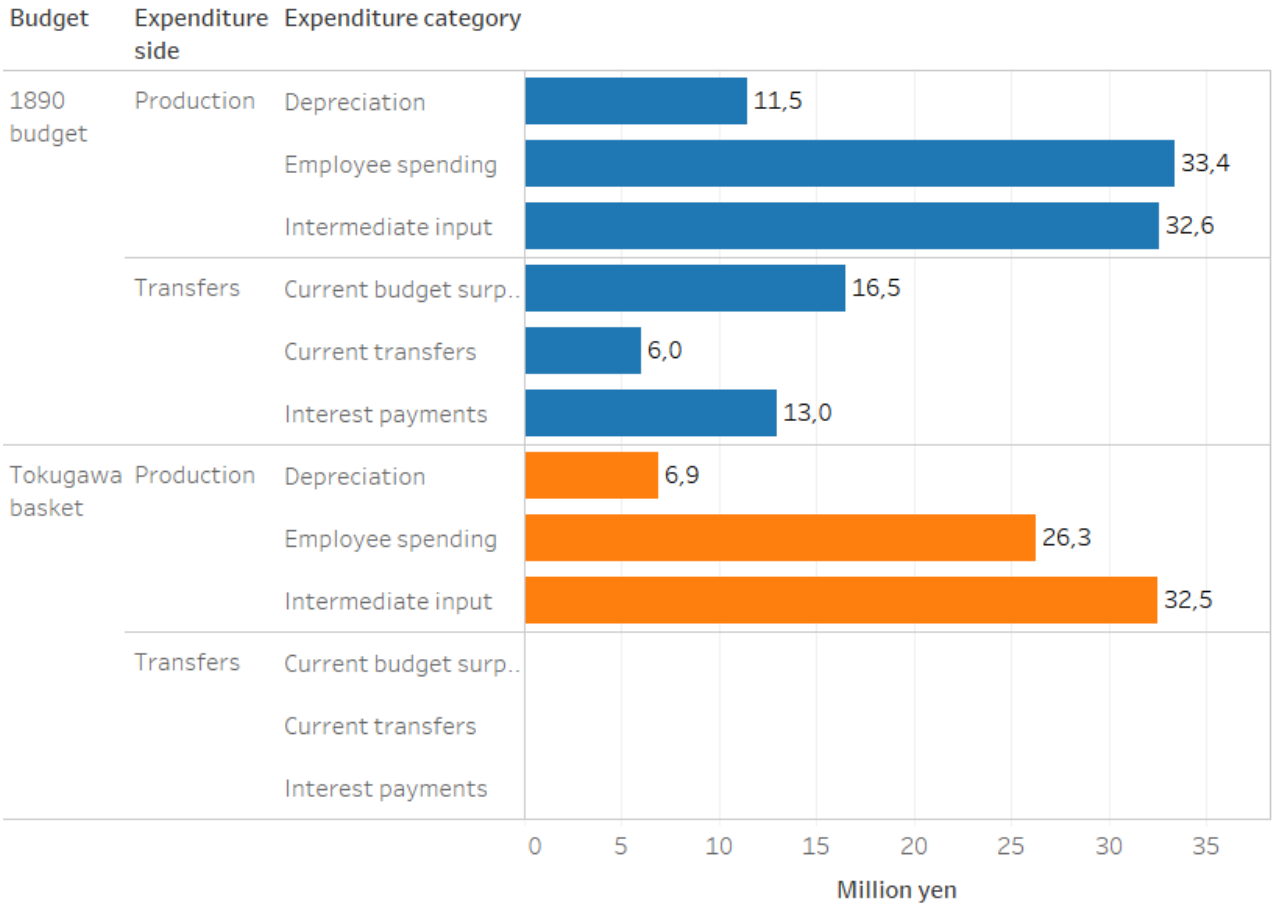
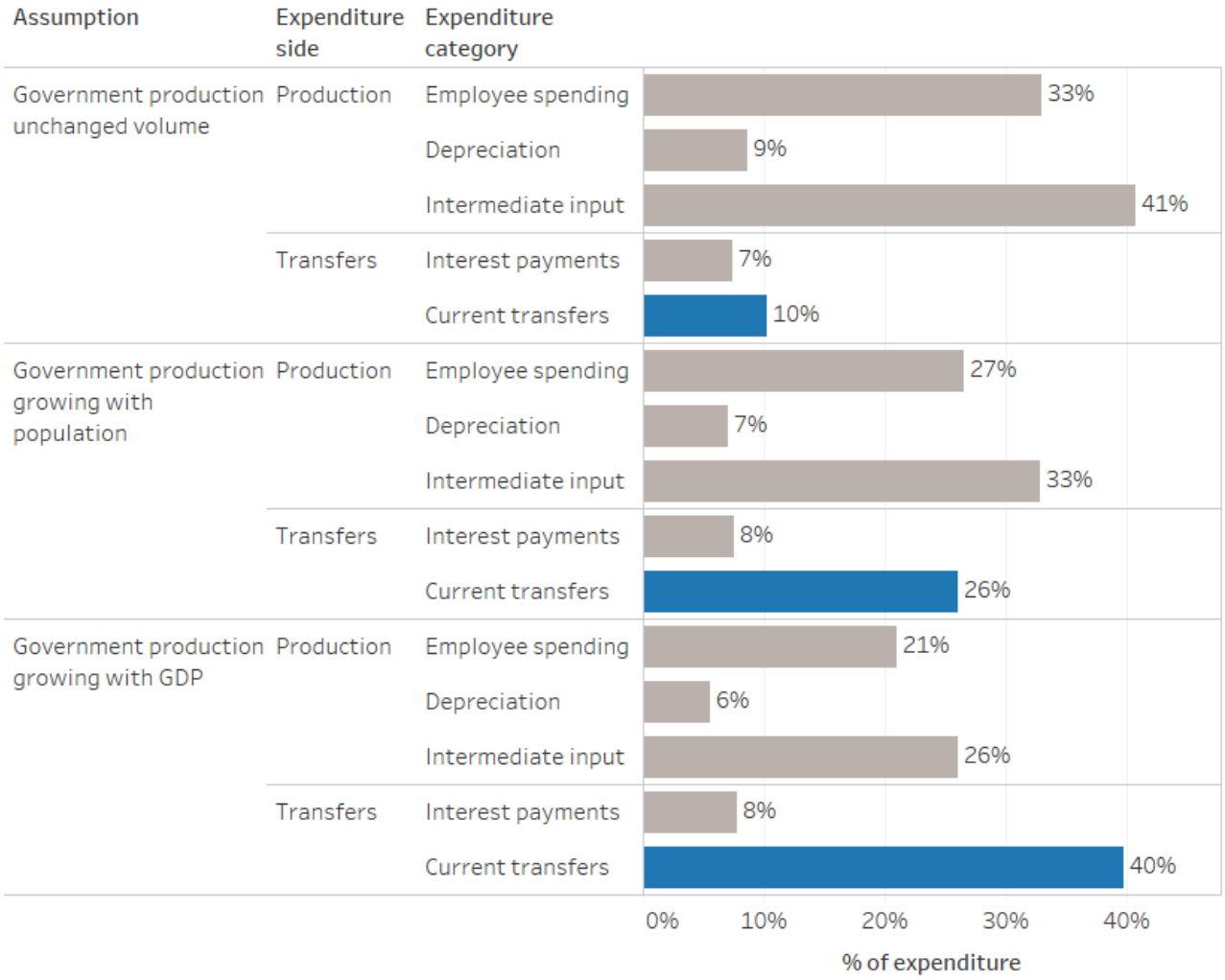


Figure 8: 1850 Current transfer estimate per assumption



Chapter 4: Mountains of the State

1 Introduction

Precious metals by their nature have historically played an important part in facilitating trade. Silver in particular has been described as the commodity to first connect trade from all continents. After the Spanish gained access to the mineral wealth of the Americas, a world wide system of trade emerged, with silver flowing across both the Atlantic and the Pacific to Europe and Asia (Flynn and Giráldez 1995). Japan played an important part in this system as the largest silver producer outside the Spanish Empire around the year 1600, and a leading copper producer after that. This position attracted significant attention from European trade powers as well as Chinese merchants. The domestic production of precious metals and the management of these outside contacts became crucial elements of Tokugawa (1603-1867) government policy.

A famous policy decision taken by the in the 1630s is the so-called 'closed country' policy, or *sakoku*. In truth the country was not completely closed, with foreign trade still playing an important part in the Japanese economy. Through a variety of intermediaries Japanese international trade continued throughout the Tokugawa period and maintained a large impact on both the world and the domestic economy.

Through the sale of silver, copper and gold on the world market, the Japanese mining industry had a profound impact on matters as diverse as the Chinese money supply and the profits of the Dutch East India Company (Vereenigde Oost-Indische Compagnie, VOC). It also put its mark on the home market, where precious metal exports facilitated imports of raw silk for the silk industry and mining revenues boosted government income. The significance of Japanese precious metal production and export during the Edo era has not escaped scholarly attention. The mining sector has been studied mostly by Japanese researchers. Kobata (1956, 1968; 1986) has dedicated decades of research to the production of the mining industry and the effects on foreign trade and Japan's currency. Iwao (1966) has described the international trade in Japanese precious metals. Yamamura and Kamiki (1983) have also written about the effects of mining and trade on the monetary situation in Japan. Sasaki (1983a, 1983b) meanwhile has focussed more on the technical aspects that made it possible to extract these amounts of metal.

The international trade of Japanese metals has gotten the most broad attention. Innes (1980) has written a very extensive account of Japan's international trade during the 17th century, while also dedicating a large part of his 600 page dissertation to the mining sector. As the final destination of most exported Japanese precious metals at that time, the connection with China has been described, among others, by Von Glahn (1996), Souza (2004) and Yamamura and Kamiki (1983). Tashiro (1981, 1989, 2004) has focussed on the trade flows through Tsushima, via Korea, to China. Another intermediary was the Dutch VOC, whose trade flows are the best documented, thanks to detailed contemporaneous bookkeeping and current archive work. The trade in Japanese metals by the VOC has been described by Glamann (1953, 1981) and more recently by Shimada (2006).

The different viewpoints from which this subject has been approached, has led to wide-ranging estimates of the Tokugawa period production and trade of precious metals, particularly for silver. Based on export figures, Iwao (1966) and Yamamura & Kamiki (1983) come to relatively high estimates of traded silver quantities. Meanwhile, according to Innes (1980), Von Glahn (1996) and Souza (2004), amounts were much smaller. Estimates based on silver production figures are much rarer. However, Kobata (1965) has made a rough production estimate that is consistent with the higher export estimates.

The main objective of this chapter is to improve estimates of the production and trade volumes of precious metals[20] in Tokugawa period Japan. The approach will be to confront the supply and demand sides for each respective commodity. Where possible data for production, imports, exports and domestic use have been compared to arrive at consistent estimates. A comprehensive evaluation of this type of data is currently lacking, both regarding the entire length of the Tokugawa period, as well as regarding the inclusion of all three metals. Special attention has been paid to the silver volumes, given the importance in trade history and the disagreement between existing estimates. A new approach has been used to interpolate production data for the largest silver mines to check against the demand side data. The improved estimates of all three metals are subsequently set off against international production estimates as well as against the latest estimates of Tokugawa period GDP. The latter is partly intended to assist efforts to improve GDP statistics for this period.

The institutional and technological setting will be the subject of section 2, while section 3 will cover the development of foreign trade. Sections 4, 5 and 6 form the central part of this chapter, describing respectively the silver, copper and gold estimates by the combination of supply and

20 In this context 'precious metals' includes copper as well as silver and gold. In current parlance the term usually does not include copper, however given the contemporaneous value of copper in the export trade – not to mention its use as coinage metal – it can justifiably be included when used regarding Tokugawa period Japan.

demand data. Section 7 looks at the significance of the precious metals production, both as a share of the domestic economy and in international comparison. Section 8 concludes.

2 Institutions and Technologies

The Japanese precious metals mining sector operated under specific institutional and technological circumstances that partly explain the growth pattern that will be shown in later chapters. More than that, the information given here can be used to inform certain assumptions necessary for some of the estimates, as will be explained later.

2.1 The beginnings of Japanese mining

Mining has been practised in Japan from at least the 7th century. A silver mine was in operation from 675 C.E. on the island of Tsushima, halfway between Korea and Kyushu, the southernmost of the main islands of Japan. In 701 the government sent an official to the province of Mutsu in in the north-eastern part of Japan's main island of Honshū with the objective of opening a gold mine (Yamamura and Kamiki 1983, 331–32). This same mine is credited to be the source of the original gilding of the Tōdaiji Daibutsu in Nara, which was finished in 749 C.E. (Bender 1979, 134). Copper has been mined from about the same period. The mine at Akenobe, in Tajima province on the Sea of Japan, was established before the 8th century (Sasaki 1983b, p. 181). Little is known about the volumes of production of these metals during this early period. However, the production of gold was sufficient to establish exports to China. In return Chinese minted copper coins were imported, starting from the Sung (960-1126) dynasty. This trade seems to have stemmed from a Japanese demand for means of exchange. The increasing export of copper coins in the 12th and 13th centuries prompted a ban on this trade by the Chinese government (Yamamura and Kamiki 1983, pp. 336–39).

There is not much evidence of big changes to the volume or technology of the production of precious metals in Japan in the following few hundred years. However, two mines were opened that would later become major centres of metal production. The gold mine on the island of Sado, off the west coast of northern Honshū, was opened during the Bun'ei era (1264-1274). Another was the silver mine at Ōmori, in the Iwami province of western Honshū, which was opened during the Enkyō era (1308-1310) (Sasaki 1983b, pp. 179–81).

2.2 The institutional setting of the early modern mining industry

Through a process of technological development that started during the second half of the *sengoku* or Warring States period (1467-1568) production of especially silver mines increased strongly. This meant that they were becoming increasingly important strategical assets for the competing warlords. They strived to open up new mines in their own territories or tried to gain control over existing ones in order to pay for their armies. A trend of centralisation is visible in the governance of the mines. During the sengoku period most mines were claimed by *daimyo.* The three unifiers Oda Nobunaga, Toyotomi Hideyoshi and Tokugawa Ieyasu all sought possession of the important mining regions (Asao 1991, pp. 61–64) Hideyoshi took a large step to gain control over the important mines, declaring them “mountains of the state” in 1589-90 (Sasaki 1980, p. 7). This policy was continued when Tokugawa Ieyasu established his dynasty. Although of strategic importance, to what extent the increasing output of precious metals has contributed to the unification of Japan is uncertain. While Nobunaga's initial base of power in Owari and surrounding lands did not contain any of the major mines, he did succeed in gaining control over the important silver mine at Ikuno in Tajima, which would have increased his power. Once the Tokugawa shogunate was established, the centralisation of profitable mines into its hands increased its fiscal potential which might have increased the shogunate's grasp on power.

There was no unified strategy on the side of the *bakufu* (shogunate) to organise the ownership and administration of the mines. The ownership of a mine could be in the hands of either the central government or the *han* government i.e. the local daimyo (Sasaki 1980, p. 8). daimyo were expected to pay royalties to the bakufu based on their mines' output. After the death of Ieyasu in 1616 the offered mining royalties were always returned by the bakufu. This suggests the later *shogun* might have put more importance on non-financial concerns compared with Ieyasu. The fact that the offering of the royalties nonetheless continued could be interpreted as an affirmation of the principle that the bakufu had a right to claim part of the revenue of all mines.

The bakufu at different times exercised its right to take control of a mine. A number of mines were confiscated from the losing side's daimyo after Ieyasu's victory at Sekigahara. Loyal daimyo could also have their mine taken over by the bakufu, like the Nobezawa silver mine in Dewa province in 1634. In that case the confiscation was motivation by a rapid increase in output from the mine. Another example is the dispossession in 1704 of the Iyo Tachikawa copper mine from the daimyo of Saijō to add it to the adjacent bakufu-held Besshi copper mine (Innes 1980, pp. 545–46).

The mines owned by either level of government were either managed by officials, titled *bugyō*, or the management was outsourced under contract to a mining operator. The last situation was more common for smaller mines. This was not exclusively restricted to small mines though, as in the case of a dominant copper mine of the period, at Besshi. This mine was located in bakufu territory, but was operated by the Sumitomo family and a big source of their wealth. The bugyō in charge of government mines, would subcontract the work to miners who would either pay the government official a fixed fee for a concession, or make an output sharing agreement. For big, profitable mines these concessions could be very limited in time and scope. In the case of the rich Innai silver mine, shortly after its opening in 1603 there were 36 different contractors operating simultaneously, some under concessions as short as 10 days (Innes 1980, pp. 546–47). It can not be a surprise that this would lead to rather suboptimal situations. Contractors will not plan ahead or invest in the mine under such short concessions, instead opting for quick wins and haphazard excavation. This opportunistic behaviour resulted in very sharp boom and bust cycles.

There seems to have been a move away from these types of concessions to more long-term contracts, with more production sharing agreements instead of fixed fees. Perhaps as a sign of a more short-term view, the shortest concessions were given out by daimyo. Long term planning and investment by the owner became more important as mines got older and less rich in ore, necessitating deeper mines. This situation also put pressure on the mining profits, leading to falling government shares of the output. In bakufu controlled gold and silver mines the government share of gross output was in the range of 25% to 50%. The higher government shares would most likely only apply during the earliest, most profitable years of operation of a mine. When the mine output levels declined the operation would no longer be able to afford such high royalty payments (Innes 1980, pp. 546–58).

The circumstances for copper mining operators were different from those in the gold and silver sectors. Instead of relying on royalty payments the government mandated that all the copper was to be delivered to the central authorities. It set production targets for each mine and determined a price. The copper was smelted on site and delivered to refineries in Ōsaka, where it was cast in one of several predetermined shapes. As a way to control the export, only copper in the shape of a bar was allowed to be exported.[21]

While the government had price control over copper at every stage from production to sale, the pricing strategy was somewhat curious. The offered price to the mines was below domestic market

21 The Japanese term is *saodō*, while in the documents of the Dutch VOC it is referred to as *staafkoper*, both meaning bar copper.

rates, as would be expected. The difference between the offered rate for producers and the domestic market rate can be regarded as a government tax. Part of this must have been used to cover the transport and refining costs. However, the rates at which copper was sold to Chinese exporters were lower than the rates offered to the mines, and the rates for Dutch exporters were lower still. This would make export a losing proposition for the government, an unlikely situation to persist. Part of the explanation is that the government not only set copper prices for export, but also negotiated what it got in return as imports as part of a zero-sum game. In essence it was therefore a virtual price, as in the end the copper was traded for other goods which were valued at the same total price as the copper. The reason for the low prices was that the export of copper was restricted to a certain maximum value in silver. At a lower price the export (and import) volumes were larger, benefiting both officials and traders at Nagasaki (Shimada 2006, pp. 51–59).

Besides royalties, han could profit in other ways from the mines on their land. They could tax the businesses that provided services in the mining towns, levy import duties on goods transported into the mining areas and reserve the right to sell rice and other goods to the mining operators. Akita han sold rice and lead to the Innai silver mine under monopoly conditions. The rice was often excess tax rice that would otherwise have had to be traded elsewhere. The lead was purchased at local lead mines and resold to the silver mine with a mark-up from 25% to as much as 200%, depending on economic situations at Innai. Of all non-royalty revenue from the mine during 9 months of 1620, rice sales represented 45% and lead sales 41%. Total payments from Innai mine to the han, including royalties and other taxes, has been estimated at 2/3 of the value of total mine production (Innes 1980, pp. 549, 550).

The enforcement of royalty payments and monopolies on intermediate goods obviously relied on control of flows of goods into and out of the mining area. Another reason to guard the roads to these areas was to keep the local labour market under control and prevent disruption of the local agriculture economy. Newly opened and fast-growing mines attracted specialised mining labourers from wide areas. Much of the unskilled labour was provided by the local population, however. There are numerous examples of daimyo issuing bans on farmers moving to mining towns. Farmers abandoning their field would be detrimental to the main source of government revenue, the tax on agricultural production. Therefore, there was a strong motivation to keep the farmers on their fields (Innes 1980, pp. 563–66).

During the late Tokugawa years the output of metal mines had decreased, and after the Meiji Restoration in 1868 the government had to decide what to do with existing as well as potential new mines. Given a situation of little private capital, the government at first tried to operate a number of

mines itself, bringing in foreign experts to help modernise the sector. Silver and gold were of particular interest to the government for their use as coin material. A majority of foreign engineers, however, was employed for coal mining, a relatively unknown activity in Tokugawa Japan. The government gradually sold its mines to private companies as capital became more readily available. The last government mines were sold to the Mitsubishi company in 1896 (Yoshiki 1980).

2.3 Technological development of the mining industry

2.3.1 Smelting and refining

From the middle of the sengoku period new technology was introduced to Japan that transformed the mining industry. In 1533 a merchant from Hakata (present day Fukuoka), who had recently reopened the Ōmori mine in Iwami, brought in two Korean mining experts. They introduced the *haifuki* or cupellation method by which silver (as well as gold) can be separated from other metals with which it is often mixed, such as lead (Innes 1980, pp. 23–25). This step is performed after the smelting stage, in which the metal alloy (silver-bearing lead) is separated from the ore. In the cupellation method the lead is melted in a bone ash 'cupel' and then air is blown across it, causing the lead to react with the ash, leaving the silver. Because of this, the method is sometimes referred to as 'ash-blowing'.

The cupellation method has been known in the Mediterranean and the Middle East regions since the bronze age, but finally reached Japan probably through China and Korea. Its first use in China is unknown. The process was described in a 15th century Chinese work by Lu Yung called "Shu-yuan Tsa-chi" (Innes 1980, 23–25). With the long history of the cupellation method further west, it is not unlikely that the Chinese knew it well before that. The following translated quotation, through a tenuous string of references, is accredited to an alchemical text called Jinbi Jing, 金碧經 (Scripture of Gold and Jasper) from around the year 200 CE (Sivin 1976, pp. 513–14):

> *Refine silver within lead*
> *And the spiritual being is born of itself.*
> *In the ash reservoir, melting in the flame,*
> *Lead sinks down, silver floats up.*
> *Pristine white the Treasure appears*
> *With which to make the Golden Sprout.*

While the significance is hard to judge given its origin, the quote fits the cupellation technique remarkably well. It is unknown when the cupellation method transferred to Korea, although silver was reportedly extracted from lead there since at least 1528 (Innes 1980, pp. 23–25).

Around the same time that cupellation found its way to Japan domestic development led to the discovery of the *mabuki* method. The method is applied during the smelting stage, before cupellation would be applied. It is meant to rid the copper ore of excess sulphur by oxidising it with blasts of air in a furnace. The old process achieved the same result by roasting the ore for a number of weeks. The new technique represented large savings in the time, manpower and fuel needed for this step. The mabuki method was developed in the village of Yamashita, in Settsu province near Ōsaka. Because of this it is sometimes referred to as the Yamashita method (Innes 1980, pp. 537–38). Another refining improvement was the *nanban-fuki*[22] technique taught to Soga Riemon by the Spanish or Portuguese during the Keichō era (1596-1615). Soga was the owner of a Kyoto copper smelting company and brother-in-law to Sumitomo Masamoto, founder of the Sumitomo company.[23] The nanban-fuki technique for refining copper that Soga learned, consists of adding lead to impure, silver-bearing copper. This alloy is then heated and mixed until the lead and silver melt, leaving pure copper. The cupellation method can then be used to separate the lead from the silver. Soga used this new process to establish a copper refining business (Innes 1980, p. 84). During the 16th century the Spanish were operating the largest silver production system in the world in their possessions in the Americas. There they discovered the amalgamation process for isolating silver from lead in 1557. Although the amalgamation method is considered to be an advancement over the cupellation method, it was not used extensively in pre-modern Japan because of a shortage of mercury. Domestic production of mercury was small and although it could be imported, this made it expensive. The only place where it seems to have been used extensively is the island of Sado, where the amalgamation process was applied for a time since 1610. By which way knowledge of the method spread to Sado is unclear (Innes 1980, pp. 540–41).

A final refining method worth mentioning is the chlorination process, also called the salt roasting process. In this method gold was isolated from gold-bearing silver in a process similar to the cupellation method, but using ordinary salt instead of ash. When and how the chlorination process appeared in Japan is not completely certain. Innes (18980, p. 539) supposes it was introduced from China some time before being used on Sado in 1643. Sasaki (1980, p. 10) adds that the method was devised around 1608 by gold- and silversmiths in the employ of the government. With this last piece of knowledge Japanese smelters could separate lead, copper, silver and gold from any mix they might encounter in ores.

22 *Nanban* means 'southern barbarian', a contemporary term for the Portuguese and Spanish. The stem of *fuki* (吹) means 'to blow'.
23 Soga's son Tomomochi married into the Sumitomo family, uniting the business ventures of the two families.

2.3.2 Mining techniques

Because of improvements in refining, ore with increasingly small amounts of metal could be profitably mined. This prolonged the economic lifespan of mines where the metal-rich ore was depleted. This also meant mines were going deeper and deeper to get out all the ore that they could. Around the same time that refining technology was advancing, surveying and excavating techniques saw big improvements. Through the improvement of metalworking, bigger hammers and harder chisels became available, improving the efficiency of miners (Nagahara and Yamamura 1988, p. 80). However, there seems to have been a strong preference for manual labour. As late as 1907 mechanical mining (use of rock drills and similar) was virtually non-existent in Japan. In that year at 35 major mines 98% of mining output was achieved with hammer and chisel (Sasaki 1980, p. 14). Surveying was a skill developed by Japanese miners starting toward the end of the 15th century. The term used for this method was *sunpō-kiri*. *Sunpō* refers to the taking of measurements and *kiri* means to cut. It involved not only establishing the run of the ore vein, but also planning the required tunnel so it would optimise the removal of water and circulation of air. If necessary, supporting tunnels called adits were constructed for drainage and ventilation. Previously miners would only dig surface trenches, or simply follow the vein into the mountain without regard for flows of water and air or overall efficiency (Nagahara and Yamamura 1988, pp. 79–80). Innes credits the Spanish or Portuguese for the innovation of horizontal adits to assist with drainage (1980, p. 534).

The importance of optimal drainage and ventilation must not be underestimated. Miners typically succumbed to respiratory illnesses after 4 or 5 years underground due to the use oil fired lamps and charcoal fires to fracture rocks. As Notehelfer put it: “The life of the Tokugawa miner was harsh and brief” (Notehelfer 1984, p. 14). Techniques for drainage and ventilation were relatively primitive. The latter was attempted by fans and partitions to direct airflows. Water was removed from the lower levels of the mine by manpower. Various tools were used including buckets and manual piston pumps. Archimedes' screws were first used on Sado in 1637. The spread of this technique seems to have been hampered by the amount of maintenance required and by the fact that the scholar who introduced it demanded royalty payments. If necessary, a number of pumps or screws would be set up in a relay. The Sado gold mine used efficient double-action Dutch pumps for a short while from 1782, but reverted back to older methods because of the maintenance requirements (Nagase-Reimer 2013, pp. 32–36). The Dutch again attempted to import a pump in 1825. However, the Japanese concluded that such a machine was not as effective as intensive use of human labour (Shimada 2006, 52). With few straight vertical or horizontal tunnels there was little opportunity to use transport equipment to move ore to the entrance of the mine. Ore had to be

removed manually, on the miners' backs. Add to that to the labour-intensive methods for drainage, and a mine will need increasingly more people to operate as the tunnels go deeper. Employment statistics on the Besshi copper mine, opened by the Sumitomo family in 1691, show this problem quite clearly. In 1713 there were 750 labourers working underground, consisting of miner/carriers, drainage workers and tunnel constructors. In 1769 the total number had risen to 1075. Most of this growth was caused by extra drainage workers, which increased from 250 to 455. Because of a simultaneous decrease of total copper output of the mine, production per worker decreased during these years, from 107.1 tonnes of ore to 50.4. During the peak of the mine's output, which took place before 1713, productivity might have been even higher (Shimada 2006, p. 56).

2.3.3 Productivity and mechanisation

Japanese efforts to increase labour productivity typically involved more effective use of manpower instead of mechanisation. Particularly in the mines only manual power was used. In contrast, European and American mining used animal, water and later steam power to do the heavy lifting. The Spanish mine at Potosí in South America used tens of thousands of mules and llamas for their labour (Moore 2010). In the 18th century, English mines pioneered the use of steam power for drainage. The great Swedish copper mine at Falun in the 17th century used both animal and hydro power. Sundberg (1991) has analysed the energy flows of this last mine, which can be used to get a sense of the potential for the use of non-human power sources in a pre-industrial mining environment.

At the Falun mine manual and horse-powered winches were used to drain water from the shafts, until floodings occurred in the 1550's and hydro power was added. Once the hydro power system was in place, the hydro power was used for lifting out water and ore from the mine as well as powering the bellows of nearby foundries. According to Sundberg (1991, pp. 11–12) of the energy required to excavate and haul up the ore and pump up water, about 180 MWh per year was provided by men and 200 MWh per year was provided by horses. In addition, the watermills could provide a maximum of 460 MWh per year, from which an unknown part was used at the foundries. Supposing that half of this hydro power was used at the mine, this would mean that only around 30% of the power used at the mine was provided by men. Even centuries later, most Japanese mines by contrast were still run on 100% manual power. The Aikawa mine on Sado island seems to have been an exception. A water wheel was intermittently used there to crush ore starting in 1626, being reintroduced in 1794 and used more intensively from the 1820s (Sasaki 1980, p. 17).

Given the different energy applications you would expect the Swedish miner to outperform the Japanese miner in terms of productivity. At Falun in the mid-17th century it took about 1050 men and 200 horses to produce around 1900 tonnes of copper per year (excluding transportation and refining of ore outside of the mine) (Sundberg 1991, pp. 5, 11, 12). The productivity was therefore about 1.81 tonnes of copper per miner per year. In the large Besshi copper mine output per worker was 1.10 tonnes in 1713 and 0.43 tonnes in 1769.[24] Clearly the Falun miners were able to extract more copper. However, direct comparisons are not very revealing, since geology and other circumstances vary greatly from mine to mine. Although this might not say all that much about the relative effectiveness of the miners, it *does* show how the productivity at Besshi would change if for example drainage was done by some other, non-manual source of power. When drainage workers are excluded, productivity at Besshi increases to 1.64 tonnes per worker in 1713 and 0.74 tonnes in 1769. Additional gains could have been made by substituting part of the human labour used for hauling up the ore and other tasks. Clearly Japanese mines could have benefited from alternative power sources. So why were they not used?

The techniques used in the West were not unknown in Japan. As mentioned, at Sado a water wheel was used to crush ore and efficient Dutch pumps were known and even recommended by the bakufu. Neither of these tools were widely used by the mining sector, reportedly because of maintenance requirements (Nagase-Reimer 2013, pp. 37–38).

Other clues can be taken from the people that first tried to implement Western mining techniques in Japan. Contemporary Dutch observer and scientist H. Burger paints a picture of a mining sector relying not so much on science as on experience. In his opinion the methods used were relatively effective where it came to prospecting, smelting, refining and metalworking, but the geological knowledge and the mechanical process used in the mining itself he regarded as very primitive (Burger 1836).

When foreign engineers were hired to modernize the industry after the opening up of the country they analysed the shortcomings of the existing system. The single biggest obstacle they identified was the subcontracting system inherited from the Tokugawa period. The government and later the mining companies purchased the ore from subcontractors. The subcontractors could make their own decisions about where and how to excavate. This led to the situation of large numbers of haphazard tunnels, abandoned because of hard rock layers or flooding. In addition, the subcontractors discarded large quantities of low-grade ore, which was refinable with the proper

24 Number of workers from (Shimada 2006, p. 56), copper output from (Sumitomo Metal Mining Co. 1991, pp. 225–29).

techniques. To successfully modernise the industry the mining operation had to be centralised, with the mining company directing the labour and installing the machinery (Yoshiki 1980, pp. 18–22).

Moreover, the circumstances at the mining sites determines the successful use of machines. Hydro power has obvious situational requirements, but the narrow and irregular shape of the tunnels meant that any type of non-manual power was very costly to implement as it would have required a completely different layout of the underground portion of the mine.

Another circumstance undermining the mechanisation of the mining sector was the low cost of labour. An interesting anecdote is provided by Gubbins, who in the early 1870s visited the Aikawa mining town on Sado island. He describes it as a poor town where labour is "absurdly cheap". Three years before his visit, a tramway was built to transport ore from the mine to the town but the service had discontinued. As he put it:

> *"Owing to the carelessness and ignorance of those in charge of the tramways, accidents were of constant occurrence, and moreover, labour being so cheap, it was found to be just as economical to employ manual labour"* (Gubbins 1884, p.87).

In addition, the transport of ore was an important occupation for the local women, making the tramway unpopular.[25]

In the 1870's the Japanese government employed the American geologist Benjamin Smith Lyman to perform a geological survey of Japan, focussing on oil and mineral deposits. Lyman noted the opportunities and difficulties of introducing labour-saving technologies:

> *"It seems pretty certain that, in many cases at least, there would be decided economy in making use of horse power (with a gin) or water power in digging the oil wells; since so large a portion of the power required is applied in so purely mechanical a way. Nevertheless the cost of the capital needed and the expense of repairs to machinery make it advisable to begin experiments in that direction rather cautiously. I am more than ever of the opinion that the setting up of steam engines and boring machines would be unprofitable; for the experiment has had now for a year or more a long trial in Kubikigōri in Echigo… Although the well proved to be in an exceptionally favorable place, the progress of the work was slow and expensive on the whole, and pieces of the apparatus had to be sent for repairs to this city, some two hundred miles."* (Lyman 1879, p. 13).

The limited availability and know-how of the more advanced machinery – even in the years after the opening of the country – illustrate the technological disadvantage suffered from the isolation policy. It is interesting, however, that the report also mentions the underutilisation of more traditional labour-saving techniques that should have been well inside the technical capabilities of

25 The mine was operating at a loss. This was partly due to the increasing problem of drainage, which had caused the miners to abandon parts of the mine and made the remaining tunnels more and more difficult to work in without modern equipment. Moreover the organisational overhead seems to have been very large due to nepotism.

the contemporary Japanese craftsmen. Lyman noted that the cost of a horse and driver were only about double that of one worker, and still costs remained prohibitive in many situation. In addition, power from small water mills was used in villages to pound and clean rice, but larger applications were uncommon. Lyman supposed this was because of unfamiliarity with the building of large dams and gathering larger sums of capital (Lyman 1879, pp. 9–16). These observations suggest that the large scale of mining operations might have been an obstacle for mechanisation.

Besides the low wages there were other factors working to keep the number of employed miners high. According to Nagase-Reimer, labour intensive mining was lucrative for mining operators because they could make profits on the sale of rice to their employees, in effect lowering the real wage even more. The mining operators bought rice from government tax rice surpluses at a preferential rate. They sold this rice on to their miners at a higher price. The miners were trapped in this system, because they were not allowed to freely move out of the mining district (Nagase-Reimer 2013, pp. 37–38).

The above descriptions show that the precious metal mining sector, and in a certain sense the Tokugawa economy as a whole, was faced with challenging institutional and technological circumstances. Management of the mines was at times inconsistent and fragmented, and many technologies were not used to their full potential. It is perhaps too easy, though, to evaluate this situation merely through the lens of efficiency or profit maximisation. In Burger's (1836, p. 5) opinion the most important role of late Tokugawa Japanese copper mining was in providing employment, both directly and indirectly. Besides that he mentions as an important factor the role copper played as an international trade good. This dimension will be explored next.

3 International Trade in Metals

During the Tokugawa period international trade and the mining sector were deeply intertwined. Not only did several technological advancements result from international contact, the availability of silver and copper were a clear incentive for European, Chinese and other trading partners to seek contact with Japan. Additionally, international trade kept large production volumes from overwhelming the local market and lowering the price dramatically. For the Tokugawa regime the interaction between trade and the mining sector was an active area of regulation, motivated by

politics, the money supply and financial gain. In Chapter 2international trade has been described in the context of political motivations. Here, we will focus on the volume and composition of the trade flows, as well as the place of precious metals within it.

3.1 Trading partners during the Tokugawa period

Table 13 shows the Japanese foreign trade values by the various carriers. In the early Tokugawa period the Portuguese and shuinjō ships handled most of the trade, although the value of Chinese trade was likely significantly higher than indicated here (see also Table 14 in paragraph 4.2.1 for the volume of traded silver). After 1635 the amount of trade handled by the Chinese and Dutch increased significantly, first taking advantage of the end of the shuinjō system, and after 1639 enjoying exclusive trading rights. During the 17th century a number of additional trade restrictions were put in place specifically targeting the trade in metals. Between 1637 and 1646 restrictions were put on the export of copper, as the bakufu needed the copper for reminting copper coins (Shimada 2006, p. 12).

The dwindling silver deposits caused increasingly tight regulation of the trade of silver. In an attempt to lure the Dutch and Chinese away from silver they were authorised to export gold coins in 1664. Because of a high mark-up however, the exchange rates were very unfavourable. This mark-up – *aigin* – went to the people of Nagasaki. From 1668 the export of monetary silver was abolished, although trade in silver utensils was still allowed. At the same time the aigin was abolished as well, causing the export of gold to soar. Meanwhile the bakufu tried to depress demand for imported items – which were usually luxury goods – through sumptuary laws. The sumptuary law of 1668 stands out for the targeting of imported goods. From 1672 the Chinese were again permitted to export silver, but the Dutch were still restricted to gold, with a reinstated aigin going to the bakufu. Around the same time Nagasaki merchants organised themselves to create a monopsony on imports, lowering the offered rates and decreasing profitability for the foreign traders Innes 1980, pp. 302–7).

Table 13: Yearly average value of Japanese foreign trade by carrier, in tonnes of coin silver equivalent

Carrier	1604-1638	1639-1684	1685-1715
Chinese	1.4+	47.4	27.7
Dutch	7.9+	28.5	13.9
Tsushima	NA	0.2+	9.4
Ryūkyū	0.7+	0.4+	5.0
Smugglers	NA	NA	14.0+
Portuguese	22.7	0	0
Shuinjō	28.5	0	0
English/Spanish	0.3+	0	0
Total yearly trade value	61.5+	76.5+	70.0+

Source: (Innes 1980, pp. 379, 380, 408, 410, 416, 417). Note: The source material is not complete for all carriers and periods. The actual amounts would likely be higher. Figures for which a significant number of years is missing are indicated by '+', or if no sources are available by 'NA'.

In 1685 limits were set on the value of imports. The Chinese were restricted to a value equal to 6 000 kanme (22 500 kilograms) of silver. The Dutch could import goods worth 3 400 kanme (12 750 kilograms) of silver, of which 400 kanme was reserved for private trade. According to Innes (1980, pp. 418–22) enforcement of the trade restrictions was relatively lax. Year after year Chinese ships would enter the harbour of Nagasaki with total merchandise exceeding 6 000 kanme. Moreover, a substantial number of ships were turned away from Nagasaki, because of additional limits on the number of Chinese ships allowed in the harbour every year. These ships would have had to find another place on the coast of Japan to sell their cargo clandestinely. Innes reasons that unless the merchandise could be traded profitably, the Chinese captains would not return every year. Therefore, the trade amount listed for smugglers during 1685-1715 in Table 1 consists of the goods on board Chinese ships that were turned away and goods that were officially unsold at Chinese ships in Nagasaki harbour. During the years up to 1700, the last year for which this kind of information is available, clandestine trade was regularly the largest single trade category. From 1695 on, barter trading of copper was allowed on top of the official quota. This possibly decreased the amount of smuggling, although the limit on the number of ships remained in place. However, in earlier years the ships being turned away had been the smaller part of the irregular activities. Within two decades however, the additional barter trade amount diminished from over 3000 tonnes of copper to under 100 tonnes (Gramlich-Oka 2008, pp. 78–80).

In 1715 new, lower quotas were set on the number of Chinese and Dutch ships permitted into Nagasaki, as well as the volume of metal to be exported. In the following years these quotas were at times amended, but the supply of copper was such that in many years these quotas were not met (Gramlich-Oka 2008, pp. 93–97).

3.2 Japan's import and export goods

Although detailed accounts of the goods carried to Japan are very fragmented, by all available accounts silk made up the bulk of the trade from before the start of the Tokugawa period, and it mostly originated in China. Initially the Portuguese were ideally situated to supply silk from Macao to Nagasaki. A Dutch observer in Macao wrote “the commodity taken from Macao to Japan is silk, while only silver is brought from Japan” (Von Glahn 1996, p. 126). In the early 17th century the Portuguese routinely carried over 1000 piculs – 60 000 kilograms – of raw silk per ship, representing about 75% of the value of the cargo. As part of the trade regulations, imports through Nagasaki were prescribed to be 1/3 silk yarn, 1/3 silk cloth and the rest medicine and miscellaneous items. Although it is uncertain precisely when this rule was first applied, for the Dutch it was in effect by 1689. As for the trade through Tsushima, in 1694 nearly 60% of the imports from Korea was silk (Innes 1980, pp. 197, 198, 322, 323, 382).

The main export goods were the metals discussed so far: silver, gold and copper. Since the Kamakura period (1185-1333) Japan had been importing Chinese copper coins for the domestic money supply in return for Japanese gold. By the second half of the 16th century the trade of Japanese silver for Chinese silk seems to have been established. Around this time silver began transforming and integrating trade on a global scale. The Spanish mines in the Americas were producing unprecedented amounts of silver, an estimated 368 tonnes per year in the first half of the 17th century. Much of this silver flowed naturally to Spain. However, considerable amounts were re-exported to South and East Asia, or shipped there from the Americas across the Pacific Ocean. China in particular imported an estimated 7 300 tonnes of silver between 1550 and 1645, about half of which came from Japan (Findlay and O’Rourke 2007, pp. 214–18). The immediate cause of this flow was the higher price of silver in China compared to other locations. In terms of the number of units of silver that could be traded for a unit of gold, during the second half of the 16th century the exchange rate was between 6 and 7 in China, in Japan the ratio rose from 7 to 10 in the same period, and in Europe the ratio was around 12 (Von Glahn 1996, pp. 127, 128).

The Chinese preference for silver stemmed from several factors. Firstly, since the 11th century the Chinese economy had relied in part on paper money for its money supply. When this system gradually came undone during the 14th and 15th centuries there was a chronic shortage in the supply of money. This shortage was exacerbated by a large and fast-growing economy. The low amount of domestic production of monetary metal was not enough to cope with these trends. Moreover, the Chinese government began to demand tax payments in silver, with a big push towards this goal in the middle of the 16th century (Flynn and Giraldez 1994, pp. 71–72).

On the supply side of the silver trade the Japanese mines' production was in decline in the second half of the 17th century. Silver began to be substituted as the principal export from the 1660s, initially by gold but eventually by copper. Although there was some demand from Europe, most Japanese export copper headed to destinations in Asia. In various countries, including China, small denomination coins were made of copper. Besides the use as currency, copper was manufactured into items as various as Buddha statues, household objects and ship-plating (Glamann 1953, p. 104). In the case of copper as well as silver, at certain times the export competed with internal use, especially for the currency supply. A copper shortage in 1700 meant silver needed to be exported (Innes 1980, p. 344). By the second half of the 18th century however, tables had turned completely, with copper being used to import silver and gold for the money supply. Between 1766 and 1842 about one quarter of the value of copper exports were used to import these precious metals (Shimada 2006, p. 64).

During the waning years of Japanese silver production efforts increased to divert the flow of silver from export to internal use. The high level of silver exports, at a time of decreasing production, was threatening the internal money supply. Besides practical reasons, there were also ideological motivations similar to the bullionism that gained some standing in Europe at the time. In order to prevent the outflow of precious metals, shogunal adviser Arai Hakuseki stressed self-sufficiency in the production of silk, cotton and other goods. This way the export of metals could be decreased while maintaining employment in the garment sector (Tsuji 1991). In the longer term self-sufficiency efforts did pay off, as Japan was able to supply itself with sufficient amounts of silk by the second half of the 18th century (Shimada 2006, p. 60). While silk imports decreased, sugar imports grew to take up its place as the most important import item. Here too though, import substitution took place and by the early 19th century cheap domestic sugar production drove imports from the market (Shimbo and Hasegawa 2004, p. 168).

3.3 Late Tokugawa trade

During the 19th century Western powers increased their reach over many parts of the world. The English and French defeated China in the Opium Wars, Russia consolidated its hold over eastern Siberia, and the United States gained access to the Pacific coast. From all these sides there were attempts, to establish trade relations and gain access to the Japanese market. The arrival of Commodore Perry in Edo Bay in 1853 and the concessions he was able to obtain in the following

year have been exhaustively written about. On the particular subject of the mining industry there are, however, a few salient points to repeat here.

The US was primarily seeking openings for trade, assistance to shipwrecked sailors and access to coal and other shipping supplies. The availability of coal in Japan was of particular relevance for the establishment of a steamer route between America's West Coast and China (Beasley 1989). By the 1850's coal mining had already developed from a sporadic activity performed in primitive pits close to the surface, to a more organised and commercialised pursuit. The progression of the method of extraction was similar to that of metal ores. In some cases miners from the metal sector advised on improvements to the techniques. At the same time the application of coal developed from a household fuel to an input for salt production. Through these changes the national output of coal increased from between 40 000 and 50 000 tonnes at the end of the 18th century, to between 120 000 and 150 000 tonnes by the 1820's. This was further boosted by the arrival of steam technology to Japan. As desired by the US, Japanese coal came to supply steamships who called at her ports. With these ships also came the technological advancement that allowed the Japanese coal mines to industrialise. Output increased to between 300 000 and 400 000 tonnes in the 1860's. During the Meiji period this multiplied by a factor of 10 and more (Murakushi 1980, 6–7).

The international treaties also had a very specific effect on the exchange of gold and silver coins. A follow-up treaty, concluded in 1859, arranged the terms under which Western powers could trade on Japanese soil. As part of these terms an exchange rate by weight was set between the Mexican silver dollar and the Japanese Tenpō Ichibuban silver coin, issued from 1837. The Ichibuban was made of nearly pure silver and was denominated in units of gold currency, which made it a kind of fiat currency. Four of these silver coins were on a fixed exchange rate to one Koban gold coin. At that time however, the silver-to-gold ratio on the Japanese market was about 5 to 1, while on the international market the prevailing rate was closer to 15 to 1. This situation enabled enormous profits through arbitrage, as traders could exchange Mexican dollars for Koban and exchange those outside Japan for three times the amount of dollars they started with. The Japanese government could not directly intervene in the resulting outflow of gold under the statutes of the trade treaty. The shogunate remedied the imbalance the next year by minting new coins which traded at a lower amount of gold per unit of silver. This enabled the shogunate to simultaneously make a re-coinage profit to pay for defensive upgrades, be it at the cost of high inflation (Saito 2011).

As mentioned earlier, the edicts of the first half of the 17th century, while restricting foreign travel, contact and trade partners, did not directly restrict trade volume. Over time the production of

precious metals shrank and the self-sufficiency of the Japanese economy increased. This did have a big impact on trade volumes. Precious metal production fluctuations have been mentioned several times so far. Let us now have a detailed look into the available data on the output and use of precious metals, starting with silver.

4 Silver

Part of the intended major contribution of this work is to present a complete picture of the size of precious metal mining in the Tokugawa period. This adds to previous works because of the focus in many of those works on either one metal, a shorter period, or both. Notable exceptions include Kobata's (1956; 1968; 1986) descriptions of the development of Japan's metal mining sector and Innes' (1980) account of Tokugawa period trade in precious metals. However, even those works stop short of providing a full quantitative report on the output of the mining sector. Kobata describes the mining production in qualitative terms and gives production data on certain individual mines. Innes provides many data points, but is primarily focussed on the export side. For silver in particular, the coverage of production data is far from complete. In this section a new approach will be tried to interpolate the production data for the four biggest silver mines, in order to obtain a complete production estimate, which can be compared to the available demand side data.

4.1 Silver supply

As explained in Chapter 2, Japanese silver production techniques improved during the so-called “Christian century”. Estimates of national silver output during the Tokugawa period are generally based on export data. Nevertheless, one of the most cited numbers regarding the size of the Japanese silver output is based on production data and comes from Kobata Atsushi. He used a figure of 30 tonnes in annual fees paid to the local governor of Sado island around 1620 to arrive at a production estimate for the island of 60 to 90 tonnes – reflecting royalty rates of 33.3%-50%. He also notes royalty payments by mines at Ikuno and Iwami of 10 and 12 tonnes. Based on this material he makes, in his own words, “a bold conjecture” of annual exports of 200 tonnes in the early 1600s, which he supposed lasted for roughly a century (Kobata 1965, p. 248). While this number of 200 tonnes is often quoted, there are some problems with the estimate. For one, the estimated peak production at Sado is higher than reported by some other sources as quoted below. A much bigger problem with these numbers is the assumption that this level of production was

sustained for an entire century. All indications based on mine production and royalty payment information point to a pattern of very pronounced peaks followed by longer periods of much lower production. The three mines mentioned by Kobata did not even experience those peak levels at the same point in time. Therefore it is highly doubtful that a production level of 200 tonnes was reached, much less maintained.

However, Kobata's is the only national silver production estimate for the period, as other estimates are based on demand side data. For this reason, a new interpolation approach will be tried, based on the available data from the four biggest producers. That data will be discussed first.

4.1.1 Existing data on individual mines

In this section the focus will be on the production at the four biggest sliver mines of the Tokugawa period, as these are responsible for a major part of production and are the best documented. The main mines are a) the mines on Sado island; b) the Ōmori mine in Iwami province; c) the Ikuno mine in Tajima province, and d) the Innai mine in Dewa province. The first three of these mines were under Tokugawa control after it came to power (Innes, 1980, p. 545).

a) Sado

There is no data about the early years of the silver production on Sado. This changes with the opening of silver production at the Aikawa mine on Sado in 1601.[26] Sasaki (1983b, p. 182) notes a peak of around 25 tonnes in royalties from the Aikawa mine in 1620. According to Kobata (1965, p. 248) from 1618 to 1627 royalties from the whole island of Sado reached an average of 30 tonnes per year. He supposes this level of production could have lasted for an entire century. Sasaki's series, however, show that Kobata's figure coincides with the absolute peak of production of the mine and that production shrinks rapidly afterwards. Innes' (1980, p. 557) estimates also come in lower than Kobata's, at roughly half the size around the same time, with yearly royalty payments of 14 tonnes during 1615-1623 and dropping slightly for the next 20 years. His figures correspond well to the longer term estimates of Yamamura & Kamiki (1983, p. 345).
In section 2.2 of this chapter it was mentioned that government royalties typically made up 25% to 50% of output. Under the assumption that the government take was highest during the most productive years, peak royalty payments of 25 to 30 tonnes result in a production estimate of 50 to 60 tonnes. For the 30 most productive years, average production was at least 25 tonnes, based on

26 It should be noted that of the sources listed for Sado silver mining, only Sasaki expressly states that the figures refer to the Aikawa mine. For the others it is not certain if the figures represent only this mine, or additionally the mines at Tsurushi and Niibo, also situated on Sado island.

Innes's figures. From the 1640s a steady decline set in until royalties reached roughly 1 tonne around the 1730s and levelled out. At a royalty rate of 25% this would represent 4 tonnes of production per year. See Figure 9 for a graphical representation of the various royalty data series.

b) Ōmori

The Ōmori silver mine in Iwami was originally opened in the early 14th century, but reopened shortly before the introduction of the haifuki process. The earliest available data indicate that production was not yet at a high level just after this introduction, with tax payments averaging just 80 kilograms per year from 1532 to 1554 (Sasaki 1980, p. 183). During the second half of the 16th century production approached 400 kilograms. A breakthrough came with the discovery of new silver deposits and the opening of the Kamayabu tunnel in 1601. This pushed tax payments up to 13.5 tonnes. With an assumed tax rate of 50% this means a production of over 25 tonnes. This high yield was short lived, as payments fell below 5 tonnes per year in the 1620s. In the 1670s total production per year fell to 1-1.5 tonnes. From the 1730s on production was down to around 400 kilograms (Kobata 1956, pp. 64–65). See Figure 10 for the full series.

c) Ikuno

The Ikuno mine opened in 1542 in Tajima province. It was not until 1598 that the mine reached a peak of 10 tonnes of silver in royalty payments (Sasaki 1983b, p. 184). Between then and the 1680s there is no data about the mine output. In terms of circumstantial evidence, the mining town population was largest between 1600 and 1650, at 15 to 20 thousand people, based on the volume of rice shipments. Although there is no information about output per person, total production must have been substantial to support this kind of population. Reportedly there was a large fire at the mine in 1660, dispersing a large part of the workers to other mines. (Innes 1980, p. 561) In the 1680s royalty payments were around 2 tonnes, climbing to 4 tonnes around 1710. After that payments to the government settled just below 2 tonnes, dropping off a bit more during the 19th century. This indicates a peak production of about 20 tonnes around the year 1600, with production levels around 8 tonnes in the longer term (Kobata 1954, pp. 20, 40-41). See also Figure 11.

d) Innai

The Innai mine was opened in 1606 and was owned by the Akita clan of northern Honshū. Innes (1980, pp. 562–63) describes that the mine had a high peak production just after opening, but by 1612 production began to decline. There are however no figures available for the size of production until the 19th century.

In the absence of production data the number of people living and working in the mining town provides circumstantial evidence for the size of the mining operation. At Innai the number of workers associated with the mine was estimated at 7000 at its peak. In comparison with the number of inhabitants at Ikuno's mining town – 15 000 to 20 000 including dependants and supporting tradespeople – the Innai mining town would have been at least as big as the one at Ikuno (Innes 1980, pp. 561–62). Without data on the relative labour productivity for these locations, the number of workers does not give us definitive information on the level of production. However circumstantial, these data points do suggest that Innai's peak production was plausibly of a similar scale as Ikuno.

There is more information about the production during the 19th century, when yearly production climbed from several hundred kilograms in the early years of that century to a peak of around 5000 kilograms in the 1830s, after which it dropped off again. According to the Furukawa Mining Company who purchased the mine in 1884, previous peak production was just below 5000 kilograms, possibly referring to the level observed in the 1830s. After transfer tot he Furukawa company production quickly increased to around 9 tonnes per year. By the early 20th century production had dropped back to 5 tonnes (Furukawa Mining Company 1910, p. 51). See Figure 12 for the graphical representation.

4.1.2 A new approach to estimating national silver production

The four big mines described in the previous section all reached peak output in a relatively short time from around the turn of the 17th century to 1630. Given the volatility of output in this period, it is very difficult to estimate yearly production levels for this period. Although peak royalty levels and some indications for other periods are available, the data for the period as a whole are far from complete.

In an effort to overcome this problem, this section will present a model for the estimation of output for each of the four big mines. This model is based on the level of peak royalty output and a plausible development path based on the remaining available data. I will use the almost complete set of data on the Sado mine to infer a pattern of development that can be applied to the other mines as well. The data on the Sado mine is complete enough to form a generalised picture of the successive stages the mine went through in terms of the size of its royalty payments. The assumption is that the other mines had a similar trajectory of development, given that they were operating in similar institutional and technological circumstances that influenced their development.

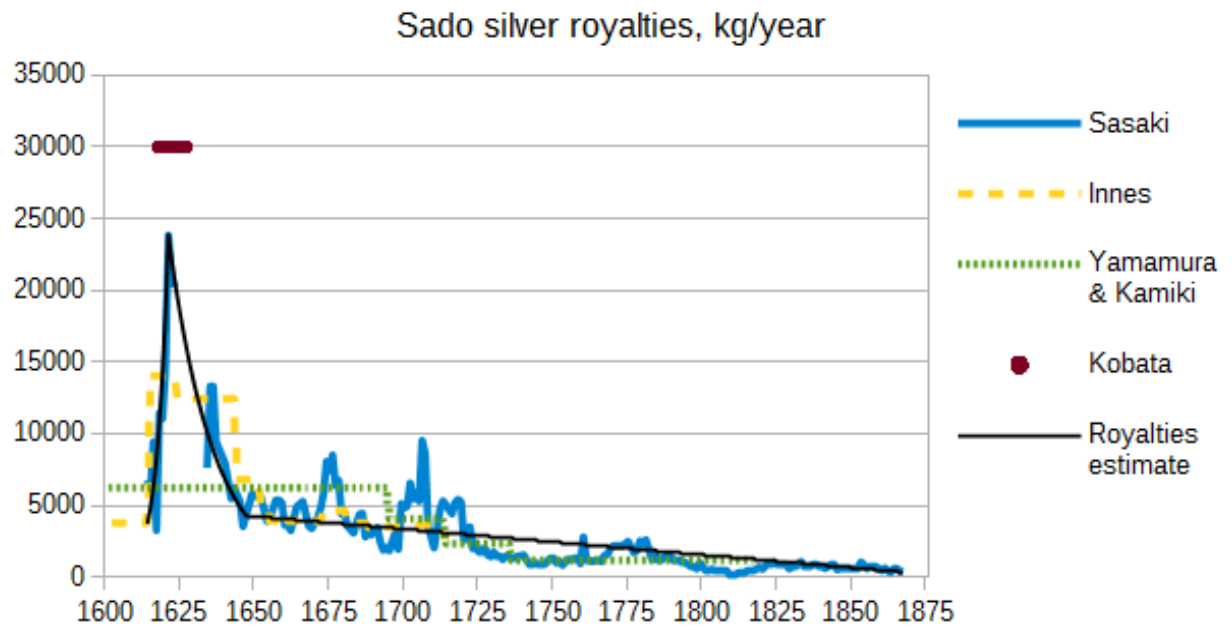
The size of each mine's output is scaled to the height of peak royalty payments. Where data shows a different pattern, the pattern of development is adjusted to take this into account.

It should be stressed that this method will not give an exact answer on the development of production. It is merely meant as a conjecture of the development that is consistent with the available pieces of evidence. It should be seen as an indication of the order of magnitude of the actual production. It is, however, a useful sketch of the development of the production of silver that can be confronted with demand side data to see if the assumptions were realistic.

a) Sado

Looking at the development of the Sado mine it is possible to discern three different stages: a boom, a decline and a tail. The period of highest output consists of the initial boom, the peak and the decline of output. In the case of Sado the boom lasted for 8 years and the decline took 26 years. The 'tail' is a period of low output and only a very gradual decline that was sustained for over two centuries. See Figure 9 for how the model compares with the historical data. The model itself consists of 3 equations expressed in relation to the peak royalty payments and visually fitted to the available data points.

Figure 9: Sado silver royalties



Sources: (Sasaki 1983b, p. 183); (Kobata 1965, p. 248); (Innes 1980, p. 557); (Yamamura and Kamiki 1983, p. 345)

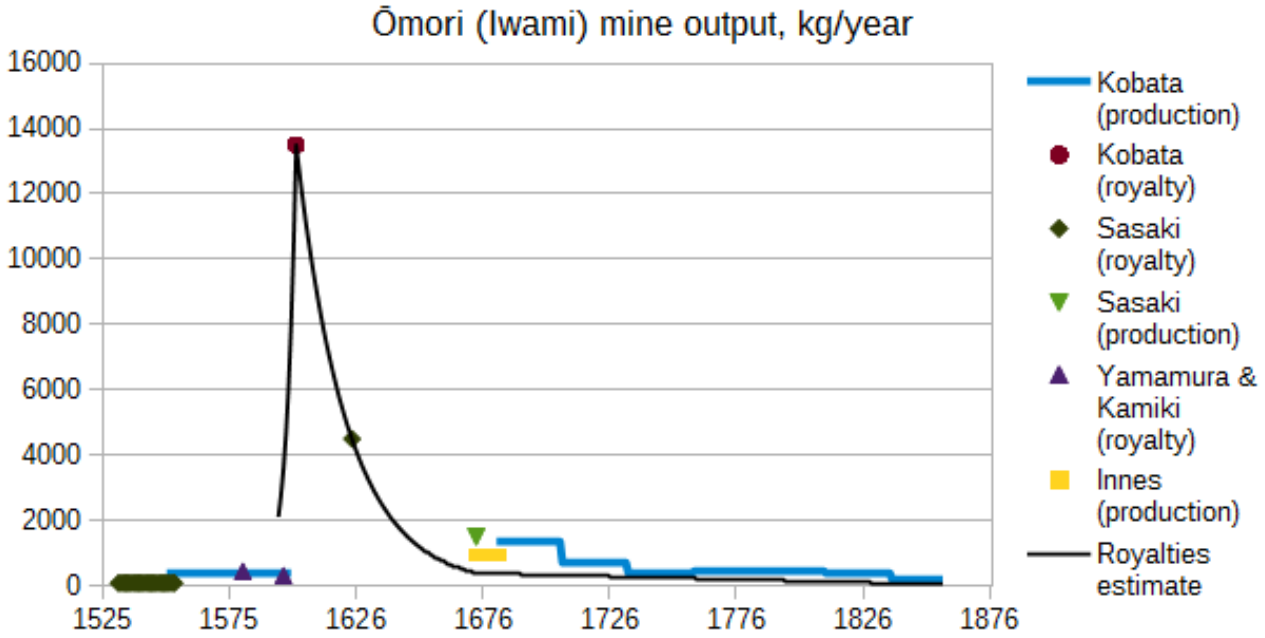
For the peak measurement the value by Sasaki (1983b, p. 182) of 23 865 kg is used, as one of the more conservative estimate. Moreover, the series is much more complete than any other available series. For the boom period an exponential equation is used with a growth factor of 1.304 per year and a starting point of 3742 kg (the average yearly royalty payments in the period leading up to the boom, according to Innes (1980, p. 557)). The decline stage is also described by an exponential function, starting from the peak in the 8th year and decaying with a factor of 0.936 per year. An exponential equation was chosen for the first two stages, based on the fact that typically mines in Tokugawa Japan saw a very volatile growth and decay pattern in the early years after opening a mine, as explained in the section on the institutional setting. In contrast, the tail stage is linear, starting at 4292 kg in the 34th year and decaying by 18 kg per year. The level and timing of this transition point is based on Sasaki's series. The linear decay reflects the more carefully managed exploitation pattern of mature mines. The total amount of royalties of the resulting series differs 1.6% from the level of the Sasaki series for the available years. A summary of data and equations used in this model and the models for the other mines are provided in the Appendix to Chapter 4.

With a series of royalty estimates in hand, the next step is to use these to estimate production levels. According to accounts from bakufu controlled mines the share of royalties in the total output varied from 50% in the higher output years, down to 25% in the lower output years (Innes 1980, p. 555). This relationship between the royalty share R in period t and total output Y_t in the same period is expressed as follows:

$$R_t = 0.25 + 0.25 * Y_t / Y_{peak} \quad (1)$$

For the Sado mine this results in a royalty share of roughly 30%-50% in the boom and decline years and a share of 25%-30% in the tail stage.

Figure 10: Ōmori silver output



Sources: (Sasaki 1983b, p. 183), (Yamamura and Kamiki 1983, p. 343); (Kobata 1956, pp. 64–65)*; (Innes 1980, p. 555).*

b) Ōmori

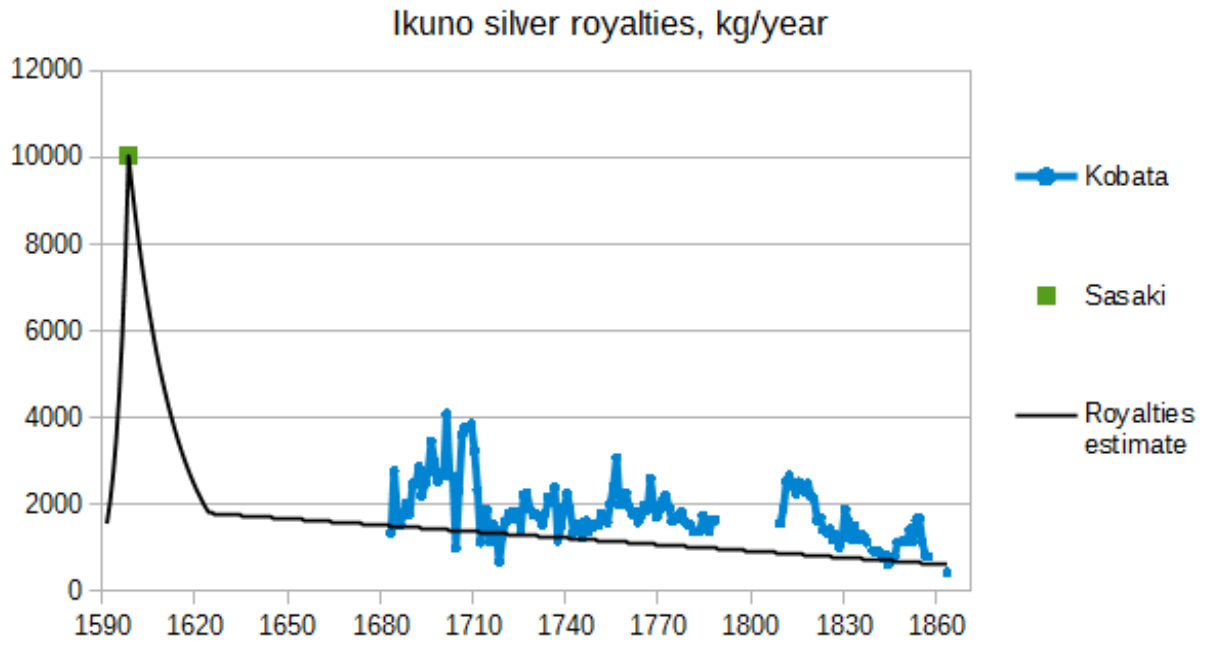
Based on the known level of the peak output, the same growth pattern can be applied to other mines. After Sado the mine with the most complete output data is Ōmori. Although not all sources agree on the exact year (Innes (1980) in 1615; Kobata (1956) in 1602; Sasaki (1983b) in 1596, peak royalty payments for the mine amounted to 13.5 tonnes per year. This mine also shows a very rapid growth and decline, although the data suggests a slightly different pattern to Sado, see Figure 10. By 22 years after the peak the royalty payments are still about a third of the peak level, higher than in the case of Sado, but 49 years after that royalties had dropped to a very low level of less than 3% (Sasaki 1983b, p. 183). In the case of Ōmori the later observations are production levels, which were converted back to royalties by the equation above in order to use them in the model.

In fitting an equation to the Ōmori output data, the boom period is taken from Sado at a lower level based on the peak output. The exponential decay of the decline stage lasts almost 3 times as long at 71 years, though with a slower decay with a factor of 0.955. The tail stage starts at a low royalty level of 387 kg and decays by only about 2 kg per year. See Tables 17 and 18 in the appendix to this chapter for the data and equations used. The method of calculation of production based on the royalty amounts is the same as described above.

c) Ikuno

Data for the Ikuno mine is restricted to one observation for the peak of royalty payments and a relatively long series describing the payments during the middle and later Tokugawa period, see Figure 11. Given the absence of information about the periods before and immediately after the peak, the pattern of Sado's development will be applied to the boom and decline periods, scaled to Ikuno's peak output of around 10 tonnes. The turning point from exponential to linear decay is not recorded, but the assumption here is that the heyday of production at Ikuno lasted a similar time as at Sado, and that royalty payments equally fell to around 18% of peak output at the end of the decline stage. From there royalties declined, but data from the 18th and 19th centuries shows that Ikuno was able to sustain a relatively high output of around 600 kg by the 1860s.[27]

Figure 11: Ikuno silver royalties



Sources: (Kobata 1954, pp. 20, 40, 41); (Sasaki 1983b, p. 184).

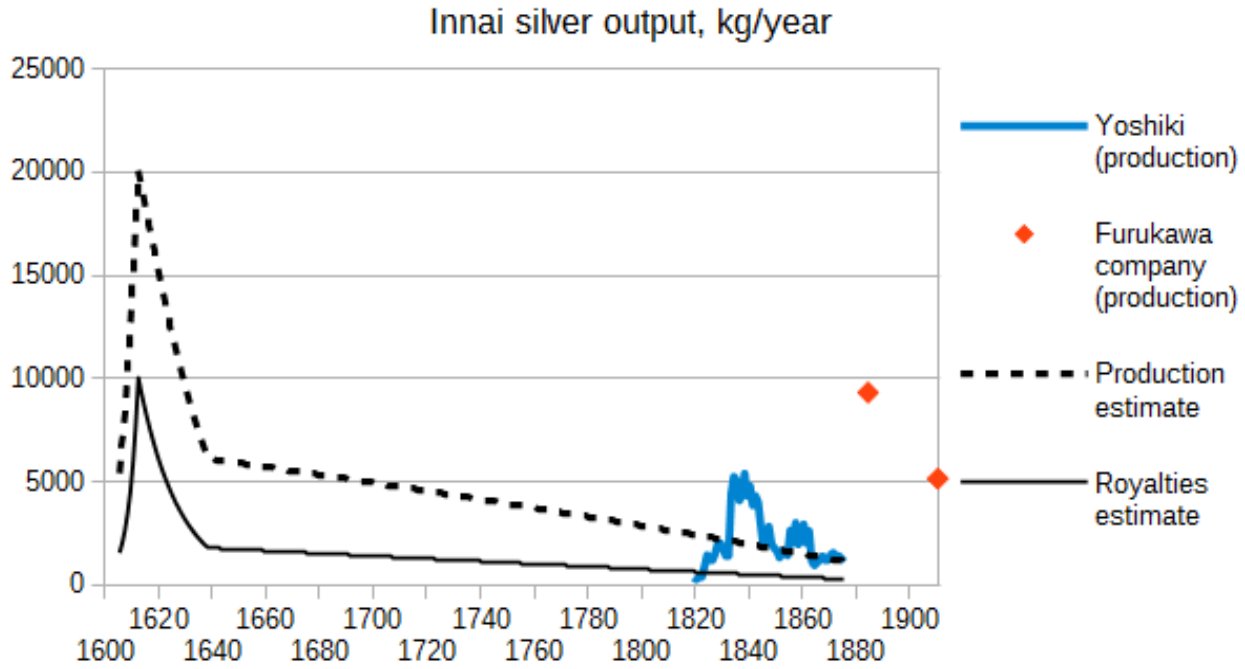
d) Innai

Unfortunately there is no data about Innai's initial boom period and corresponding peak output, making an estimation of production levels even more speculative. From the information quoted in paragraph 4.1.1 about the size of the mining workforce at Innai, it seems the mine was of a comparable scale to Ikuno. In order to account for Innai's production an option is then to use the

27 In this case an average of the final two observations is used, since the final observation of 429 kg in 1863 was clearly below the trend (Kobata 1954, pp. 20, 40-41).

Ikuno mine as a template and use its peak production data to estimate Innai's boom and decline stages – be it offset to let the peak coincide with the reported timing of peak of production at Innai around 1612 (Innes 1980, pp. 562–63). This is even more speculative than the estimates of the other three mines, but without it there would be an unacceptable gap in the data. There is production data available spanning the middle of the 19th century, which provides a data point for the end of the tail stage. The end point of 296 kg of royalties in 1875 implies that the decay during the tail stage was slightly more rapid than for the Ikuno mine. See Table 18 in the appendix to this chapter for the model specifications.

Figure 12: Innai silver output



Sources: (Yoshiki 1980, p. 1); (Furukawa Mining Company 1910, p. 51)

e) Other mines

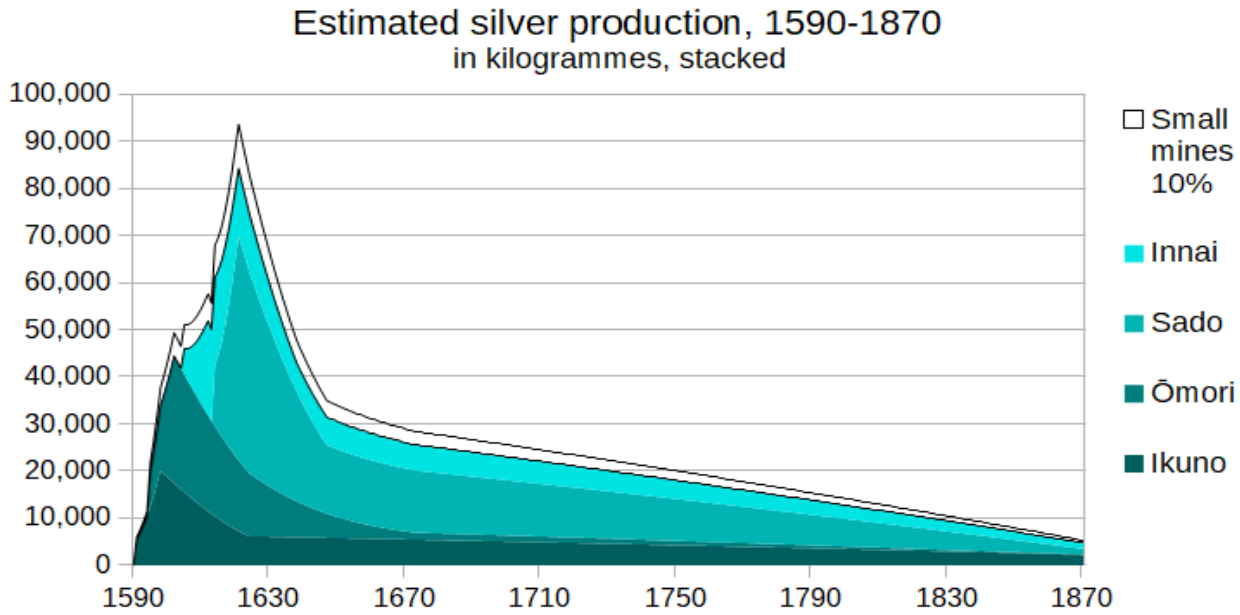
A remaining unknown quantity is the production of the smaller mines. The exact number of these mines is unclear, but could have numbered into the hundreds. There were a number of medium sized mines, like the Tada mine in Settsu which had its peak production of almost 6 tonnes of silver per year in the second half of the 17th century (Innes 1980, pp. 566–68). Smaller operations, such as at the towns of Yoshino and Kameya had an average production of several dozen kilograms per year (Kobata 1956, pp. 440–41). With a handful of medium-sized and up to hundreds

of small mines, yearly production at these sites could have been 10 tonnes or more. In addition, silver was sometimes a minor side-product of copper mines, depending on the ore type. Therefore the previous estimates should be seen as minimum figures. A conservative estimate of the output of smaller mines is that they made up 10% of total production, compared to 90% for the big 4. This results in a peak of 9.4 tonnes in 1621.

f) National production

Adding the estimated production of the smaller mines to the production estimates of the large mines, arrived at by the method described above, results in the total silver production curve in Figure 13.[28] The aggregate curve presents a fast, almost uninterrupted rise to a peak of over 90 tonnes and a smooth decline which decelerates significantly after the 1630s. Initially Sado and Ōmori dominate, but by the end of the period Ōmori barely had any production while the other three mines combined for about 5 tonnes of production.

Figure 13: Model estimates of silver production

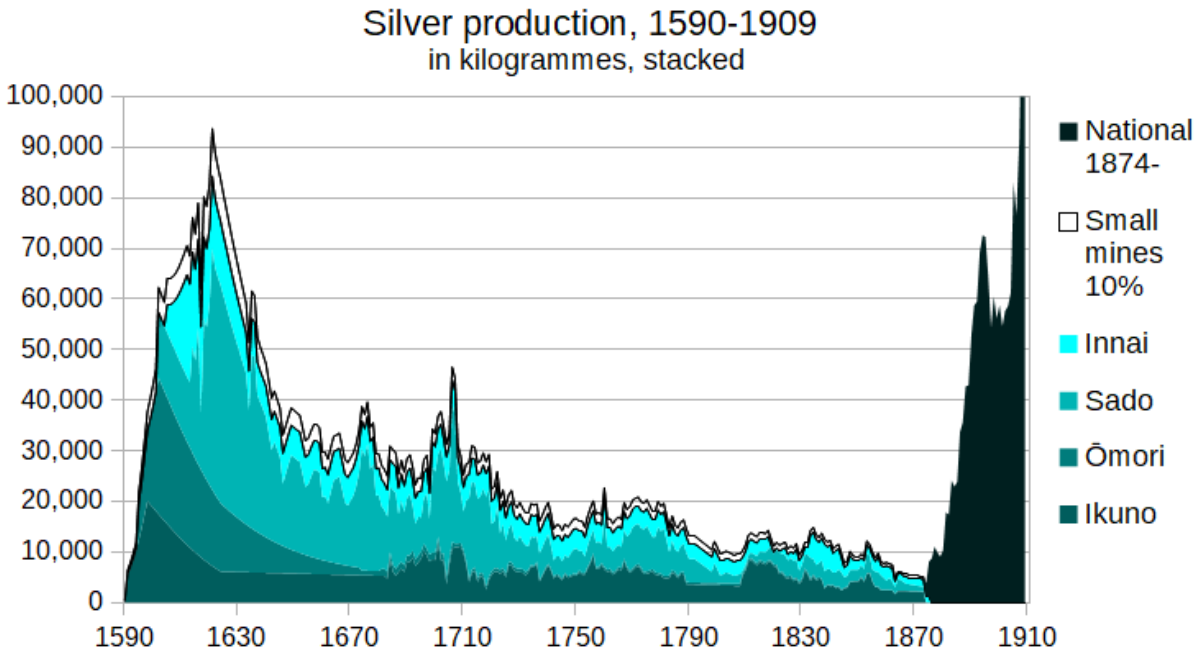


This rather stylised result can be combined with the available observations for each mine. For the cases where actual output numbers are available, these override the model estimates, in order to

28 For most of the big mines, the last known production volumes are from before the start of the production statistics in the 1870s. Therefore, the equations from Appendix to Chapter 4 are extended to project the production estimate beyond the final observations of the individual mines. This was not necessary for Innai, which has a continuous series from the first half of the 19th century.

make optimal use of all existing information. In addition, information about national silver production from the Japanese Long-Term Economic Statistics (LTES, No. 10: Shinohara 1972) is used to extend the production data from 1874 to 1909. This is presented in Figure 14. The Y-axis is cut off to improve comparison with the curve of the previous graph, however national production grew to 128 tonnes in 1909. There are a few periods where the additional data changes the model graph to a greater extent. Data on early 17th century Sado royalties, converted to production, adds almost 13 tonnes on a yearly basis. Then there are a few periods in the tail stage where production temporarily flared up, the most striking one taking place around 1700-1710 when both Sado and Ikuno had a spike in production.

Figure 14: Silver production data combined with model estimates



Sources: Ikuno: 1598: (Sasaki 1983b, p. 184) 1683-1788, 1809-1837, 1839-1857, 1863: (Kobata 1954, pp. 20, 40–41) Innai: 1819-1875: (Yoshiki 1980, p. 1; *Ōmori: 1590-1594, 1602, 1681-1857:* (Kobata 1956, pp. 64–65), *1673: (Sasaki 1983b, p. 183)* 1674-1680: (Innes 1980, p. 555) *Sado: 1602-1613: (Innes 1980, p. 557); 1614-1623, 1634-1867: (Sasaki 1983b, p. 182); National 1874-: (Shinohara 1972, Table 51)*; Small mines output: 10% of total including production data.

The years around the end of the Tokugawa period were a time of great turmoil, possibly explaining the drop production in those years. Soon thereafter production grew quickly, surpassing 70 tonnes in the 1894 and 100 tonnes tonnes in 1908 (Shinohara 1972, Table 51). Mining was one of the industries where foreign experts were brought in to modernise production. For the silver mines the Meiji period brought a boom in production on a similar scale to the one around the beginning of the Tokugawa period.

4.1.3 Silver imports

Besides production, the other component on the supply side are imports. During the later Tokugawa period silver came to be imported into Japan by Chinese and Dutch traders. According to Shimada (2006, p. 61) this was motivated by bullionism, of which he identifies Arai Hakuseki as the first Japanese proponent. However, an account by Meylan (1833, pp. 198–200), a chief of the VOC's mission in Nagasaki, suggests there were also other considerations in play. In 1768 a Dutch ships was lost at sea on the way from Batavia (current Jakarta) to Nagasaki, leaving the single remaining ship unable to carry the full export quota of copper for that year. The next year the two ships allowed entry into Nagasaki exported both that year's and the previous year's remaining copper, but were not able to carry enough imports to balance the trade. The difference was compensated in silver paid to the Nagasaki traders. Since during the earlier Tokugawa period trade was generally balanced, this was a change in policy.

The Chinese traders started the import of silver a few years earlier around 1762. Between 1763 and 1782 the Chinese and Dutch combined imported 2.9 tonnes of silver coins per year, or 2.7 tonnes of silver at a purity of 93% (Uchida, 1921, pp. 456–57). These silver imports continued at a rate of about one quarter ad valorem of copper exports between 1766 and 1842 (Shimada 2006, p. 64). Silver imports are depicted in Figure 15 at 2.7 tonnes from 1763 to 1782, and after that at a fixed rate of 0.18% to the copper export volume, equal to the rate during 1763-1782. After 1782 imports are estimated to be less than 2 tonnes per year. Given the increasing import substitution taking place during the Tokugawa period (See Chapter 3) the import of silver could be seen as a consequence of the fact that Japanese traders were lessening their trade of goods such as silk or sugar.

4.2 Silver demand

4.2.1 Silver exports

As described in the section on foreign trade, silver was the main export product of Japan during the late 16th and early 17th centuries. The exact size of this trade is the subject of some debate. One group of researchers suggests relatively high silver exports. The estimate of 200 tonnes per year for the 17th century by Kobata has already been mentioned. Another often quoted source is Iwao Seiichi, who combined estimates of the quantities exported to by the separate carriers during the

early 17th century.[29] Converted to 93% purity, his total comes to 140 to nearly 180 tonnes per year (Iwao 1966, pp. 222–23). Based on this data, Shimbo and Hasegawa (2004, p. 167) estimate that in the early 17th century silver exports represented a value equal to around 10% of *agricultural* output. Yamamura and Kamiki (1983, pp. 351-52 have used Iwao's and other, supplemental information to come to their own estimates for the late 16th and early 17th centuries. For the former period they come to exports of around 40 tonnes per year, while for the latter they suppose exports of 150 to almost 190 tonnes per year. The various estimates are summarised in Table 14.

Several other researchers come to quite different, lower estimates. George Bryan Souza used numbers and types of ships making the voyages between Macao and Japan to estimate Portuguese silver exports from Japan to China. He arrived at 14.9 to 18.3 tonnes per year during the period 1546-1597 (Souza 2004, p. 56). For the first half of the 17th century Richard Von Glahn has estimated silver exports by using the data for the value of total external trade from Innes quoted in Table 14. Based on VOC accounts for certain years, Von Glahn estimated that at least 80% of the value of the imports was traded for silver. By this method he arrived at yearly exports of silver during 1601-1645 of 54 tonnes, about a third of the figures proposed by Iwao and Yamamura & Kamiki (Von Glahn 1996, p. 136).

Table 14: Estimates of silver export from Japan to China by carrier, in tonnes per year

	Iwao[30] early 17th C.	Y&K 1560-1599	Y&K 1600-1639	Von Glahn 1550-1600	Von Glahn 1601-1645
Portuguese	48 – 57	22.5 – 37.5	45.0 – 56.25	14.5 – 18.0	14.4
Chinese	38 – 49			8.8	13.3
Shuinjō	43 – 53	11.25*		NA	18.7
Dutch	13 – 19	-		-	7.6
Total	141 – 177	33.75 – 48.75	150.0 – 187.5	23.3 – 26.8+	54.0+

Sources: (Iwao 1966, pp. 222–23; Von Glahn 1996, p. 140; Yamamura and Kamiki 1983, pp. 351–52). All figures 93% pure. Totals may differ from individual values due to rounding.
*Together with Chinese traders.

29 Iwao himself is somewhat vague about the period his estimates refer to. Others have interpreted his figures to apply to the years 1596-1623 (Shimbo and Hasegawa 2004, pp. 166–67), or 1615-25 (Souza 2004, p. 58). The widest plausible limits of the applicable period are the start of the shuinjō system in the 1590s and the start of seclusion in 1639.

30 Iwao gives estimate of total export in pure silver and figures per carrier in coin quality silver, apparently using a range of possible purities to arrive at a wider estimate range for the level of the total in pure silver. The carrier figures have been back-calculated to be consistent with the total, both at 93% purity.

According to Von Glahn and Innes, the figures by Iwao, Kobata and Yamamura & Kamiki are overestimations of the actual silver exports, because those researchers used each carrier's top years for their estimates of the period. This can lead to very different outcomes, as the export amounts of the traders were very changeable. The Portuguese, Chinese, Dutch and Japanese traders were all competing with each other for trade. The availability of ships, capital and merchandise, the incidence of shipwrecks and temporary bans of trade for certain carriers all influenced the trade volume of the individual carriers and their relative dominance during the years.

As an example, let us take a look at the value of Portuguese silver exports during different periods and see how Iwao's estimates compare to known data points. Iwao estimates that during the early 17th century the Portuguese exported 15 000 kanme, or 56¼ tonnes of silver per year (Iwao 1966, pp. 222–23). In the 18 years between 1600 and 1617 a total of only 10 Portuguese *carracks* (large cargo ships used by the Portuguese) made the journey to Japan (Souza 2004, p. 55). From the surviving records of the cargo carried by the Portuguese on the Nagasaki-Macao route, 3000 to 4000 kanme (11¼ to 15 tonnes) of silver seems to have been a typical value of the total cargo of each carrack (Innes 1980, p. 382). With less than one ship arriving per year, the average yearly export value would have been only 7.7 to 10.2 tonnes of silver. Taking a longer view, 1598 sticks out as an unusually good year in which 3 ships arrived (Souza 2004, p. 55). Yet even that high mark would only be good for an estimated trade value of 33.75 to 45 tonnes of silver.

From 1618 the Portuguese traders started using the smaller *galliots*, in reaction to their carracks being captured by the Dutch. During the 16 years between 1618 and 1633 a total of 69 galliots made the journey. The best year was 1619 with 8 ships. Trade was halted for a few years in the late 1620s by a Japanese trade embargo on the Portuguese, in reaction to a shuinjō ship under Japanese protection being attacked by a Spanish fleet stationed in Manilla (Souza 2004, pp. 56–60). In 1618, 6 galliots made a total trade of 7000 kanme (26 250 tonnes of silver) . Going by the average cargo value per ship in that year (4 375 tonnes of silver) the average yearly export value during 1618-1633 would have been an estimated 18.9 tonnes of silver, with a high of 35 tonnes in 1619 (Innes 1980, p. 383).

During 1634-1638 the Portuguese trade did reach a size similar to the figure used by Iwao. During those five years trade value averaged 58 tonnes of silver (Innes 1980, p. 17). This high trade level was due to the specific circumstances of the time. From 1635 overseas voyages by Japanese traders were forbidden and the shuinjō system was ended, leaving the Portuguese, Dutch and Chinese to pick up the slack and increase their trade (Souza 2004, p. 58). In addition, the prohibition on Japanese international trading missions restricted the number of trading partners and

possibly caused prices on imports to rise, as the number of suppliers of foreign goods was restricted and the supply of Japanese silver was unchanged. The result would have been a worsening of the terms of trade for Japanese exports. A few years later when the Portuguese were also barred from trade and only the Dutch and Chinese were allowed to trade, the price of foreign goods doubled according to Arai Hakuseki. This worsening of the terms of trade has been connected to the increased outflow of Japanese specie in those years (Takekoshi 1930b p. 130).

As the Portuguese case shows, the figures of Iwao and Yamamura & Kamiki are consistent with only the best export years for the Portuguese and are overestimations for the rest of the period. By contrast, Von Glahn uses data spanning a much wider period. Using mostly data gathered by Innes, he has constructed a 5-yearly time series of silver exports starting in 1606. Until 1647 the estimates are based on the assumption that 80% of the value of imports was paid in silver. From 1648 to 1672 actual silver exports through Nagasaki are available. The Dutch were not allowed to export silver from 1668, therefore exports of silver through Nagasaki for 1673-1684 are based on Chinese export figures. The Chinese exported mostly silver until the mid-1680s when the shogunate applied restrictions on silver exports through Nagasaki, and the profitability of copper exports motivated a switch to that metal (Von Glahn 1996, p. 232). From 1686 the silver export data represents the trade through the island of Tsushima to Korea, as that became the main route for silver to flow out of the country. Two successive series by Tashiro are used for the export through Tsushima until 1752 (Tashiro 1981, p. 325, 1989, Table 1). The combined series converted to pure silver is shown in Figure 15, together with the production estimate explained above and the use of silver in the money supply which will be discussed below.

4.2.2 Silver in the money supply

Export was not the only destination for the silver produced in the Tokugawa period, as large amounts ended up in the money supply. The gradual commercialisation and monetisation of the economy during this period has been extensively documented. See for instance Hayami, Saito and Toby (2004). During the Tokugawa era both the volume and purity of silver coins varied greatly from period to period. There was a general tendency for coins to become less pure, as the shogunate was tempted to augment their income by currency devaluation. In addition, from 1765 the shogunate began issuing silver coins with a nominal value expressed in *ryō*, a gold coin of the time. This was in effect a type of fiat money, although it still required substantial amounts of precious metal, be it silver instead of gold.

Table 15 Shows the average yearly addition of silver to the money supply from the beginning of the Tokugawa period to 1854. It is based on an estimate of the currency in circulation at different times, combined with information on the purity of issued coins. It should be noted that the amount in circulation at times differed greatly from the coins issued. During 1600-1695 a very large amount of coins was stamped, using 3 600 tonnes of pure silver in total (Nishikawa 2000, p. 8). This is close to the total production of silver during those years as estimated above at 3700 tonnes. Most of the silver coins issued in those years were exported, however. Total exports from 1606 to 1695 were almost 3 400 tonnes. Conversely, the currency in circulation in 1695 only contained about 470 tonnes of pure silver (Yamaguchi 1963). Comparing the silver in circulation and exported a possibly conclusion is that the production is underestimated. However, the shogunate could also have used existing stocks of silver and gold. After the siege of Osaka castle in 1615 the shogunate claimed the substantial Toyotomi treasure for the issue of new coin (Miyamoto 2004b, p. 84). Another aspect to take into account is the fact that existing coins could be melted down to use the specie for the issue of new coins.

Besides the coins valued as their weight in silver, Table 15 also includes silver coins which were denominated in units of gold coin. The former category is converted from *kanme* (3.75 kg) of coins to tonnes of pure silver, using purity figures for the coins issued in the preceding period (Nishikawa 2000, p. 8). For 1710 and 1714 it was necessary to use average purity figures as there were many successive coin issues in those years. Therefore the 1710 purity is an average of the purity of the 1695 and 1706 issues, while 1714 uses the purity of the 1710 and 1711 issues. Gold denominated silver coins entered the money supply in 1765 and are counted in the table starting in 1818 in millions of ryō. The majority of gold denominated silver coins at that time were the *Meiwa nanryō nishugin* issued from 1772. These weighed 2.7 *monme* (1 monme = 3.75 grammes), consisting for 97.8% of silver with a face value of 1/8 of a ryō gold coin. Using these ratios it is possible to calculate the exchange rate of monme pure silver per ryō of gold and through it the amount of silver used in the issue of these coins (Taya 1963).[31] Adding up the silver content of the silver coins by weight and the gold denominated silver coins in circulation yields the total amount of silver contained in the money supply in the estimated years. Subtracting the silver amount in the money supply in the previous known year and dividing by the number of intervening years yields the yearly change of silver in the money supply.

31 For the 1818 stock the exchange rate was 21.1 monme silver per ryō. The 1832 stock consisted in roughly equal parts of a 2 monme coin with a 1/8 ryō face value, and a 0.7 monme coin with a nominal value of 1/16 ryō, resulting in a weighted exchange rate of 13.2 monme per ryō. From 1837 a 2.3 monme, 1/4 ryō coin was issued in large amounts, resulting in an even lower rate of 9.1 monme per ryō.

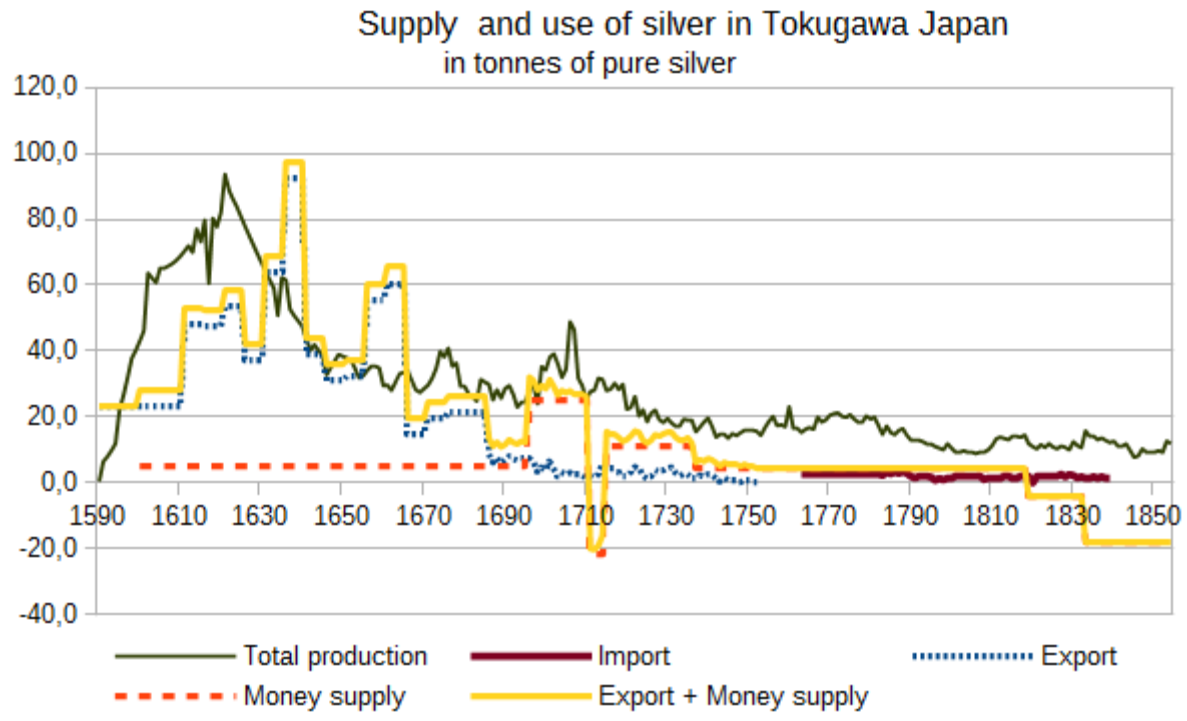
For most of the Tokugawa period the money supply absorbed more and more silver. However, according to these calculations, during 1710-1714 and 1818-1854 there was a net extraction of silver from the money supply. These years line up with known periods during which the shogunate used its minting monopoly to support the budget (Miyamoto 2004a, 2004b).

Table 15: Silver used in money supply

Year	Silver by weight (1000 kanme)	Silver purity (%)	Silver by weight (tonne pure)	Gold denom. silver (M. ryō)	Monme pure silver/ ryō	Gold denom. silver (tonne pure)	Total silver money (tonne pure)	Yearly growth of silver supply (tonne pure)
1695	157.1	80	471.2	-	-	-	471.2	5.0
1710	394.2	57	842.6	-	-	-	842.6	24.8
1714	774.5	26	755.1	-	-	-	755.1	-21.9
1736	331.0	80	993.1	-	-	-	993.1	10.8
1818	527.8	46	908.7	5.9	21.1	469.3	1378.0	4.7
1832	381.4	36	515.0	16.3*	13.2	809.4	1324.3	-3.8
1854	234.1	26	228.2	20.5	9.1	700.3	928.6	-18.0

Sources: Columns 2 and 5: (Yamaguchi 1963); column 3: (Nishikawa 2000, p. 8); *, column 6: (Taya 1963, p. 388), the other columns are calculated based on the sourced columns.

Figure 15: Supply and use of silver in Tokugawa Japan



Sources: Production: see Figure 14; Import: 1763-1782: (Uchida 1921, 1: pp. 456–57), after 1782: fixed rate to copper exports; Export: 1590-1685: (Von Glahn 1996, pp. 140, 232), 1686-1752: (Tashiro 1981, p. 325, 1989 Table 1); Money supply: see Table 15

4.3 Confronting supply and demand

Figure 15 shows the estimates of production and imports together with those of exports and use in the silver supply. These make up the known sources of supply and demand of silver in Tokugawa Japan. A few things are obvious from the graph. Firstly, the peak in silver exports occurs after the peak in production. This is to be expected, as a large part of the silver was first made into coin, possibly spent some time in circulation, and was only then exported. In addition, the production of coins would be likely be focussed mostly in the early years of the period of issue, for instance in the early 1600s, while in the calculations the use of silver is assumed to be spread equally. A second period of high production relative to observed consumption is when exports of silver were at a low level in the 18th and 19th centuries. Given the impact of the casting of coin on silver consumption in certain periods, and the uncertain spread of currency issue over the time span of currency regimes, it is best to compare the supply and use of silver based on the currency regime periods. In Table 16 this is done for four periods.

Estimated supply includes the production of the big 4 mines and 10% of production for smaller mines, plus silver imports. Imports of silver start from 1763 but remain at a comparatively low level. On the use side silver exports are added to the silver absorbed in coinage. The 1600 to 1695 time span includes the period of highest production and export, resulting in excess supply of 568 tonnes, or 5.9 tonnes per year. In the following two periods the yearly excess is about twice as high, and in the final period it doubles again.

Table 16: Silver supply and use compared, in tonnes pure silver

	Supply	Use	Excess supply	Yearly excess
1600-1695	4557	3989	568	5.9
1696-1736	1120	660	460	11.2
1737-1818	1374	403	971	11.8
1819-1854	443	-449	892	24.8

Sources: see Figure 15

For the interpretation of these results there are a few possibilities to keep in mind. Firstly, the production estimates may be too high. The production estimates are speculative, although data

availability differs per period. This puts a lower bound on the production estimates for the more complete years. For the 1737-1818 years for instance information is relatively good, with data from three mines being mostly complete. During those years, Sado paid an average of 1.2 tonnes in royalties. For Ikuno data is missing for 1789-1808, but during the remaining years royalties averaged 1.8 tonnes. Therefore royalties for this period from just these two mines amounted to about 3 tonnes per year on average. Even at a relatively high royalty share of 50% this would represent a production of 6 tonnes, but as these periods were far from the peak years royalties were likely closer to 25%, putting production at 12 tonnes. In addition there was the production from Ōmori, known to have been 0.4 tonnes per year on average, as well as Innai, smaller production centres, and silver imports during the later years. Conversely, the average use of silver during the same period is estimated at to less than 5 tonnes per year. Although overestimation of production is a possibility, it is at most only a partial explanation of the difference between supply and use.

A second explanation is that there is more use of silver than shown here. There was likely illicit trade taking place between Japan and China during certain periods of the Tokugawa period, as Chapter 3 describes. Smuggling could have taken place during the time when silver was allowed to be exported but limited by amount or value, but also during the later Tokugawa period, when trade in silver was banned from Nagasaki. According to Sakai (1964) smuggling was relatively widespread in Satsuma, a domain which was distant and relatively independent from the Edo government, and had a semi-independent outpost in the Ryūkyū islands. Especially during the earlier period of high silver production, silver would have been an attractive export commodity for smuggling, being both in demand and having a high value-to-weight ratio.

Besides unaccounted international trade, the domestic market would have absorbed a certain amount of silver in decorative and household objects. Unfortunately, estimates of domestic consumption are not available. From qualitative accounts it appears there was a growing market for luxury decorations and objects, to the degree that successive shogun found it necessary to increasingly restrict the type of materials people of different social classes could use. There were restriction on the use of silver and gold in objects like building ornaments, altars, clothing and equipment worn during festivals, the clothing of prostitutes, women's combs and bodkins, tray-stands, bowls and cups used when entertaining, and even the costumes of puppets in the theatre.[32] The fact that these sumptuary laws had to be issues again and again, and that many of the restricted uses were hard to police, suggests that these restrictions were not very effective (Shively 1964). It is a distinct possibility that the domestic use of silver increased during the Tokugawa period.

32 Amusingly, there was an exception for puppet generals.

Table 16 suggests that after the moratorium on silver exports in the late 17th century the excess, unaccounted, supply of silver increased. This makes sense, for if the demand for silver through (official) export was cut off, this would have induced illicit trade and/or the domestic consumer market to capture a larger amount of silver. A separate growth of the domestic luxury goods market as a whole could have contributed to this development.

Comparing the supply and use of silver in Tokugawa Japan the estimates used here are broadly consistent with each other. Given the speculative nature of the production estimates, the level of total production carries an amount of uncertainty. Since the timing and height of the peak output and the late Tokugawa output are mostly based on observations, these are the more reliable aspects of the production side estimates. The amount of silver used in export and currency is supported by more extensive data than the production side. There are, however, gaps in the use side data as well, such as the unknown amounts of silver used in the domestic market and illicit trade, which could plausibly account for the excess production. Therefore the difference between the supply and use estimates cannot simply be assumed to be an overestimation of the production side. Especially for the most important period of silver production, the 17th century, the supply and use totals seem very plausible.

5 Copper

Copper was also a major export commodity in the Tokugawa period. The level of output of copper is much less disputed than the output of silver, however. The much higher availability of data undoubtedly contributes to this fact. Export through Nagasaki, starting in honest in the 1640's was much better recorded than the earlier silver trade. When export data starts to show gaps in the 18th century, production data is much more complete than in the case of the silver mines. This is due in part to the fact that the copper mines were administrated in a far more centralised style. The fact that the data was recorded does not necessarily mean that it is all gathered in one place. There are a number of valuable sources that present data on the production or export of copper during the Tokugawa period, including works by Shimada (2006), Glamann (1953), Izawa (2013), Innes (1980), Sasaki (1983a, 1983b) and Kobata (1968; 1986). However, most of these works focus only on part of the Tokugawa period, typically the late 17th and 18th centuries, or on only one aspect of the copper market. In this section the goal is to gather and present data from both the copper supply and use sides for the entire Tokugawa period.

5.1 Copper supply

Copper was in many ways a successor to silver after deposits of that metal became more scarce. Copper mine openings were concentrated most heavily in the second half of the 17th century (Sasaki 1983b, pp. 179–81). Several silver mines, including the previously discussed Ikuno mine, expanded their production to include copper in order to stay operational. As mentioned earlier, by 1703 copper was mined at an impressive 243 locations around the country (Innes 1980, p. 568). Among these were the largest copper mines at Besshi, Ashio and Ani, in addition to the province of Mutsu which featured a large number of smaller mines (Murakami 2006, p. 628). The most important mining locations will be described briefly below. Their production is summarised in Figure 16.

5.1.1 Copper production

a) Besshi

The Besshi copper mine on the island of Shikoku was situated on bakufu land, but was managed by the Sumitomo family since its opening in 1691. In 1749 the Tatsukawa mine was removed from the control of the daimyo of Saijō and added to the Sumitomo mining operations. The reason for the transfer was that the Tatsukawa mine was located on the same mountain as the Besshi mine and targeted the same copper vein. Production statistics on the Besshi mine are available for the whole period, owing to the fact that it was continuously operated by the Sumitomo company until the 1970s (Shimada 2006, p. 49).

Due to its association with the Sumitomo company and continued sizeable production the Besshi mine is perhaps the most famous copper mine of the period. Peak capacity reached over 1500 tonnes in 1698. Two decades later the mine stabilised at an output of 400 to 500 tonnes annually, which lasted until the 1870s, when it started growing quickly. Total production between 1691 and 1867 was around 100 000 tonnes (Sumitomo Metal Mining Co. 1991, pp. 225–29).

b) Ani

The Ani mine was situated in the Akita domain in Dewa province in northern Honshū. The whole region was rich in copper deposits with numerous mines in operation. Ani was the biggest of these. While initially a silver and gold mine, its main production was switched to copper when supply of those ores dried up. Ani produced 130 000 tonnes of copper between 1670 and 1867. Its rate of production was roughly 400 tonnes per year before the end of the 17th century, and by the early 18th century it reached a peak of around 1800 tonnes. After that followed alternating periods of

decay and growth, trending down to an output of about 400 tonnes around the end of the Tokugawa period (Izawa 2013, p. 18; Sasaki 1983b, p. 184). In 1885 the Ani mine was sold to the Furukawa mining company and in the early 20th century it produced around 1400 tonnes per years (Furukawa Mining Company 1910, p. 21).

c) Ashio

Ashio is not mentioned in all overviews of major Japanese early modern copper mines. For instance, Innes (1980, p. 568) and Shimada (2006, p. 48) do not include it in their tables counting up the national production. Yet according to Izawa (2013, p. 18) it is the mine with the largest known total production during the Tokugawa period at close to 150 000 tonnes from 1610 to 1867. Production topped 1000 tonnes from the 1660s to the 1720s, peaking in the early 18th century. At the end of the Tokugawa period, production had decreased to a few dozen tonnes. Ashio was privatised in 1871 and sold to the Furukawa company in 1877. Under Furukawa management production increased to 7600 tonnes in 1891, becoming the largest producer in Japan with around 40% of national production (Murakami 2006, p. 628; Shinohara 1972, pp. 266–67).

d) Mutsu

Mutsu was the largest province of Tokugawa Japan, spanning most of northern Honshū. As in neighbouring Dewa province there were many small and medium-sized mines. Largest of these was the Osarizawa mine, a former gold mine. During most years between the late 17th and early 19th centuries it produced 200-400 tonnes of copper (Izawa 2013, p. 18). Another mine at Shirane produced 120-360 tonnes during the 1660s to 1680s (Shimada 2006, 49). Additionally, in the early 18th century there were several other mines that produced around 100 tonnes per year (Kobata 1956, pp. 179–80). Although the data is fragmented, during the 18th century the yearly output for the whole province seems to have ranged from 300 to 800 tonnes. By the 1840s however, production had decreased to around 100 tonnes (Shimada 2006, p. 48).

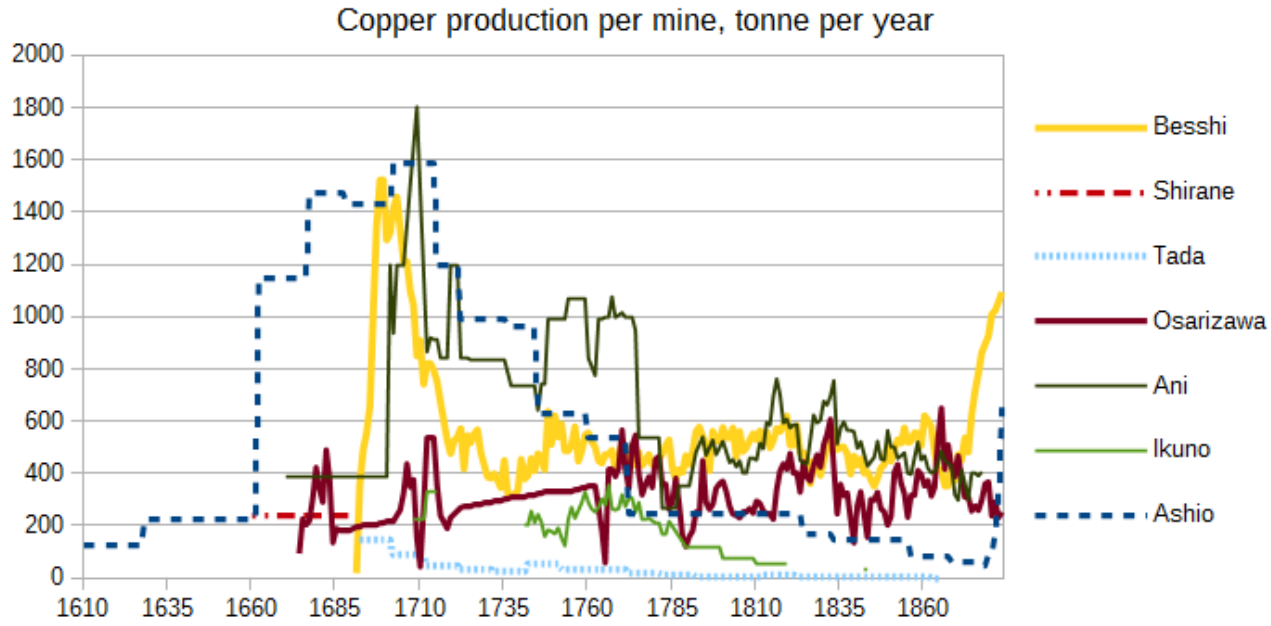
e) Ikuno

The Ikuno mine – also covered in the chapter on silver – had diversified into copper by 1708. Production rose from over 200 tonnes per year around 1710 to over 300 a few years later. Production mostly seems to have fluctuated around those levels until the 1780s when a downward trend started that brought levels down to 50 tonnes in the 1810s (Kobata 1956, p. 69, 1968, pp. 236–38; Shimada 2006, p. 48).

f) National production

The production developments of copper mines for the Tokugawa period is shown in Figure 16, including 6 mines already mentioned and the Tada mine near Osaka. For the early 17th century only production data on the Ashio mine is available. There are a few mines that are known to have opened around the same time as the Ashio mine, but production amounts for them are not known (Sasaki 1983b, pp. 179–81). The second half of the 17th century saw more mines opening up and total production peaked in the early 18th century.

Figure 16: Copper production major mines



Sources: Ashio: (Murakami 2006, p. 628); Tada: (Kobata 1986, p. 242); Osarizawa: 1674-1685, 1765-1883: (Fumoto 1964, pp. 56–57, 436–39), 1686-1764: (Izawa 2013, p. 18); Ani: 1670-1700, 1811-1877: (Sasaki 1983b, p. 184), 1701-1810: (Izawa 2013, p. 18); Besshi: (Sumitomo Metal Mining Co. 1991, pp. 225–29); Ikuno: 1741-1784, 1789-1819:(Kobata 1956, p. 69; Kobata 1986, pp. 236–38), 1785-1788: interpolated, 1842-1843: (Shimada 2006, p. 48)

5.1.2 Copper import

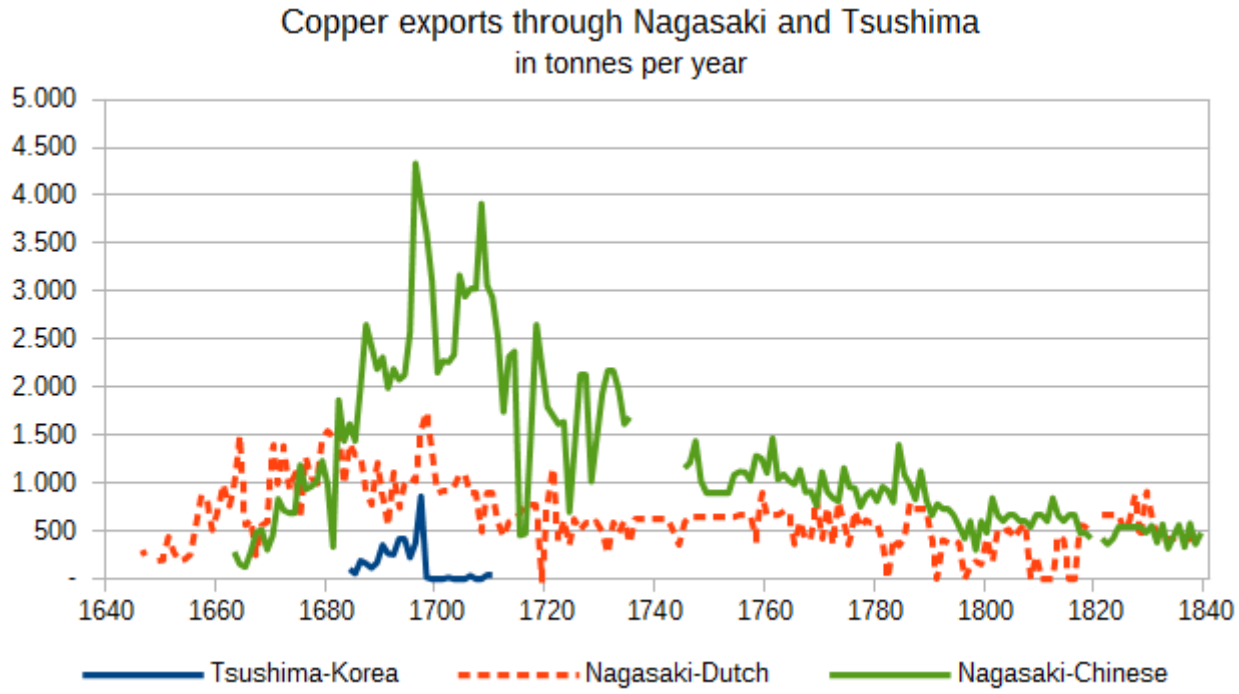
From the Heian (974-1185) through the sengoku (1476-1573) periods large amounts of Chinese copper coins flowed into Japan to serve as the country's money supply. Gradually Japanese imitations of these coins, called *bitasen*, came to replace the Chinese-made coins. By the late 16th century only “samples” were imported, to be used as a template for domestic mass production (Von Glahn 1996, pp. 89–95). Assuming copper imports had stopped by the beginning of the Tokugawa period, that leaves domestic production as the only supply for the period in review here.

5.2 Copper use

Data on the use of copper concerns mostly export. By far most of these exports were carried by the Dutch and Chinese traders at Nagasaki. During the early 17th century copper exports were sporadic and small in scale. From 1637 to 1646 exports stopped completely as copper output was reserved for the issue of new copper coins. As silver became increasingly scarce its export was restricted, most notably by a ban on the export of silver coins in 1668. Copper took over silver's position as export commodity and exports increased. In 1685 the value of total imports at Nagasaki were limited, with a ratio of roughly 2:1 to the Chinese and Dutch respectively. In practice his new policy held copper exports at a level of around 3000 – 3500 tonnes per year. From 1695 a barter trade was allowed on top of the official quota, in response to a petition from a Japanese trading house that evidently had an abundant supply of copper to sell. Copper exports quickly reached 6000 tonnes, but this level could not be sustained and two decades after its start the barter system became obsolete. The quotas were lowered to 2700 tonnes in 1715, and further reduced to under 1900 tonnes in 1746. However, in most years the shogunate could not provide enough supply to the Nagasaki traders to reach these limits (Gramlich-Oka 2008).

The export through the Tsushima domain to Korea also shows a peak at the end of the 17th century. The shogunal restrictions mentioned above did not apply to this part of Japan's foreign trade. However, a 1695 re-coinage, resulting in a silver coin of lower purity, hurt the desirability of Japanese silver coins for the Korean market. Immediately after the currency change Korean traders increased their copper imports, but they soon lost interest in the commodity (Innes 1980, pp. 599–601).

Figure 17: Export of copper from Nagasaki and through Tsushima



Sources: Tsushima: (Tashiro 1981, p. 274); Dutch: 1646-1649: (Glamann 1953, Table 1), 1650-1754, 1775-1777: (Shimada 2006, p. 198); 1755-1774, 1778-1839: (Katsu 1929, pp. 2–10); Chinese: 1650-1715:(Shimada 2006, p. 199); 1716-1754: (Gramlich-Oka 2008, p. 76); 1755-1839: (Katsu 1929, pp. 11–29)

5.3 Confronting copper supply and use

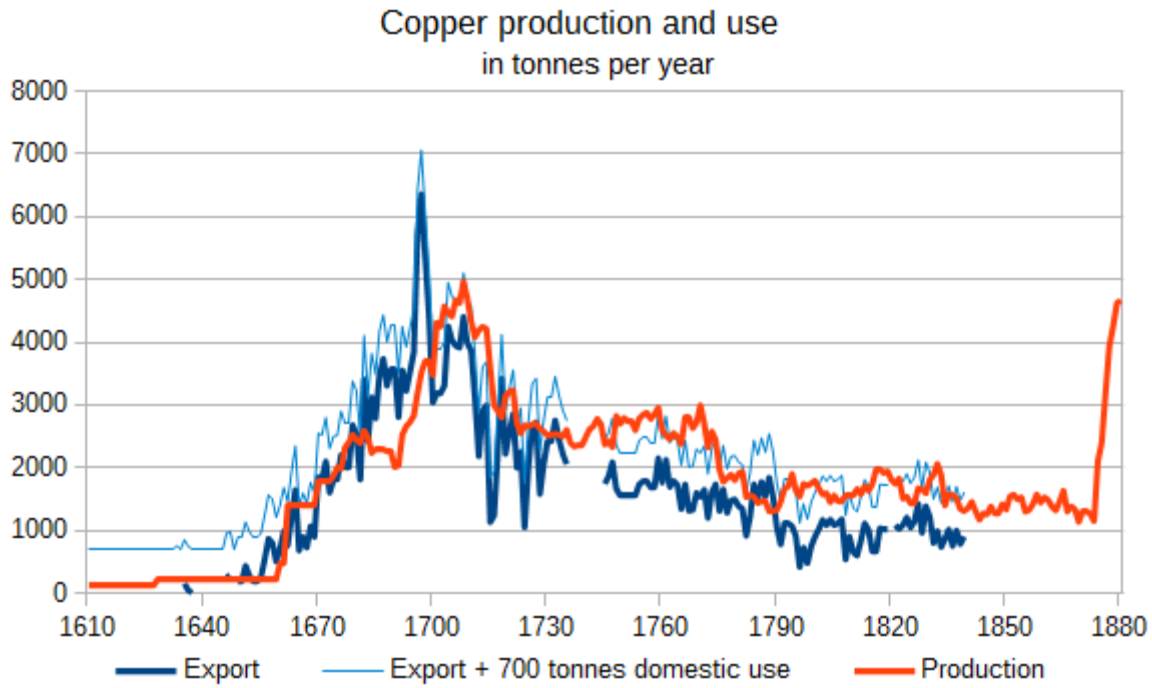
As in the case of silver, the supply and use sides of copper are confronted to determine the consistency of the data. Unlike for silver, there is no detailed information about the amount of copper used in coins. Fortunately there is a lengthy period for which relatively reliable data is available for both the production and export of copper to be confronted with each other.

As mentioned before, the only production information for the early Tokugawa period is on the Ashio mine. Production was almost certainly taking place at other locations as well, given the already-established copper coin manufacture and the opening of other mines around the same time as the Ashio mine. The fact that during the casting of the *Kanei tsūhō* coins from 1636 the export of copper was prohibited, suggests that domestic production at the time was large enough to allow for the making of the new coins, but not enough to permit exports at the same time. Unfortunately the size of the coin issue is unknown. A late Tokugawa period issue of copper coins (*Bunkyū Eihō*, 1863-1869) took roughly 10 000 tonnes of copper (Izawa 2013, p. 15). Given that in the early

Tokugawa period the population was smaller and the economy less monetised, the size of the Kanei coin emission was likely smaller, but perhaps still requiring some thousands of tonnes of copper.

In addition to the casting of coins, copper would have been used on the domestic market for utensils, religious statues, roof construction, etc. In the case of copper the allocation decision towards export or domestic was made by the bakufu. The copper for the two destinations was subsequently refined and cast to the appropriate specifications at the Osaka refineries. For 1708-1712 an average of 763 tonnes of copper per year was destined for the domestic market in this way (Gramlich-Oka 2008, p. 87). Since imports are assumed to be zero in the Tokugawa period, the domestic consumption plus export should in principle be equal to production. In Figure 18 the production and export series from the previous graphs are respectively added up and can be compared.

Figure 18: Production and use of copper



Sources: see Figure 16 and Figure 17, Production 1875-1880: (Shinohara 1972, Table 51).

From around 1650 export and production roughly keep pace with each other until the mid-1680's, when output at Osarizawa and Ashio stagnated and the Ani and Besshi mines had not yet reached a high level of output. Meanwhile, copper exports plateaued at a level higher than recorded production, bound by a value limit for total exports starting in 1685. After 1695, when barter trade

for copper was allowed, the difference between export and production grew even larger until exports dropped to a level below production from 1700. After that, production generally exceeded exports. Since in the long term production is expected to be higher than export, the reverse relationship between 1685 and 1700 is puzzling. Adding to this is the fact that in 1695 at least some trading houses had a surplus of copper, as evidenced by their petition to start the barter trade for copper. Assuming the export figures are correct, it is possible the production series is an underestimation. Not all mines are covered, possibly the biggest omission being the Tatsukawa mine, adjacent to Besshi. It opened in 1636 and in 1715, before being added to the Besshi mine, it had a production of over 400 tonnes (Innes 1980, p. 568; Sumitomo Metal Mining Co. 1991, p. 271).

The possible underestimation of production before 1700 does not even take account of domestic consumption. From 1700 to 1839, the final year of the exports series, the average surplus of production over exports amounted to 703 tonnes per year. Assuming domestic consumption was 700 tonnes per year, we can add that to the export figures to arrive at total use amounts. Looking at the total use series, the gap with production from 1685 to 1699 grows to nearly 2000 tonnes per year. Although not included in the review of production data of individual mines, two sources report national output in excess of the export figures in these years. In 1668 there was reportedly a peak output of 5400 tonnes (Sasaki 1983a, p. 181), and in 1685 total production was reportedly 5200 tonnes (Yoshiki 1980, p. 2). These estimates do not come with a breakdown of individual contributing mines, so it is not possible to say where the difference with the individual series total comes from. It is possible Tatsukawa had its peak output in these years and accounted for a substantial part of the missing output, but this is as yet unverified.

Given the possibility of underestimating the production before 1700, and the indication that there was excess supply, for these years the data on copper use seems more reliable than the data on copper production. After 1700 the production data seems more complete and forms a plausible total for export plus domestic use. Because of this, and the gaps in the export data in some of the later years, the production side data appears the best of the two after 1700.

6 Gold

The data available for the production of gold is much less broad than for silver and copper. Not only is the number of mines with production data much smaller, it also spans a shorter time period, and sources on the other elements of gold use and supply are much less developed. First the known

gold production will be presented, and subsequently the import and the use of gold will be discussed.

6.1 Gold supply

Gold mines had their period of high output around the same time as silver mines. In fact, some mines simultaneously produced both gold and silver in significant amounts. Sado island, already discussed in the silver chapter, was similarly prominent in Japanese gold production. The Sado mines were overseen by a governor on behalf of the bakufu. For most years Sado's actual production levels are unknown, but data on government royalties is known for many years. As discussed above, the government typically took between 25% - 50% of production. The revenues from the Sado mines for the 17th and early 18th century show an average of over 200 kilogrammes per year for the period 1615-1643, decreasing to an average of 90 kilogrammes per year until 1715 (Innes 1980, p. 557). Conservative production estimates – using 50% royalties – imply production of less than 200 kilogrammes in the low-output years and around 400 kilogrammes per year during the peak.

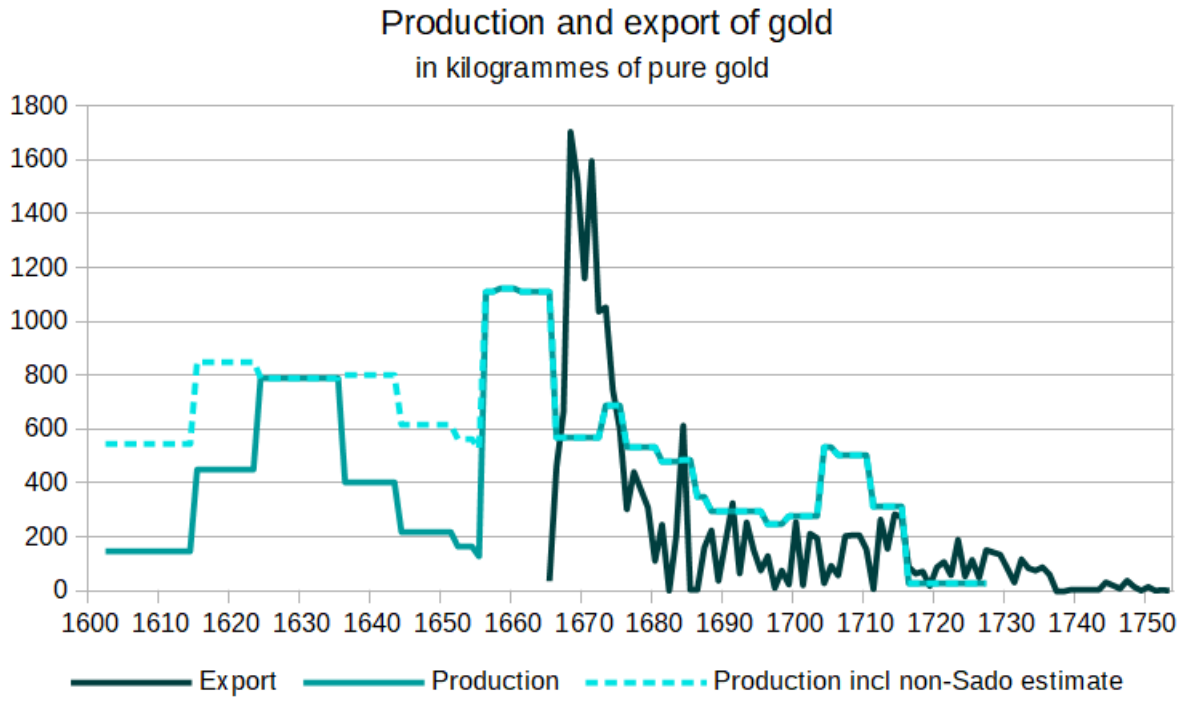
Besides the island of Sado the other important location of gold mining was in the southern part of Kyushu in the territory of Satsuma han (Kagoshima), including mines at Yamagano and Serikano. Yamagano was operated by Satsuma han and had a much more pronounced output fluctuation. For 10 years around 1660 the average production was almost 1000 kilogrammes of gold, after which an exponential decay set in, ending in a yearly production of a few dozen kilogrammes (Innes 1980, p. 566).

For a few years gold production figures are available for the whole country and a number of important mines. This data puts national output at just under 600 kilogrammes in 1597, and around 800 kilogrammes per year around 1630 (Takekoshi 1930a, pp. 416–17, 551–52). In these tallies the output from mines other than Sado was almost 450 kilogrammes in the former figure and just over 400 kilogrammes in the latter. In Figure 19 the national production estimate is presented, based on Sado royalty data,[33] Satsuma production data,[34] and total production data.[35] A second series is also presented, which includes an estimate of the non-Sado production for those years where there is only data for the Sado output. This non-Sado production is set at 400 kilogrammes, at the lower amount indicated by the national total of 1630. According to these estimates, aggregate output was

33 Up to 1715
34 From 1656 to 1727
35 For 1624-1635, 1699-1715

at a high point in the early 17th century, before being surpassed in the late 1650's when output at Yamagano peaked. After that output gradually decreased.

Figure 19: Production and export of gold



Sources: Export: (Gramlich-Oka 2008, p. 69); Production: Total 1624-1635:(Takekoshi 1930a, pp. 551–52), *Sado: (Innes 1980, p. 557; Takekoshi 1930b, p. 371), Satsuma:* (Innes 1980, p. 566; Takekoshi 1930b, pp. 230–31), *Other mines:*(Takekoshi 1930b, pp. 230–31, 371)*; 1602-1623, 1636-1655: Non-Sado production estimated at 400 tonnes.*

As was the case for the silver trade, in the second half of the Tokugawa period Japan changed from a net exporter to a net importer. Not many statistics are available on this point, but Japan reportedly imported nearly 750 kilogrammes of gold per year from 1763 to 1815 (Takekoshi 1930b, p. 406). In contrast to silver, this amount is relatively large compared to the historical gold production.

6.2 Gold use

Figure 19 also presents the amounts of gold exported during the middle of the Tokugawa period. These exports suddenly spiked after the ban on silver exports in 1668. As described in

Chapter 3 the shogunate tried to shift the export focus to gold coins for a short time. However, according to, this shift to gold exports took place just as gold production fell. The fact that the exported gold was in coin form tells us that the exports were likely not from concurrent production, but rather from an existing stock of gold. In the long term the gold output was not enough to pay for Japan's imports. Eventually copper emerged as the main export commodity.

In the case of gold, the amount contained in the currency supply was very large relative to yearly production. In 1695 gold coins in circulation amounted to 10.6 million ryō (Yamaguchi 1963). At a purity of 84.5% and a weight of slightly less than 18 grammes, these coins in total contained about 160 tonnes of pure gold. Given the highest known yearly production during the Tokugawa period of 1125 kilogrammes, this represents 142 years of peak level output. Comparing this to the silver in circulation, at 471 tonnes (see Table 15) this represents 5 years of peak output (as estimated in Figure 14). The relatively large amount of gold in the currency supply means that it is crucial to estimate the yearly change of gold in circulation in order to compare the supply and use of gold in the economy. However, similarly as for silver, information on the gold in circulation is only available for a few specific years, making it impossible to estimate yearly changes. Moreover, the money supply at the start of the Tokugawa period is unknown.

Lastly, the domestic use of gold for decoration was responsible for an unknown part of the total use of gold. Similar to silver, this application of gold possibly increased as the Tokugawa period wore on, however data on this use is not available.

When it comes to estimating the production of the gold mining sector, the confrontation of supply and use data does not give any opportunity to test the data accuracy. The peak in gold exports was likely from existing stock of gold coins instead of from contemporary production. Gold coins in general formed a relatively large stock of gold. Without estimates of the stock at the beginning of the period, nor of the yearly change in the stock, this creates uncertainty for the total amount of gold used. Other domestic use of gold is even more uncertain. As the total use of gold is unknown, it can not possibly be compared to production or supply. Therefore, the production data will be used without the benefit of a consistency check.

7 Significance of the Precious Metals Sector

In this section the significance of the precious metals mining sector will be shown by comparing the value of these activities with total GDP. Secondly, the importance of the sector will be discussed in terms of providing employment. And lastly the production volumes will be compared with the major international producers.

7.1 Value added

When studying modern economies one of the common ways to evaluate the importance of a certain sector is to look at its share in total Gross Domestic Product (GDP). For the Tokugawa period the GDP estimates I have been using in earlier chapters are based on output from farming, forestry and fishing, which formed the main part of GDP (Fukao et al. 2015, Table A1.10). This is combined with production in the other sectors of the economy, estimated indirectly by looking at the relationship with urbanisation and population density in the Meiji period. Regression analysis is used separately for the secondary and tertiary sectors to determine how output in these sectors changes with changes in population density and urbanisation (Saito and Takashima 2016, Table 3). The resulting coefficients were applied the to Tokugawa period using contemporary measures of urbanisation and population density. The idea behind this approach is that industry and services take place either in cities or in densely populated rural areas. The mining sector is not separately included in these estimates. However, it is included in the secondary sector estimates, which is correct in the sense that large mining operations tended to create substantial mining towns, which should be accounted for in the urbanisation rate. I have combined the primary sector estimates from Fukao et al. with the sectoral shares from Saito and Takashima to arrive at my GDP estimates. The Meiji period GDP, based on extensive source material such as the Long-Term Economic Statistics (LTES). The GDP estimates, provided at intervals of 10 to 50 years, have been linearly interpolated for this research to facilitate comparison with the mining output on a yearly basis (Fukao et al. 2015, Table 3.1).

With a GDP estimate in hand the remaining challenge lies in making the output of the precious metals mining sector comparable to these GDP series. By definition GDP measures the value added of industries. The value of intermediate goods and services should therefore be subtracted from the value of produced goods should. Mining is by its nature an activity that stands at the beginning of many production columns, which means the share of intermediate goods in the final production can be expected to be relatively small. However, there were some intermediate inputs used in the

mining and refining of precious metals, such as wood – both as fuel and for construction – and other metals, such as lead. The scarcity of data makes it problematic to construct detailed data on the value added share of production. The GDP shares calculated below therefore include supporting activities such as procuring wood and other metals.

The Japanese historical GDP series are expressed in terms of rice, since it was a major output of the Tokugawa economy, and it was used as a quasi money. In addition, because rice was such an important commodity, there are good historical price series for rice in terms of silver or gold. Therefore, the best way to compare the precious metals mining output to total GDP is to first convert it to units of rice. It can then be easily expressed as a percentage of GDP. In the next sections the output of silver, copper and gold will be converted to rice values and compared to total GDP.

7.1.1 Silver

The silver production estimate was presented in Chapter 4. As noted there, the estimated total is higher for the silver supply than for the silver use, especially for the later Tokugawa period. However, the use estimate does not include illicit trade and domestic use outside the money supply. For the important period of high production before 1695, supply was only 14% higher than use. In addition the production series better reflect the timing of economic activity in the silver mining sector. There was a possibly substantial delay between production and export, which fact is supported by the export peak taking place in a later period. Therefore, despite the better coverage of export data, the production series will be used for the GDP comparison. The series is extended to 1909 by using the LTES series, which provides silver production in weight as well as in yen. See Figure 14 for the sources.

The output is converted from kilogrammes of pure silver to *koku*[36] of rice by using yearly rice prices in silver monme. The monme was a unit of account representing 3.75 grammes of silver. The price series used are mainly from the Hiroshima rice market (Iwahashi 1981, p. 460; supplemented by Kin'yūkenkyūkai 1937, pp. 1-18). However, during the Tokugawa period the purity of this silver differed according to the currency in circulation, which the silver price has to be adjusted for. This is done by using information on issue and validity dates of silver currency (Nishikawa 2000, p. 8).[37]

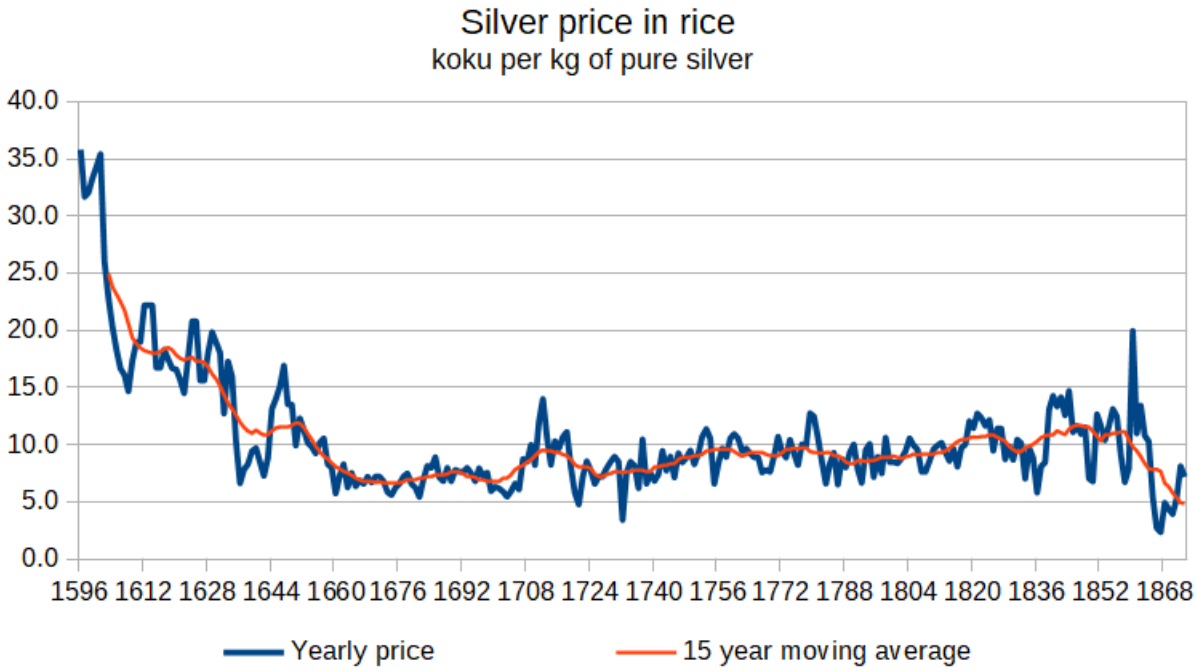
36 A koku is about 150 kilogrammes, considered at the time the amount of rice necessary to feed a person for one year.

37 The purity of silver currency is in principle adjusted starting from the year after a major issue of silver at a different purity level. Generally a change of purity meant a lower purity. Under Gresham's Law – bad money drives out good – the adjustment of prices should have been relatively quick. During the Tokugawa period the purity of silver was

The resulting price of pure silver expressed in koku of rice is presented in Figure 20. The value of a kilogramme of silver was over 30 koku around 1600, but it dropped to 16 koku by 1606. The silver value plateaued around that level until it fell to less than 10 koku per kilogramme in the 1630s. After a short rebound the value dropped to around 6 koku per kilogramme. In the long term, however, there was a rising trend starting in the early 18th century.

The falling value of silver is possibly a sign that the Japanese market became saturated with silver in the early Tokugawa period. The price fluctuations are of course equally a reflection of the value of rice as they are of silver. It should be noted that the turning point in the early 18th century takes place around a fundamental change in Japanese demography, when the country switched from a high population growth during the early Tokugawa period to virtual demographic stagnation. This could be an underlying process that explains part of the change in rice value. During the 17th century arable land and production per capita were falling, but from around 1720 arable land, land productivity and labour productivity started to increase (Fukao et al. 2015, p. 239; Miyamoto 2004b, p. 38). This fits the pattern of rice becoming gradually cheaper from that point on.

Figure 20: Silver value expressed in rice

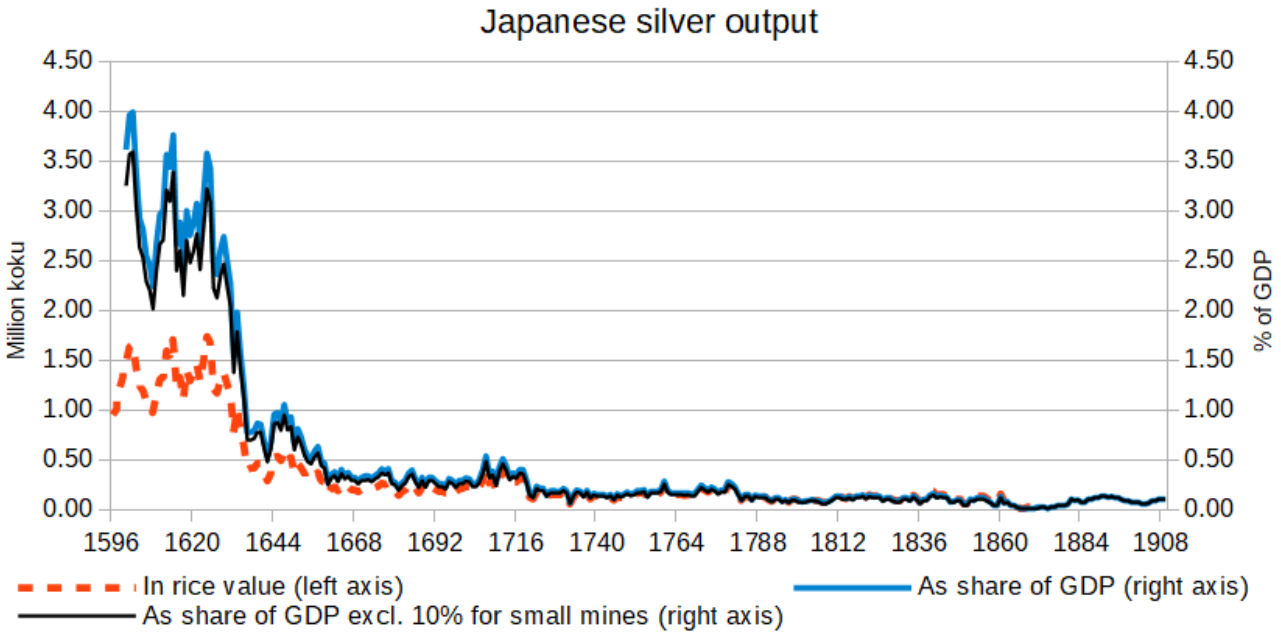


Sources: 1620-1858: Hiroshima rice prices (Iwahashi 1981, p. 460), 1596-1619, 1859-1873: (Kin'yūkenkyūkai 1937, pp. 1–18; 9 years linearly interpolated), silver coin purity: (Nishikawa 2000, p. 8)

increased only once, in the 1714 currency re-issue that raised it from 20% to 80%. The 20% silver was legal tender until 1719. For this case Gresham's law implies that people will hoard the good money and only spend the bad, and market prices would reflect that. In the case of rice prices they declined by 20% in the year following the issue of the new silver, but by 65% in the year the old silver left the market. Therefore the silver purity rate used in combination with the rice price is 20%, until 1719 when it is changed to 80%.

The silver price in rice is used to calculate the value of the total production of silver expressed in terms of koku of rice in Figure 21. The resulting series shows three peaks above 1.5 million koku. From the 1620's the silver output declined quickly and silver values fell further. By the end of the Tokugawa period the output was worth only 20 to 40 thousand koku. The next step is to calculate the rice value into a GDP percentage using an interpolation of the GDP series from (Fukao et al. 2015, Table A1.10). The series is extended after 1873 by using silver production value in yen from the LTES (Vol. 10, Shinohara 1972, Table 49), and GDP in yen from Fukao et al. (2015, Table 3.1). Expressed in terms of GDP the output started above 3%, but declined even faster than the rice value, due to the fact that GDP grew from 41 million koku in 1600 to 128 million koku in 1874. During the Meiji period silver output climbed to 128 tonnes in 1909, and to a temporary peak of 223 tonnes in 1917 (not shown in the graph) (Schmitz 1979, p. 149). Although the 1909 output was 34 tonnes higher that the Tokugawa peak, in the contemporary GDP this only made up 0.1%. As a reference, an additional GDP share series is given of the silver output estimate without the 10% supplement for small mines, i.e. just the output of the 4 large mines.

Figure 21: Japanese silver output converted to rice, GDP %



Sources: Production: See Figure 14, 1874-1909, production in yen: (Shinohara 1972, Table 49) silver/rice price series: See Figure 20; GDP: see text.

7.1.2 Copper

The best estimate of copper production uses both the supply and use sides from Figure 18. Given the export figures and estimated domestic consumption, the production series before 1700 is likely an underestimation, as discussed in Chapter 5. Therefore the total use of copper – export plus domestic consumption – is adopted to estimate 17th century production. From 1700 the production series is used.

To calculate the copper production share of GDP it is again necessary to express this production in terms of koku of rice. Compared to silver and gold, converting the copper output to a rice amount presents a bigger challenge, however. Rice prices in terms of copper are much less common. The prices that are available are given in *mon*, the unit of copper currency (see for instance Kin'yūkenkyūkai 1937, pp. 1-18). The problem with using this unit is that the purity of the copper coins – called *sen* – is not well recorded, and during the second half of the Tokugawa period there were even sen made entirely of lesser materials like iron. As a result the value of 'copper' coins seems to have been fluctuating more in concordance with the issue of the coins than with the supply and demand of the raw material (Takekoshi 1930b, p. 448).

It would perhaps be more appropriate to look at the price of copper that was traded as a commodity, instead of as a coin. This trade has been most extensively described in context of its export, but as explained in Chapter 2 the prices recorded in those exchanges were virtual prices, artificially lowered by the Nagasaki traders to keep total trade within the import value restrictions. The domestic price for bulk copper was substantially higher than the official export price (Gramlich-Oka 2008, p. 89; Shimada 2006, pp. 57–58). Domestic market prices for copper sold at the Osaka refineries were set by the bakufu. These consisted of the purchase price from the mine plus a fee for refining and other costs. These prices were given as an amount of silver monme per 100 *kin* (60 kg) of copper (Imai 1988, p. 55).

The purchase prices and domestic market prices for copper are available for certain years in the early and mid 18th century, see Table 19 in the appendix. In addition, for 1763 and 1764 there are both purchase and sale prices. In these two years the refinery margin came to around 35 monme per 60 kg of copper. This refinery margin can be used with purchase prices for 1766 – 1774 to estimate domestic sale prices for those years. According to these figures, the value of copper converted to silver climbed from just over 207 units of copper for each unit of silver in 1701, to a peak of 368 to 1 in 1717. After that the ratio dropped to 200-250 in the 1750's and to about 180 in the 1770s.

The domestic copper price expressed in silver can be used in combination with the rice price in silver to calculate a rice price in terms of copper. The results range from 30-40 koku per tonne of copper in the early 17th century to around 50 koku per tonne – with a wide margin – from 1751 to 1774. These years correspond respectively to periods of high and medium output. It is logical that the value of copper is lowest in the period of highest output, when the supply is large and the copper can be extracted with relatively little effort. After production fell below 2000 tonnes in 1775 prices could have risen above 50 koku per tonne. The copper production from Figure 18 (calculated from total use pre-1700) has been converted to a value in koku of rice using three price points based on domestic market prices. The series for prices of respectively 35, 50 and 70 koku of rice per tonne of copper are presented in Figure 22.

Using domestic bulk copper rates has a couple of arguments against it. First of all the years for which prices are available are limited. Secondly, copper exports outweighed domestic copper use by a factor of 2 to 1 during the Tokugawa period. Therefore, the price of copper on the international market might be more relevant. Compared to international rates copper was relatively cheap in Japan (or silver expensive) in those years for which prices are available. Let us first look at a few copper producing countries. In Norway the silver to copper price rate was 104 during 1718-1720, and it averaged about 114 in the second half of the 18th century. In the UK the ratio dropped from 126 in the 1770s to 87 in the 1790s, possibly influenced by a rising demand for copper due to the UK's involvement in the French revolutionary wars (based on, respectively, Norwegian and UK copper prices and European silver prices from Schmitz 1979, pp. 268, 269, 273, 289).

Prices in Amsterdam for Norwegian and Swedish copper are available for many years in the 17th, 18th and mid-19th centuries. Coupled with the silver content of the Dutch Guilder coin the copper to silver price ratio can be calculated for the Amsterdam market. Between 1600 and the 1860s the silver to copper price ratio fluctuated mostly between 80 and 100 to 1, making copper relatively expensive there compared to Norway and the UK. The average of the linearly interpolated series for the period after 1650 to the 1860's is 89.8 (Own calculations based on Posthumus 1946, Tables V, pp. 173, 174). Prices for Japanese copper sold by the VOC in Amsterdam are also available for certain years during the second half of the 17th century and the first half of the 18th century. During 1689-1712 these prices resulted in an average silver to Japanese copper price ratio of 90.8. In the same years the Scandinavian copper had a ratio of 88.0 meaning Japanese copper was slightly cheaper (Glamann 1981, Table V).

Within Europe copper was slightly more expensive in Amsterdam than other markets, like Norway which was a producer country. A balance between prices in copper producing and non-

producing countries leads to a silver to copper value rate of in the neighbourhood of 100 for the 17th to mid-19th centuries. This rate can be used to convert the copper production into silver amounts. Through the rice price in units of silver this can in turn be converted to rice amounts. In effect this is the same as using the series of Figure 20 divided by 100 as the copper price. The result is presented in Figure 22, both for the original and a 15 year average. The running average is added to smooth out some of the extreme fluctuations found in the silver rice price. As explained above, the purity of silver in circulation changed periodically, and although it has been corrected for, the process is only an approximation. In the case of copper the period of highest output coincides with a period of big changes to the silver purity (from 64% down to 20% and back up to 80% between 1695 and 1714). In addition there was a famine in 1714 that drove rice prices up sharply (Miyamoto 2004b, p. 61).

What is left is to make a choice of which price series to use. During the peak copper production years the international price series yield a similar amount of rice as the higher domestic price series of 70 koku per tonne. This is not unexpected, as international prices tend to be higher than the prices in producing countries. In Japan the restrictions on copper exports would have meant a possible oversupply of copper, which would have resulted in very low prices. In the second half of the Tokugawa period the price of rice falls, which is reflected in the international series as a rise in the price of copper. This change is not reflected in the domestic rates, as they are fixed at the same price. Due to these circumstances, the international price 15 year running average will be used to convert the copper production value into rice.

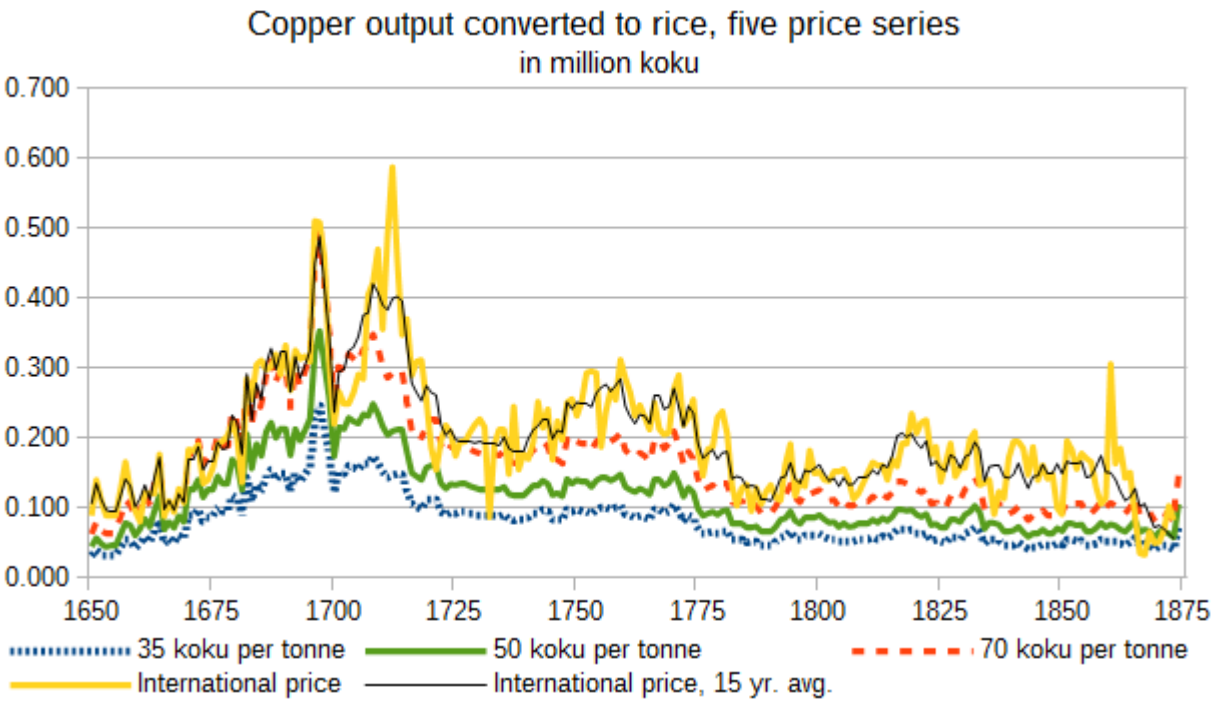
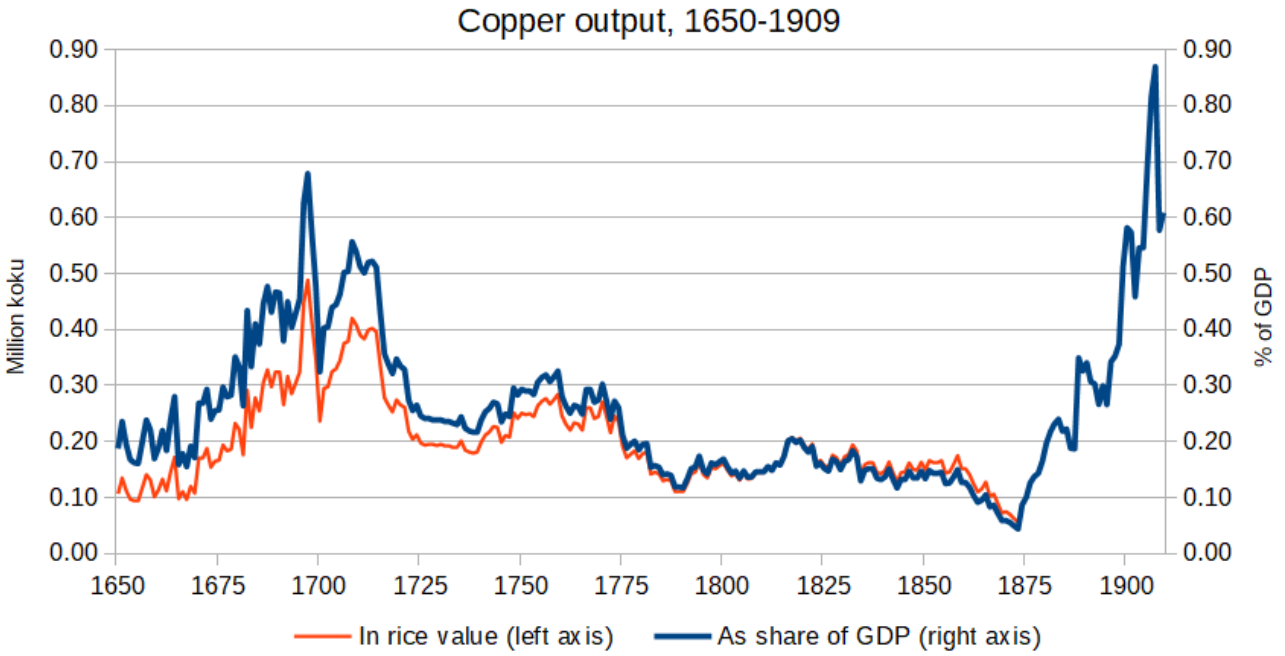


Figure 22: Copper output converted to rice by five price series
Sources: see text

The copper output in terms of rice is converted to a GDP percentage using the same interpolated GDP as described for the silver production. The production after 1873 is again a yen value taken from the LTES (Vol. 10, Shinohara 1972, Table 49). In comparison with silver, the copper output made up a smaller part of GDP, see Figure 23. Starting off around 0.2% of GDP, copper output rose relatively quickly to 0.4% and attained a short-lived peak at 0.6% around 1700. From 1725 production stabilised around 0.25% before dropping to a level of about 0.15% at the end of the 18th century. During the Meiji period, however, copper became a more important sector in the economy, almost reaching 0.9% of GDP in in 1907. Price changes diminished the GDP share again in 1908.

Figure 23: Copper output in terms of rice and GDP %



Sources: 1610-1873: see text, 1874-1909 production value: (Shinohara 1972, Table 49)

7.1.3 Gold

For gold the same procedure will be followed as above. Production is taken from Figure 19 for 1602 to 1727. This is converted to rice amounts using the available market rates for rice in ryō, a gold coin of a set weight. Similar to the silver currency, these gold coins were of different purity levels, depending on the period (Miyamoto 2004b, pp. 60, 61). This has been corrected for, to arrive at the value of a kg of pure gold expressed in koku of rice, see Figure 24. Using this rate the output of gold in a rice equivalent value is calculated and presented in Figure 25. Two variants are shown here, one with the amount added for missing data on mines other than Sado in certain years. The other series does not include this imputation. Both series are further used to calculate a GDP share for the gold production, using the same reference GDP as above. The GDP share was highest in the first few decades of the 17th century, peaking a little below 0.4% of GDP. The GDP share fell during the course of the 17th century until recorded output reached zero early in the 18th century.

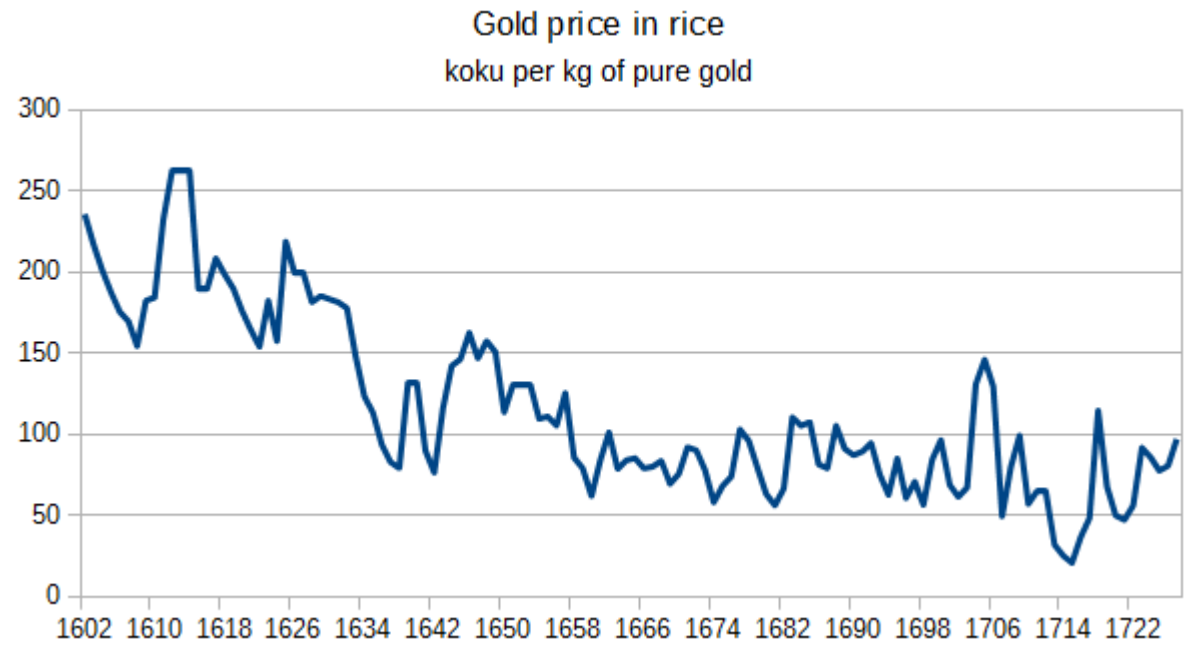
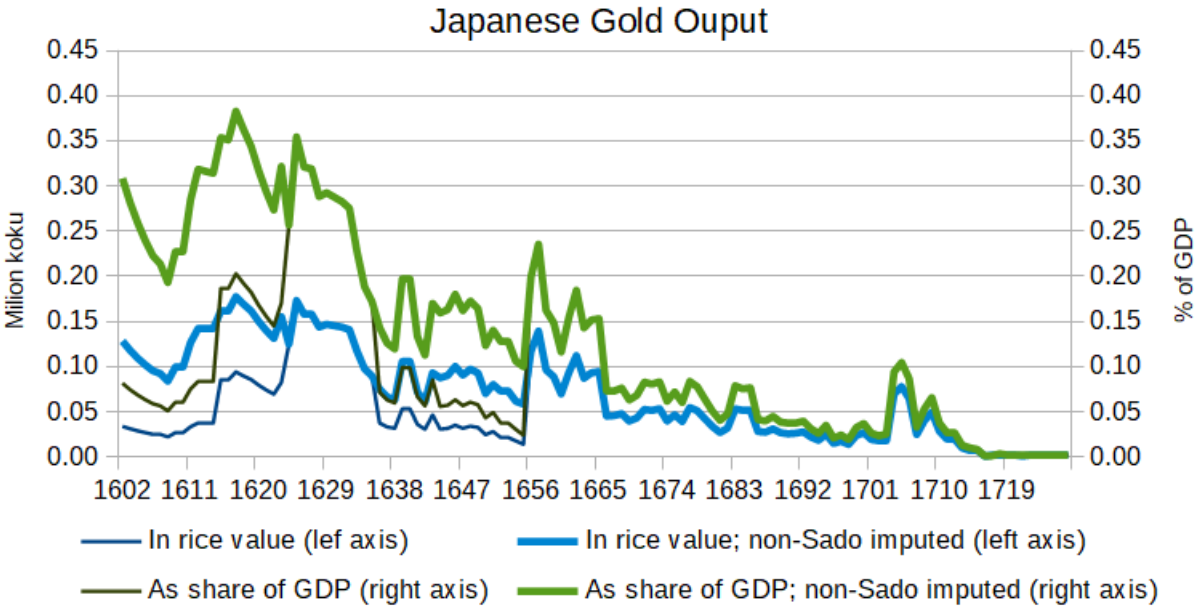


Figure 24: Gold value expressed in rice
Sources: Rice prices in ryō: (Kin'yūkenkyūkai 1937, pp. 1-18, 6 years interpolated), *Gold coin purity: (Miyamoto 2004b, pp. 60, 61)*

Figure 25: Gold output in terms of rice and GDP %



Sources: See Figure 19, GDP: (Fukao et al. 2015, Table A1.10)

7.1.4 Composite GDP share

Gathering the GDP shares for the three precious metals gives an overall picture of the importance of the these activities in the Tokugawa economy. Another point of interest is how these activities compared to the mining activities of the Meiji period. To that end, the GDP shares of coal

mining and other mining activities are included from 1874. Figure 26 underscores the extent of the silver boom during the first half of the 17th century. At roughly 3% of GDP at its peak it was 6 times the size of the copper boom as a percentage of total economic activity. Gold production was the smallest sector of the three in terms of share of the economy. The fact that copper was able to fulfil a similar export role as silver, despite its smaller GDP share, is due to a number of factors. Silver had its peak at a time when it was relatively expensive in terms of rice, while copper had its peak when rice was relatively expensive in Japan (see Figure 20). Secondly, the size of the total economy had grown substantially in the time between peak silver production and peak copper production. In 1700 GDP was 78% larger than in 1600 (Fukao et al. 2015, Table A1.10). Another factor is the increasing self-sustainability of the Japanese economy by import substitution, which relieved pressure from the export commodities.

Another interesting point is the comparison between the early Tokugawa mining peak and with the Meiji period mining peak. After the start of the Meiji period mining was one of the booming sectors. By 1909 the entire mining sector made up 2.6% of GDP, a smaller share than silver mining had by itself during its peak. However, the Meiji economy by 1909 was a much more industrialised economy. In the post-Tokugawa mining sector the dominant commodity was coal, followed by copper. Demand for Japanese coal by foreign powers was one of the factors that led to the opening up of the country, as mentioned in Chapter 3, so it is not surprising this sector would grow quickly. A detailed account of late Tokugawa period coal production is lacking, but coal output grew from a reported 1.4 million tonnes in the 1820's to 5.7 million tonnes in 1875 (Murakushi 1980, p. 7; Shinohara 1972, Table 51). By that later period it made up 0.25% of GDP. It is likely that the coal sector's share of GDP began to rival those of silver and copper sometime around the middle of the 19th century. Of the three metals that are the main focus of this paper, copper is the only one that during the Meiji period surpassed its Tokugawa period peak GDP share. By 1909 copper output volume was at 6.5 times its previous peak, while by the same measure silver production increased only 1.4 times and gold 3.5.

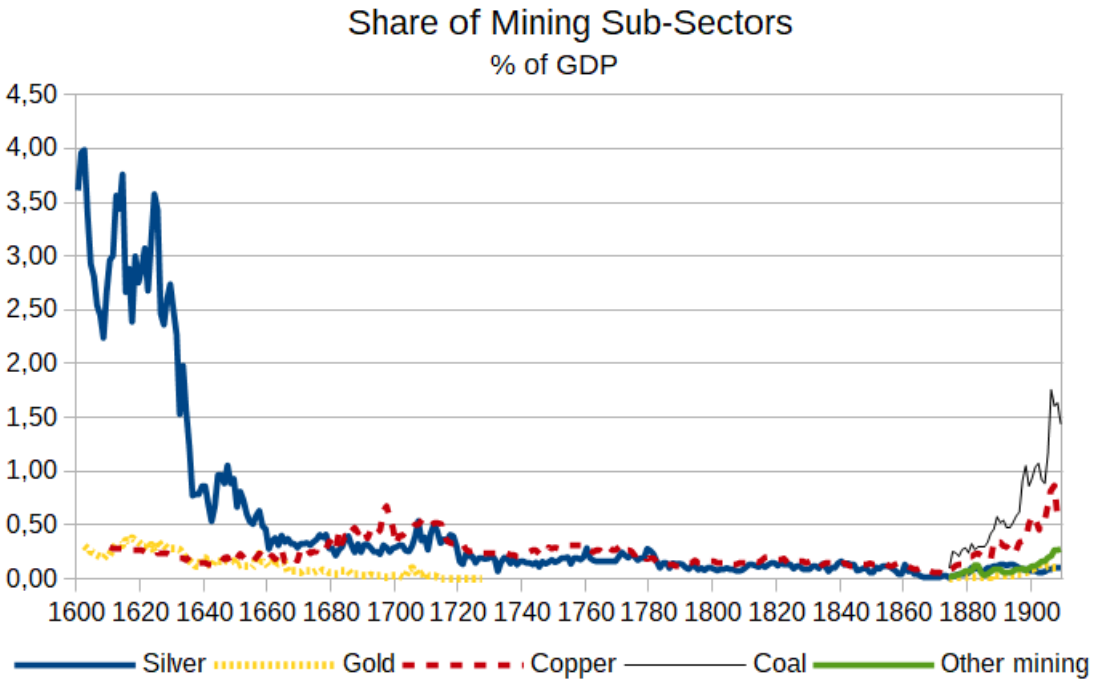


Figure 26: Share of mining sub-sectors in GDP

Sources: 1600-1873: see Figure 25, Figure 23 and Figure 21; 1874-1910: Mining output: (LTES Vol 10, 1972, Table 49), GDP: (Fukao et al. 2015, Table 3.1).

It seems obvious that the regime change from Tokugawa to Meiji was the cause for the sudden growth in mining output, with international trade policy a prime suspect for the main catalyst. The exact causal chain is less obvious however. As stated above, exports of precious metals were by the late Tokugawa period not only hampered by trade restrictions and import substitution, the production capacity was also lacking. How then would the trade regulations have influenced production capacity?

There are parallels with the ascendency of Japan as a producer of precious metals in the 16th century. That blossoming of precious metals production was relatively near in time to the first contact with Portuguese traders and exchanges with Korean specialists that brought new refining techniques. Subsequently, silver and gold output increased, as did the attraction of Japan as a trade partner. It is easy to see how a virtuous cycle could set in where trade fosters sharing and advancement of technology, which increases production, which stimulates trade, in turn advancing technologies, and so on. From the 1630s, while the value of Japanese exports was not necessarily reduced, the number of contacts with the rest of the world was curtailed however. This hampered the sharing of technology and possibly slowed down this virtuous cycle. During the Meiji period the

cycle would have regained momentum with the opening up of Japan to more trade partners, and boosted by hiring foreign engineers.

7.2 Employment

Besides the value of the output, from a socio-economic perspective it can be illustrative to look at the jobs the precious metal mining sector provided. Additionally, the information can be used to calculate production per worker, to give some sense of the consistency and plausibility of the production figures. The information on the number of workers is quite scant, however, therefore only a broad impression can be given.

The mining sector of Tokugawa Japan employed a large number of workers, possibly upwards of 100 000 people. Total population at large mining towns during the silver peak in 1620 has been estimated at 180 000 (Innes 1980, pp. 569–71). Given that total urban population increased from 1 to 3 million in these years, the mining towns would have made up a significant part of the city population (Bassino et al. 2015, p. 28). Assuming that one third to half of the mining town population was employed in the mines and smelters, this would mean 60 000 – 90 000 people were directly employed in the mining sector. Adding employment at smaller mines, the total workforce could have been 100 000 or more. In the middle of the 17th century the workforce would have shrunk as gold and silver production decreased. As copper production increased, employment would have shifted to his sector. Between 1670 and 1715 employment in the copper sector, including in the Osaka refineries, was an estimated 30 000 – 50 000 workers. The gold and silver sectors might have employed another 25 000 – 30 000 workers (Innes 1980, pp. 569–71).

At a national population of 17 million in 1600 and 21.8 million in 1650, 100 000 mining workers would have made up about 0.5% of the total population in the first half of the 17th century (Fukao et al. 2015, Table A1.2). In the total working population, on which there is no estimate available, the silver workers would have constituted a larger part. Together they produced around 3% of GDP at the peak, or 15 koku of rice per worker. Compared to national income per capita of 2.6 – 2.7 koku this is relatively high, but not implausibly so (Fukao et al. 2015, Table A1.10). First of all, national income per worker would be slightly higher than per capita income. Secondly, in the years of high production only an estimated 50% of the value of the mining output was used to pay for the mining costs. Additionally, the output would had to pay for certain inputs, like wood and charcoal. It follows that the final compensation per worker would have been only a fraction of that 15 koku, probably 5 koku or less. Given that this was the figure at the peak of the silver boom, it is not unlikely that compensation would have dropped in the later periods.

The copper sector workers would have made up 0.11% to 0.18% of the 28.1 million total population in 1700 (Fukao et al. 2015, Table A1.2). Again, as a share of the working population the percentage would be slightly higher. Copper production was on average 0.45% of GDP during the 30-year span surrounding 1700. This represents about 8 koku per worker, compared to national income per capita of 2.7 koku (Fukao et al. 2015, Table A1.10). The bakufu did not take a share of the output of copper, but set a price at which copper was bought from the mines. The Osaka refineries also received a compensation and separate prices were in effect for the domestic and export trade. Due to this complicated and non-transparent system it is difficult to assess who ended up with which share of the income from copper. It is safe to say, however, that a worker ended up with substantially less than 8 koku per year.

Besides the direct employment in the mining sector, the trade in precious metals facilitated additional jobs. The traders in Nagasaki for instance, were dependent on silver, copper and gold as the main export products. This trade in turn supplied the Japanese silk weaving industry with raw materials, at least until import substitution took place. At the end of the 17th century the silk industry supported around 70 thousand people (Innes 1980, p. 10). Precious metals were of course also used in the domestic market. The size and exact make-up of this market is uncertain, but it would have provided jobs in fields such as minting, copper roofing and other metal crafts. H. Burger, a contemporary Dutch observer, who made a trip from Nagasaki to Edo (present-day Tokyo) in 1826, mentioned in particular the widespread and skilful copper craft that provided many people with a relatively good income (Burger 1836, p. 4).

7.3 International comparison

Judging the relative importance of the metal mining activities in Tokugawa Japan can be done not just by comparing it with the rest of the economy, but also with the rest of the world. In this section Japanese output of silver, copper and gold will be compared with the output volumes of prominent producing countries for each commodity. Most data are taken from Schmitz' (1979) *World non-ferrous metal production and prices, 1700-1976*, supplemented with additional sources.

7.3.1 Silver

International silver output before the 18th century is based on *Summarized data of silver production* by Merrill (1930). He estimated Japanese silver production by looking at exports by

Dutch, Portuguese and English traders – not including Chinese traders. By this method he arrives at an estimate of 2 tonnes per year for the 17th century, less than half the estimate used in this paper (Merrill 1930, p. 51). The three largest producers during this period were all Spanish possessions. Among them, Bolivia had the highest output, reaching over 200 tonnes per year from 1601 to 1620 (see Figure 27). In comparison, Japan during the 20 years around its peak (1611-1630) produced 77 tonnes of silver per year on average. Even by Merrill's underestimated output, Japan was the fourth-largest silver producer during the 17th century. Using the estimates from this paper, Japan might have held on to that ranking for the 18th century as well, although Mexico was by then a very dominant producer with an output of 500 tonnes per year. During the 19th century The United States achieved production on a similar scale as Mexico. After the Meiji period Japan quickly increased production and surpassed the previous peak, reaching 2%-3% of total world output by the 1910's.

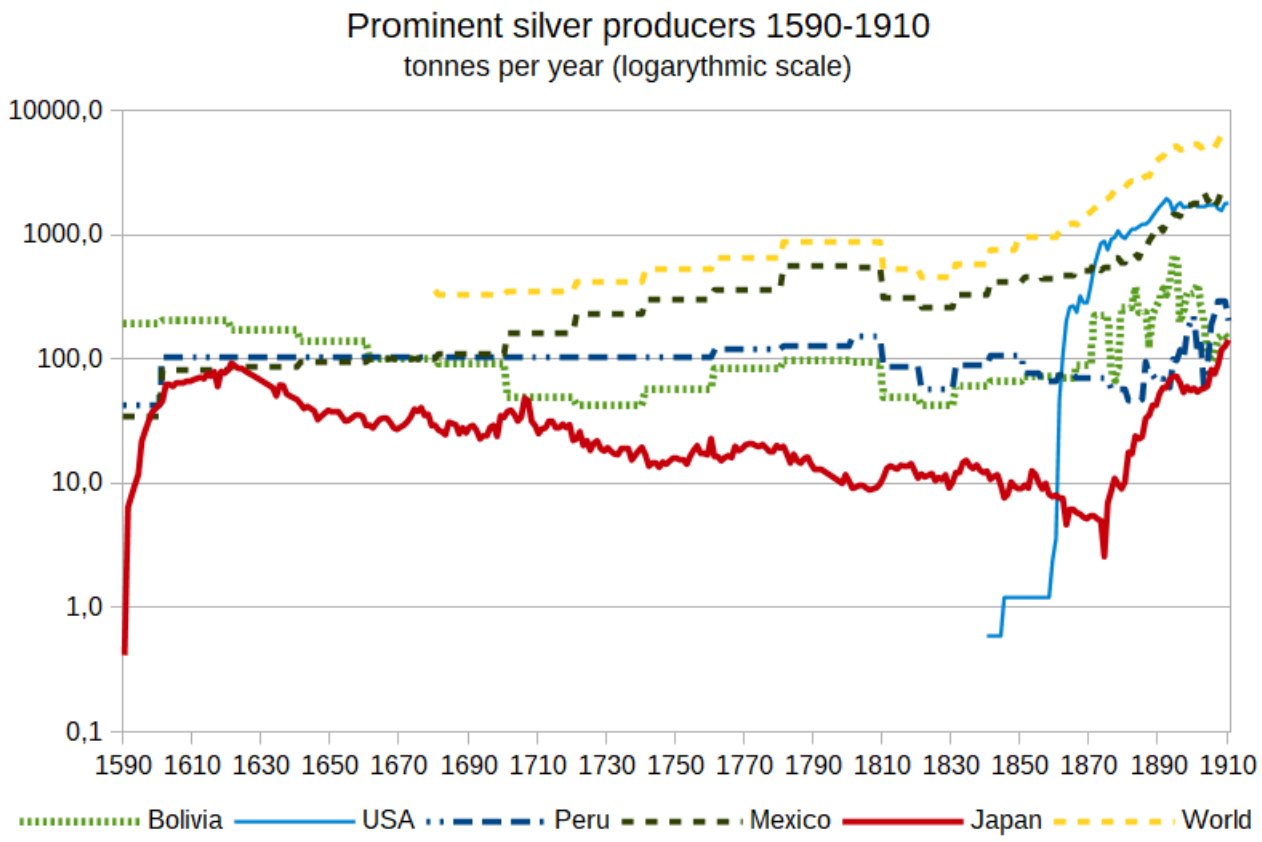


Figure 27: Prominent early modern silver producers
Sources: Japan: 1590-1873: See Figure 14, 1874-1910: (Shinohara 1972, Table 51), others: (Schmitz 1979, pp. 143–59; Merrill 1930, pp. 29, 36, 40)

7.3.2 Copper

Copper output is less well described than both silver or gold, possibly due to its not being traditionally counted as a precious metal. For instance, for the period before 1800 Schmitz lacks the data for Japan, Sweden and China. He reports world data from 1726, but at a level lower than the Japanese output estimated in this paper. From 1801 Schmitz' world output seems to match the rest of the data much better (Schmitz 1979, 66–78). The pre-19th century discrepancy underscores the lack of aggregated historical data on this topic.

The first big copper source for which detailed production data is available is the Falun mine in Sweden. By the estimates in this paper Japanese copper output surpassed it around 1670, becoming the world's largest copper producing country. Japanese output was suddenly overtaken by China, which reached 6000 tonnes per year around 1740. Output grew to around 7000 tonnes per year, but it is unclear exactly how long this was maintained. Next the UK, as the first industrialised country, took China's crown in the early 19th century. The UK in its turn was overshadowed by Chile and later the United States. After the end of the Tokugawa period Japan rapidly increased its copper production, growing from around 1% of world output to over 6% in 1890. From that date to 1910, despite still growing strongly, Japanese output growth was barely enough to keep up with world output growth (Schmitz 1979, pp. 66–69).

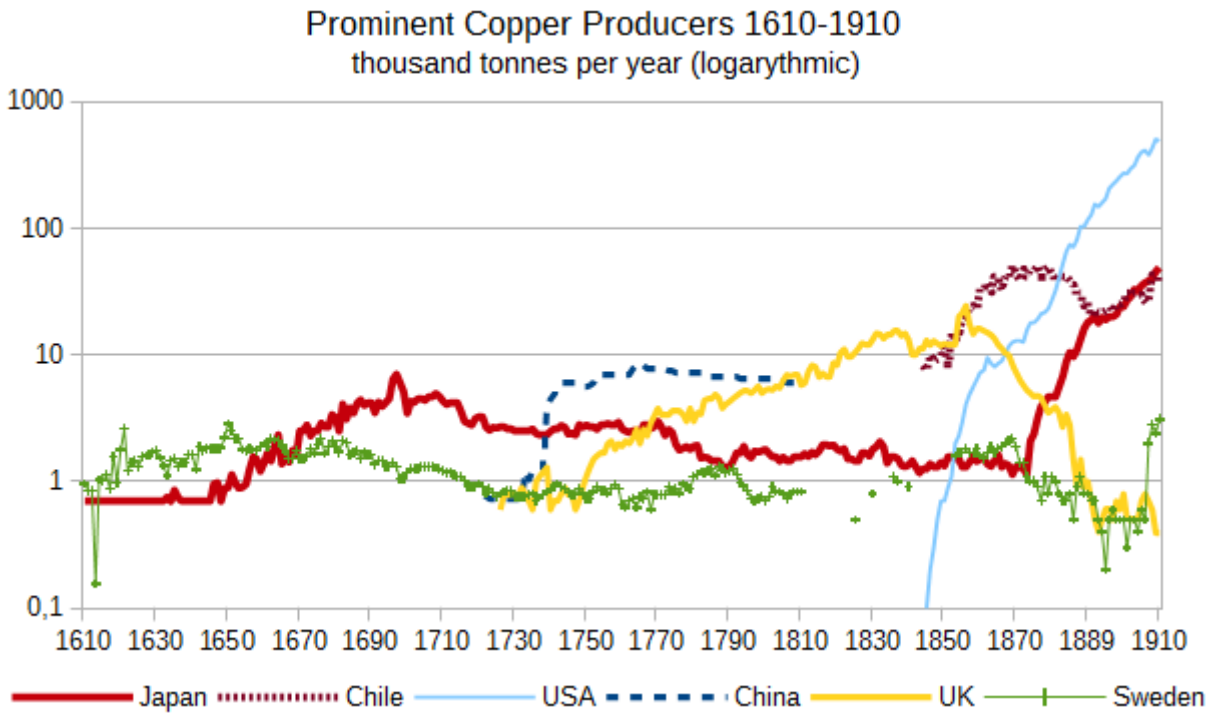


Figure 28: Prominent early modern copper producers
Sources: Japan: 1610-1873: See Figure 16 and Figure 17, 1874-1910: (Shinohara 1972, Table 51), China: (Izawa 2013, p. 16), UK: 1790-1793: (Izawa 2013, p. 16), 1726-1789, 1794-1910: (Schmitz

1979, pp. 61–78) Sweden: 1610-1810: (Izawa 2013, p. 16), 1825-1910: (Schmitz 1979, pp. 61–78) others: (Schmitz 1979, pp. 61–78)

7.3.3 Gold

According to the available information, gold production was dominated by Columbia and Brazil during the 17th and 18th centuries. During most of the 17th century Japan was likely the second or third largest producer, beating out Mexico and Peru. At its peak Japanese production might have been over 10% of world production, although world output for that period is highly speculative. During the 19th century Russia, the United States, Australia (not depicted) and South Africa successively became the world's largest producer. When Japan started producing gold again in appreciable amounts, output grew steadily to over 1% of world output in the 1910's (Ridgway 1929, p. 48).

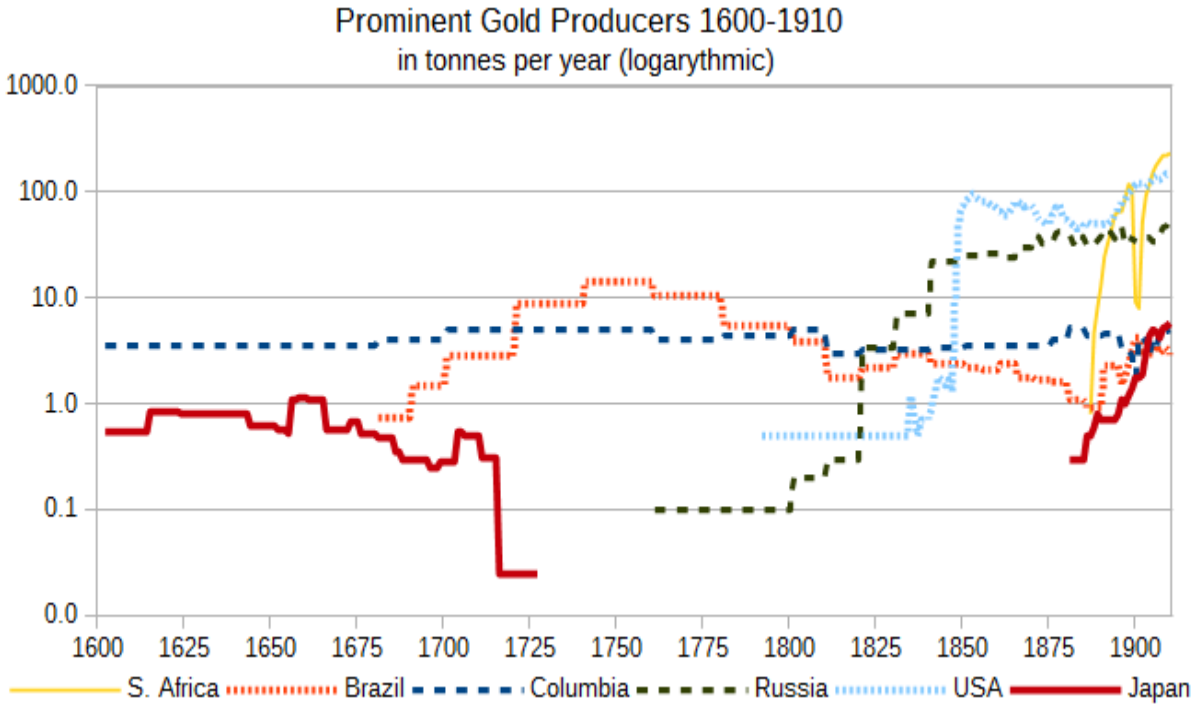


Figure 29: Prominent early modern gold producers
Sources: Japan: 1602-1727: see Figure 19, 1874-1910: (Shinohara 1972, Table 51), others: (Schmitz 1979, pp. 79–91; Ridgway 1929, pp. 34, 36)

8 Conclusion

The main goal of this chapter is to provide a comprehensive account of the production and economic importance of the precious metals mining sector in Early Modern Japan. Results based on interpolation show that silver production probably peaked around 1630, estimated at over 90 tonnes per year. Trade data corroborates production levels of this order of magnitude, in contrast to much higher trade figures suggested by Iwao (1966), Kobata (1965), Yamamura & Kamiki (1983), Shimbo and Hasegawa (2004) and others. Since these studies are often quoted, also in recent works such as by Osamu Saito (2016) (in Baten 2016) it is important to open discussion on this topic. In my opinion the works above likely contain overestimations, due to the use of data from unrepresentative years. The higher values have been used to estimate a peak silver export value equal to 10% of agricultural output. This study finds that the peak value of silver production was equal to about 3% of GDP and falling quickly after 1630. Gold production peaked around he same time at an estimated value of about 0.35% of GDP. Copper production grew to an estimated peak of about 0.5% of GDP around the year 1700. The outcomes of this study are consistent with both the available supply side and the use side data. However, the domestic use of precious metals – especially outside the money supply – is a matter that is very much underexposed and could benefit from further study.

Compared to other production regions around the world, in its peak years the Japanese silver and copper mines were among the biggest producers in the world. Silver output was comparable to the main production centres in the Americas, and Japan lead the world in copper output for a time.

The production and subsequent trade in precious metals was heavily influenced by trade policy. In contrast to the word 'sakoku', usually used to describe Japanese international policy, Japan was not entirely closed off. Moreover, trade policy and the size and composition of imports and exports changed significantly over time. Previous work by Innes (1980) shows that for the first half of the Tokugawa period total foreign trade did not markedly decrease after the restriction of Nagasaki trade to the Chinese and Dutch. The precious metals production share of GDP did, however, show a sharp decrease after the 1630s, and copper mining did not achieve anywhere near the GDP share that silver mining had. Several circumstances worked together to cause this divergent development of foreign trade and mining GDP share. Partly this is a price effect caused by the early 17th century decreasing value of precious metals versus rice, which was the main agricultural product and the

measurement unit used for GDP. In addition, the Japanese GDP grew by 69% between 1600 and 1700 (Fukao et al. 2015, p. 246).

Confrontation of supply and use side data also shows that there was often a delay between the production and export of precious metals, especially in the case of silver and gold. Production of silver peaked in the early 1620s, while exports peaked in the late 1630s and again around 1660. Copper on the other hand, had a more direct connection from mine to export. This combination of a delay in silver export, a short period of gold exports, and a relatively quick pick-up of copper exports, partly insulated total export values from supply shocks. This is another reason why foreign trade was sustained at a high level throughout the 17th and early 18th centuries. From the 18th century new export quotas reduced the export of copper, although over time supply failed to meet even these lower maximum amounts. This coincided with an increase in import substitution, first of silk and later of sugar.

In the early Meiji period the mining industry experienced a boom. This was most pronounced for copper and coal, but silver and gold output also surpassed their Tokugawa period peaks. This boom period seems a response to the opening up of the country. The sakoku trade restrictions primarily reduced the number of trade partners. Although volume or value restrictions were in place at times, these were frequently higher than production capacity. Consequently, the process through which the opening of the country would have stimulated the growth of mining production is more likely to be related to the increase in number of trade partners than a relaxation in trade volume restrictions.

Appendix to Chapter 4

Table 17: Silver royalty estimates under assumption of 3-stage development

Mine/Stage	Type of change	Period	Royalty level at end of period	Observation
Sado				
Boom	Exponential growth	1614-1621	23 865	Royalty payment
Decline	Exponential decay	1622-1647	4 292	Royalty payment
Tail	Linear decay	1648-1867	349	Royalty payment
Ōmori				
Boom	Exponential growth	1589-1596	13 500	Royalty payment
Decline	Exponential decay	1597-1673	387	Production level
Tail	Linear decline	1674-1857	40	Production level
Ikuno				
Boom	Exponential growth	1591-1598	10 040	Royalty payment
Decline	Exponential decay	1599-1632	1 806	
Tail	Linear decline	1633-1863	617	Royalty payment*
Innai				
Boom	Exponential growth	1605-1612	10 040	
Decline	Exponential decay	1613-1638	1 806	
Tail	Linear decline	1639-1875	296	Production level

*Average of final two observations

Table 18: Estimation model for silver royalty and production development

The following equations describe the model for development of royalty payments for each mine:

Sado: Y_{peak} = 23 865 kg

Boom (t=0;7): $Y_t = 0.15604 * Y_{peak} * (1+0.30392)^t$ (2)

Decline (t=8;33): $Y_t = Y_{peak} * (1-0.06386)^{t-7}$ (3)

Tail (t=34;253): $Y_t = 0.17984 * Y_{peak} * (1-0.00418 * (t-33))$ (4)

Ōmori: Y_{peak} = 13 500

Boom (t=0;7): $Y_t = 0.15604 * Y_{peak} * (1+0.30392)^t$ (5)

Decline (t=8;84): $Y_t = Y_{peak} * (1-0.04509)^{t-7}$ (6)

Tail (t=85;268): $Y_t = 0.02865 * Y_{peak} * (1-0.00487 * (t-84))$ (7)

Ikuno: Y_{peak} = 10 040

Boom (t=0;7): $Y_t = 0.15604 * Y_{peak} * (1+0.30392)^t$ (8)

Decline (t=8;33): $Y_t = Y_{peak} * (1-0.06386)^{t-7}$ (9)

Tail (t=34;272): $Y_t = 0.17984 * Y_{peak} * (1-0.00276 * (t-33))$ (10)

Innai: Y_{peak} = 10 040

Boom (t=0;7): $Y_t = 0.15604 * Y_{peak} * (1+0.30392)^t$ (11)

Decline (t=8;33): $Y_t = Y_{peak} * (1-0.06386)^{t-7}$ (12)

Tail (t=34;270): $Y_t = 0.17984 * Y_{peak} * (1-0.00353 * (t-33))$ (13)

Royalty/Production relationship:

Royalty share of production in period t: $R_t = 0.25 + 0.25 * Y_t / Y_{peak}$ (14)

Table 19: Copper domestic bulk prices

Year	Purchase price monme/60 kg	Costs monme/60 kg	Domestic sale price monme/60 kg	Copper/ silver ratio	Koku rice per tonne copper
1701			121	206.6	29.8
1708			103.5 – 136	267.2	31.8
1709			101 – 136	270.0	37.0
1710			104.6 – 132.8	269.6	30.4
1711			121.3 – 194.4	316.8	37.9
1712			191.5 – 251.5	361.2	38.8
1717			195 – 240	367.8	29.0
1718	175 – 268	24 – 37	212 – 295.6	315.2	35.3
1738			270	128.8	51.0
1751			130 – 145	253.0	36.4
1752			130 – 146	252.0	42.6
1753			139 – 145	244.9	46.4
1754			143 – 197	204.6	51.5
1755			150 – 176	213.4	30.8
1756			153 – 164	219.4	37.7
1757			150 – 160	224.4	43.1
1758			150 – 153	229.6	38.8
1759			150 – 194	202.2	52.1
1760			160 – 195	196.0	55.8
1761			190 – 240	161.8	65.2
1762			194 – 248	157.4	59.9
1763	165 – 259		233 – 258	141.7	68.2
1764	209.5 – 234.5		242 – 276	134.3	68.7
1766	160.8	35	195.8	177.6	50.2
1767	158.4	35	193.4	179.9	42.1
1768	160.4	35	195.4	178.0	43.7
1769	159.5	35	194.5	178.8	42.7
1770	158.5	35	193.5	179.7	50.1
1771	157.8	35	192.8	180.4	59.3
1772	156.6	35	191.6	181.6	51.7
1773	159.1	35	194.1	179.2	49.5
1774	152.6	35	187.6	185.4	56.2

Sources: (Gramlich-Oka 2008, p. 89; Shimada 2006, pp. 57–58; Imai 1988, pp. 53, 55, 62, 65; Kobata 1980, pp. 106–7), 1766-1774 refinery costs and domestic sale prices: own estimate, based on 1763-1764 prices, copper/silver ratio corrected for silver coin purity.

Concluding Remarks

At the start of this thesis I laid out a theoretical framework for how government institutions develop. I also described the effects these institutions have on economic development (Acemoğlu et al. 2014, Besley and Persson 2010). The reasoning is that institutions, as shapers of human interaction (North 1990), affect economic outcomes. Property rights are an important component of this (Williamson 1998), and they are in turn dependent on a balance of coercion constraints and contract enforcements (Greif 2005). These types of institutions, as well as other government attributes such as taxation and bureaucracy are influenced by both static and dynamic effects. The static effects come mainly through culture (Williamson 1998) as well as geography. The dynamic effects that promote institutional development can happen through war (Tilly 1992, Kiser and Linton 2001), or other types of state competition. A particular set of geographical and cultural factors can give rise to a situation called a States System (Jones 2003), also called a world-system (Wallerstein [1974] 2011), in which competition between economically interdependent states spurs continual political, economic and other institutional development. This dynamic has been described as Systems Competition (Sinn 1990, 2008) for modern occurrences as the Cold War and a regulatory 'race to the bottom'. Systems are in this context defined as collections of complementary institutions, such as political (e.g., government type, military organisation, and/or tax system), economic (e.g., property rights, trade policy, and/or market regulation) and social institutions (e.g., occupational mobility, and/or education systems). Wallerstein contrasts the world-system with empires, which are not only economically self-sufficient but also politically centralised. In terms of Systems Competition, I characterise empires as minimising internal competition. An Island Empire additionally minimises external competition. In this thesis I applied the concept of Systems Competition to the early modern setting of Tokugawa Japan (1600-1867).

As set out in chapter 2, the Tokugawa period was one of high contrast with both the circumstances in Europe at the time, as well as those the preceding and following epochs in Japanese history. In early modern Europe, war was a frequent occurrence, often between opposing alliances, and resulting in military, technological and institutional innovations. It is a situation high in competition. The same thing can be said about Japan from the start of the Sengoku (Warring Sates) period (1467). There, a breakdown of centralised power led to a prolonged power struggle between warlords. Many of those started with small holdings and depended on personal leadership. As power consolidated, institutions changed to make the organisation become more centralised,

structured and bureaucratic. There was also copying of the institutional innovations of the central area of Japan, as is shown by the example from Tosa domain. In the final consolidation under the Tokugawa shogunate, institutions became highly structured, bureaucratic and restricted. In terms of structure there were the division in status and class, as well as a multi-layered governance structure from the shogun down to the individual family. The bureaucracy is shown through the large number of samurai administrators, and the elaborate alternate attendance system. Restrictions were placed on contact with the outside world. The main element these institutions share, is an aim towards stability, and towards an elimination of competition. The Tokugawa shogunate took extraordinary steps to prevent threats to its authority, either domestically or from abroad. This led to Japan becoming an 'Island Empire System', a relatively large, economically independent centralised state with low levels of Systems Competition with the rest of the world.

Can we say that as a consequence of low Systems Competition the institutional development of Japan stagnated, and its economic development suffered? Previous Euro-centric literature might suggest so. In this thesis I have presented several pieces of evidence that give a more nuanced view. First of all, in international comparison Japan's development did not suffer, and it actually caught up to a range of reference countries in the years 1600 to 1850. The biggest exception was the UK, a clear winner of the world-system struggle by 1850. In comparison with continual war in Europe, the years of peace under the 'Pax Tokugawa' would have been an economic benefit as well. There were also clear costs however, which I have tried to enumerate.

In chapter 3, I have estimated the efficiency loss of the Tokugawa governance system. The system of control over the samurai class led to at least two costly institutions. The first was the employment into government service of large numbers of samurai. Ostensibly this was for administrative purposes, but there was not enough administrative work to justify the number enrolled. The employment of samurai was also a way to keep close the social class that traditionally held the key to the control of land – and who had permission to bear arms. The second costly institution was the alternate attendance system for daimyo, which went hand in hand with large expenses, especially in the capital. There are no comprehensive figures about the costs of either of these practices. There is information about total government revenue and expenses, but not about the specific use of these funds – e.g. whether a stipend went to a samurai who contributed to government production or who had an empty job. Therefore I have estimated the costs by using a the government budget from the Meiji administration (from the year 1890) as a reference for realistic government expenditures. The Tokugawa government was different in some ways from the Meiji government, therefore adjustments have to be made for the basket of government goods and

services provided, prices, the size of the population etc. The resulting estimate is that compared to costs Meiji taxpayers were paying, Tokugawa costs were higher by 25% or more. In government finance terms these excess costs were income transfers from taxpayers to the groups profiting from the expenditure – the samurai class. The takeaway from this is that the Tokugawa government incurred an inefficiency loss on its expenditure of 25% or more, due to its control system.

In chapter 4, I have given an account of the production of the precious metals mining sector in Tokugawa Japan. This was the main export sector during the Tokugawa period, and therefore a primary subject of the restrictions to international trade and contact. The results, based on wide reading, interpolation and comparison of sources, indicate that production was less than some earlier studies have indicated, especially for silver. Nevertheless, I found that silver production peaked at around 3% of GDP in the early 17th century. Compared to other countries, at peak production Japan was an important global source of silver and copper. The results indicate that despite certain restrictions on trade, export volumes were more often limited by the supply of precious metals production than by regulatory trade restrictions. This also brings into the discussion the role of technology, since production methods in Japanese mines were severely behind in terms of technological development. This was a direct result of restrictions to international contact, as the Meiji period pick-up of production indicates. Finally, restrictions to international relations kept foreigners from discovering other potential Japanese exports, and vice versa. This ensured that without drastic change, Japan would remain aside from the wider international economy and technology, and keep its status as an Island Empire.

In my view, and in more than one sense of the term, Tokugawa Japan's choice of structured, bureaucratic and restrictive institutions was a kind of 'local optimum'. Japan's particular geographic isolation and size made it a viable Island Empire. It enjoyed decent economic growth compared to other Asian and European states. Another 'locality' is the time period during which Japan remained an Island Empire. This may have been a strategic choice for a limited amount of time, but at a certain point the 'world-system' had expanded, and it encroached upon Japan as one of the last hold-outs. The Tokugawa institutions did bring Japan economic growth, but in the end it could not keep Systems Competition from its shores.

Data supplement

This section contains the main descriptive statistics and outcomes for the three precious metals, in order, silver, copper and gold. For a detailed description of the sources, see the main text.

Table 20: Silver data

Year	Export	Money supply absorption	Import	Production	Price	Production
	Tonne pure	Tonne pure	Tonne pure	Tonne pure	Koku per kg of pure	Million koku
1596	23.3			26.7	35.8	0.95
1597	23.3			31.9	31.7	1.01
1598	23.3			37.7	32.1	1.21
1599	23.3			40.2	33.3	1.34
1600	23.3	4.9		43.1	34.3	1.48
1601	23.3	4.9		46.2	35.4	1.63
1602	23.3	4.9		63.7	26.0	1.66
1603	23.3	4.9		62.2	22.8	1.42
1604	23.3	4.9		60.8	20.3	1.24
1605	23.3	4.9		65.3	18.3	1.20
1606	23.1	4.9		65.4	16.7	1.09
1607	23.1	4.9		65.8	16.1	1.06
1608	23.1	4.9		66.5	14.7	0.98
1609	23.1	4.9		67.5	17.3	1.17
1610	23.1	4.9		68.8	19.0	1.31
1611	48.2	4.9		70.3	19.0	1.34
1612	48.2	4.9		72.0	22.2	1.60
1613	48.2	4.9		69.9	22.2	1.55
1614	48.2	4.9		77.0	22.2	1.71
1615	48.2	4.9		73.2	16.7	1.22
1616	47.7	4.9		79.8	16.7	1.33
1617	47.7	4.9		60.5	18.3	1.11
1618	47.7	4.9		80.3	17.5	1.40
1619	47.7	4.9		77.7	16.7	1.30
1620	47.7	4.9		82.2	16.6	1.36
1621	53.3	4.9		93.7	15.6	1.47
1622	53.3	4.9		88.7	14.5	1.29
1623	53.3	4.9		86.0	17.6	1.52
1624	53.3	4.9		83.5	20.8	1.74
1625	53.3	4.9		80.6	20.8	1.68
1626	37.5	4.9		77.7	15.6	1.22
1627	37.5	4.9		74.9	15.6	1.17
1628	37.5	4.9		72.1	18.0	1.30

Year	Export	Money supply absorption	Import	Production	Price	Production
1629	37.5	4.9		69.4	19.8	1.38
1630	37.5	4.9		66.7	18.9	1.26
1631	64.1	4.9		64.1	18.0	1.16
1632	64.1	4.9		61.6	12.7	0.78
1633	64.1	4.9		59.2	17.3	1.02
1634	64.1	4.9		50.8	15.9	0.81
1635	64.1	4.9		62.4	10.3	0.64
1636	92.2	4.9		61.5	6.6	0.41
1637	92.2	4.9		52.7	7.8	0.41
1638	92.2	4.9		50.8	8.3	0.42
1639	92.2	4.9		49.2	9.4	0.46
1640	92.2	4.9		47.5	9.7	0.46
1641	38.9	4.9		44.0	8.5	0.37
1642	38.9	4.9		40.2	7.3	0.29
1643	38.9	4.9		42.0	8.8	0.37
1644	38.9	4.9		40.2	13.1	0.53
1645	38.9	4.9		38.5	14.0	0.54
1646	31.0	4.9		32.8	15.1	0.49
1647	31.0	4.9		34.9	16.9	0.59
1648	31.0	4.9		37.0	13.6	0.50
1649	31.0	4.9		38.9	13.6	0.53
1650	31.0	4.9		38.4	9.9	0.38
1651	32.3	4.9		37.9	12.3	0.47
1652	32.3	4.9		37.5	11.3	0.42
1653	32.3	4.9		34.7	10.2	0.35
1654	32.3	4.9		31.9	9.8	0.31
1655	32.3	4.9		32.5	9.2	0.30
1656	55.2	4.9		34.1	10.2	0.35
1657	55.2	4.9		35.6	10.5	0.38
1658	55.2	4.9		35.4	8.3	0.29
1659	55.2	4.9		34.9	8.0	0.28
1660	55.2	4.9		29.4	5.7	0.17
1661	60.5	4.9		29.7	7.3	0.22
1662	60.5	4.9		28.1	8.3	0.23
1663	60.5	4.9		30.7	6.3	0.19
1664	60.5	4.9		33.1	7.5	0.25
1665	60.5	4.9		33.5	6.3	0.21
1666	14.7	4.9		33.9	6.9	0.23
1667	14.7	4.9		31.1	6.6	0.20
1668	14.7	4.9		28.2	7.2	0.20
1669	14.7	4.9		27.4	6.7	0.18
1670	14.7	4.9		28.5	7.2	0.21
1671	19.4	4.9		29.6	7.2	0.21
1672	19.4	4.9		31.7	6.8	0.22
1673	19.4	4.9		34.7	5.8	0.20
1674	19.4	4.9		39.9	5.6	0.22
1675	19.4	4.9		38.2	6.2	0.24

Year	Export	Money supply absorption	Import	Production	Price	Production
1676	21.6	4.9		40.9	6.6	0.27
1677	21.6	4.9		35.4	7.2	0.25
1678	21.6	4.9		36.4	7.5	0.27
1679	21.6	4.9		29.4	6.6	0.19
1680	21.6	4.9		29.6	6.2	0.18
1681	21.6	4.9		27.0	5.4	0.15
1682	21.6	4.9		26.2	6.9	0.18
1683	21.6	4.9		24.8	8.1	0.20
1684	21.6	4.9		31.3	8.0	0.25
1685	21.6	4.9		30.6	8.9	0.27
1686	8.7	4.9		29.9	7.1	0.21
1687	6.1	4.9		25.2	6.8	0.17
1688	7.5	4.9		28.3	8.0	0.23
1689	6.0	4.9		25.6	6.8	0.17
1690	6.7	4.9		28.6	7.8	0.22
1691	8.2	4.9		29.5	7.6	0.23
1692	7.3	4.9		26.9	7.6	0.21
1693	6.8	4.9		22.9	8.0	0.18
1694	7.7	4.9		24.5	7.5	0.18
1695	7.3	4.9		24.3	6.8	0.17
1696	7.3	24.8		28.5	7.9	0.23
1697	6.2	24.8		29.5	7.2	0.21
1698	3.4	24.8		24.0	7.5	0.18
1699	4.8	24.8		35.3	5.9	0.21
1700	3.8	24.8		34.2	6.3	0.22
1701	6.6	24.8		38.1	6.2	0.24
1702	4.3	24.8		39.1	5.9	0.23
1703	1.8	24.8		36.0	5.4	0.20
1704	3.2	24.8		32.0	5.9	0.19
1705	2.6	24.8		34.6	6.6	0.23
1706	3.1	24.8		48.9	6.1	0.30
1707	2.3	24.8		46.5	8.7	0.41
1708	2.4	24.8		31.8	8.5	0.27
1709	2.3	24.8		29.5	10.0	0.29
1710	1.5	24.8		25.3	8.2	0.21
1711	1.9	-21.9		27.7	12.0	0.33
1712	1.6	-21.9		28.1	14.0	0.39
1713	2.9	-21.9		31.7	10.7	0.34
1714	5.9	-21.9		31.4	8.2	0.26
1715	4.7	10.8		28.0	10.3	0.29
1716	4.2	10.8		28.4	9.7	0.27
1717	4.1	10.8		30.2	10.7	0.32
1718	2.9	10.8		28.3	11.1	0.31
1719	1.7	10.8		29.9	8.0	0.24
1720	2.3	10.8		22.3	5.8	0.13
1721	3.4	10.8		22.9	4.8	0.11
1722	4.9	10.8		26.2	7.2	0.19

Year	Export	Money supply absorption	Import	Production	Price	Production
1723	4.5	10.8		20.2	8.5	0.17
1724	2.1	10.8		22.2	7.7	0.17
1725	1.2	10.8		18.6	6.6	0.12
1726	2.1	10.8		21.1	7.2	0.15
1727	3.8	10.8		22.1	7.2	0.16
1728	3.3	10.8		19.1	7.9	0.15
1729	4.1	10.8		18.3	8.5	0.16
1730	4.4	10.8		19.5	9.0	0.17
1731	4.8	10.8		18.2	8.5	0.15
1732	3.0	10.8		17.4	3.4	0.06
1733	2.1	10.8		17.1	7.6	0.13
1734	2.3	10.8		19.3	8.5	0.16
1735	2.9	10.8		19.0	8.1	0.15
1736	1.3	10.8		19.3	6.2	0.12
1737	1.5	4.7		15.5	10.5	0.16
1738	2.3	4.7		16.9	6.6	0.11
1739	1.8	4.7		18.4	7.5	0.14
1740	2.7	4.7		19.6	6.8	0.13
1741	2.3	4.7		17.1	7.4	0.13
1742	1.4	4.7		13.8	9.5	0.13
1743	0.3	4.7		14.8	7.7	0.11
1744	1.5	4.7		14.6	9.0	0.13
1745	0.8	4.7		13.5	7.1	0.10
1746	0.8	4.7		14.9	9.2	0.14
1747	0.8	4.7		14.3	8.5	0.12
1748	0.3	4.7		15.2	8.9	0.13
1749	0.9	4.7		16.1	9.5	0.15
1750	0.6	4.7		16.3	8.3	0.13
1751	0.3	4.7		15.7	9.2	0.14
1752	0.0	4.7		15.6	10.7	0.17
1753		4.7		14.4	11.4	0.16
1754		4.7		16.7	10.5	0.18
1755		4.7		18.6	6.6	0.12
1756		4.7		20.2	8.3	0.17
1757		4.7		17.3	9.7	0.17
1758		4.7		17.6	8.9	0.16
1759		4.7		17.0	10.5	0.18
1760		4.7		23.1	10.9	0.25
1761		4.7		16.4	10.5	0.17
1762		4.7		16.3	9.4	0.15
1763		4.7	2.7	15.3	9.7	0.15
1764		4.7	2.7	16.2	9.2	0.15
1765		4.7	2.7	16.8	8.9	0.15
1766		4.7	2.7	16.2	8.9	0.14
1767		4.7	2.7	20.0	7.6	0.15
1768		4.7	2.7	18.5	7.8	0.14
1769		4.7	2.7	19.1	7.6	0.15

Year	Export	Money supply absorption	Import	Production	Price	Production
1770		4.7	2.7	20.5	9.0	0.18
1771		4.7	2.7	21.0	10.7	0.22
1772		4.7	2.7	21.2	9.4	0.20
1773		4.7	2.7	20.2	8.9	0.18
1774		4.7	2.7	19.9	10.4	0.21
1775		4.7	2.7	20.7	9.2	0.19
1776		4.7	2.7	19.4	8.2	0.16
1777		4.7	2.7	18.2	10.0	0.18
1778		4.7	2.7	18.2	9.9	0.18
1779		4.7	2.7	20.3	12.7	0.26
1780		4.7	2.7	19.4	12.5	0.24
1781		4.7	2.7	20.0	10.6	0.21
1782		4.7	2.7	17.3	8.5	0.15
1783		4.7	2.2	14.7	6.6	0.10
1784		4.7	3.2	17.3	8.3	0.14
1785		4.7	2.8	15.3	9.3	0.14
1786		4.7	3.3	14.6	6.5	0.09
1787		4.7	2.9	15.9	8.7	0.14
1788		4.7	3.4	16.4	8.0	0.13
1789		4.7	2.9	14.4	9.3	0.13
1790		4.7	1.9	13.0	10.0	0.13
1791		4.7	1.4	13.0	7.8	0.10
1792		4.7	2.1	12.9	6.6	0.09
1793		4.7	2.0	12.5	9.5	0.12
1794		4.7	2.0	12.0	10.1	0.12
1795		4.7	1.7	11.5	7.2	0.08
1796		4.7	0.8	11.0	8.9	0.10
1797		4.7	1.3	10.5	7.5	0.08
1798		4.7	0.9	10.0	10.6	0.11
1799		4.7	1.4	11.8	8.5	0.10
1800		4.7	1.7	10.5	8.5	0.09
1801		4.7	1.9	9.2	8.4	0.08
1802		4.7	2.2	9.4	8.8	0.08
1803		4.7	2.0	9.8	9.5	0.09
1804		4.7	2.2	9.5	10.6	0.10
1805		4.7	2.0	9.2	9.9	0.09
1806		4.7	2.1	8.9	9.6	0.08
1807		4.7	2.2	9.1	7.7	0.07
1808		4.7	1.0	9.3	7.6	0.07
1809		4.7	1.7	10.0	8.6	0.09
1810		4.7	1.2	11.3	9.6	0.11
1811		4.7	1.1	13.3	9.9	0.13
1812		4.7	1.6	13.9	10.2	0.14
1813		4.7	2.1	13.4	9.3	0.13
1814		4.7	1.9	13.1	8.6	0.11
1815		4.7	1.2	14.1	9.6	0.14
1816		4.7	1.2	13.9	8.1	0.11

Year	Export	Money supply absorption	Import	Production	Price	Production
1817		4.7	1.9	13.8	9.7	0.13
1818		4.7	1.9	14.5	10.0	0.15
1819		-3.8	1.9	12.7	12.1	0.15
1820		-3.8	0.0	11.1	11.4	0.13
1821		-3.8	2.0	12.0	12.7	0.15
1822		-3.8	1.9	11.3	12.3	0.14
1823		-3.8	2.0	11.7	11.6	0.14
1824		-3.8	2.2	12.1	12.2	0.15
1825		-3.8	1.9	10.6	9.5	0.10
1826		-3.8	2.1	11.2	11.4	0.13
1827		-3.8	2.6	10.8	11.4	0.12
1828		-3.8	1.8	11.8	8.7	0.10
1829		-3.8	2.6	9.2	9.9	0.09
1830		-3.8	2.3	10.3	8.7	0.09
1831		-3.8	1.5	12.2	10.4	0.13
1832		-3.8	1.8	12.1	10.1	0.12
1833		-18.0	1.4	14.7	7.0	0.10
1834		-18.0	1.6	15.4	9.7	0.15
1835		-18.0	1.9	13.9	8.9	0.12
1836		-18.0	1.4	13.2	5.8	0.08
1837		-18.0	1.8	14.2	8.1	0.11
1838		-18.0	1.4	12.8	8.4	0.11
1839		-18.0	1.7	12.3	13.1	0.16
1840		-18.0		12.6	14.3	0.18
1841		-18.0		10.8	13.3	0.14
1842		-18.0		11.4	14.1	0.16
1843		-18.0		11.8	12.6	0.15
1844		-18.0		9.8	14.7	0.14
1845		-18.0		7.7	11.1	0.09
1846		-18.0		8.2	11.6	0.10
1847		-18.0		10.3	10.9	0.11
1848		-18.0		9.5	11.5	0.11
1849		-18.0		9.2	7.0	0.06
1850		-18.0		9.1	6.8	0.06
1851		-18.0		9.8	12.7	0.12
1852		-18.0		9.2	11.6	0.11
1853		-18.0		12.7	10.4	0.13
1854		-18.0		11.9	11.6	0.14
1855				10.2	13.1	0.13
1856				9.1	12.5	0.11
1857				10.1	9.1	0.09
1858				8.2	6.7	0.05
1859				7.9	7.9	0.06
1860				8.1	20.0	0.16
1861				7.8	11.0	0.09
1862				7.6	13.4	0.10
1863				4.7	10.8	0.05

Year	Export	Money supply absorption	Import	Production	Price	Production
1864				6.2	10.3	0.06
1865				6.2	5.4	0.03
1866				5.8	2.7	0.02
1867				5.7	2.3	0.01
1868				5.4	4.9	0.03
1869				5.2	4.4	0.02
1870				5.4	3.9	0.02
1871				5.5	5.3	0.03
1872				5.2	8.1	0.04
1873				5.0	7.2	0.04

Table 21: Copper data

Year	Export	Domestic consumption	Production	International price,15 year average	Production
	Tonne	Tonne	Tonne	Koku per kg of copper	Million koku
1610		700	122	0.188	0.132
1611		700	122	0.185	0.129
1612		700	122	0.182	0.128
1613		700	122	0.181	0.127
1614		700	122	0.180	0.126
1615		700	122	0.179	0.126
1616		700	122	0.181	0.127
1617		700	122	0.184	0.129
1618		700	122	0.185	0.129
1619		700	122	0.183	0.128
1620		700	122	0.178	0.125
1621		700	122	0.176	0.123
1622		700	122	0.174	0.122
1623		700	122	0.175	0.123
1624		700	122	0.176	0.123
1625		700	122	0.173	0.121
1626		700	122	0.173	0.121
1627		700	122	0.172	0.120
1628		700	225	0.168	0.118
1629		700	225	0.162	0.113
1630		700	225	0.157	0.110
1631		700	225	0.151	0.106
1632		700	225	0.144	0.100
1633	58	700	225	0.136	0.103
1634		700	225	0.131	0.092
1635	157	700	225	0.126	0.108
1636	51	700	225	0.120	0.090
1637	11	700	225	0.115	0.082
1638		700	225	0.112	0.078
1639		700	225	0.110	0.077
1640		700	225	0.113	0.079
1641		700	225	0.110	0.077
1642		700	225	0.109	0.076
1643		700	225	0.108	0.076
1644		700	225	0.112	0.079
1645		700	225	0.114	0.080
1646	257	700	225	0.116	0.111
1647	286	700	225	0.116	0.114
1648		700	225	0.116	0.081
1649	189	700	225	0.117	0.104
1650	197	700	225	0.119	0.107
1651	439	700	225	0.119	0.135
1652	278	700	225	0.115	0.113

Year	Export	Domestic consumption	Production	International price,15 year average	Production
1653	187	700	225	0.110	0.097
1654	204	700	225	0.104	0.094
1655	254	700	225	0.099	0.094
1656	549	700	225	0.094	0.117
1657	871	700	225	0.090	0.141
1658	803	700	225	0.087	0.131
1659	509	700	225	0.084	0.101
1660	704	700	465	0.081	0.113
1661	988	700	465	0.079	0.133
1662	760	700	1 390	0.077	0.112
1663	1 229	700	1 390	0.075	0.145
1664	1 649	700	1 390	0.073	0.172
1665	683	700	1 390	0.071	0.098
1666	901	700	1 390	0.069	0.111
1667	732	700	1 390	0.068	0.097
1668	1 069	700	1 390	0.068	0.120
1669	900	700	1 390	0.067	0.108
1670	1 850	700	1 780	0.067	0.170
1671	1 822	700	1 780	0.068	0.170
1672	2 103	700	1 780	0.067	0.188
1673	1 606	700	1 780	0.067	0.154
1674	1 803	700	1 874	0.066	0.165
1675	1 817	700	2 007	0.066	0.167
1676	2 205	700	1 984	0.067	0.194
1677	2 014	700	2 323	0.068	0.184
1678	2 007	700	2 408	0.069	0.186
1679	2 682	700	2 527	0.069	0.232
1680	2 528	700	2 446	0.069	0.222
1681	1 814	700	2 393	0.070	0.176
1682	3 410	700	2 594	0.071	0.292
1683	2 427	700	2 486	0.072	0.225
1684	3 125	700	2 238	0.073	0.278
1685	2 790	700	2 292	0.073	0.255
1686	3 471	700	2 287	0.073	0.306
1687	3 737	700	2 287	0.074	0.328
1688	3 307	700	2 250	0.074	0.298
1689	3 568	700	2 250	0.076	0.324
1690	3 561	700	2 015	0.076	0.325
1691	2 808	700	2 038	0.076	0.266
1692	3 555	700	2 524	0.074	0.317
1693	3 227	700	2 662	0.073	0.285
1694	3 529	700	2 729	0.072	0.305
1695	3 843	700	2 831	0.071	0.324
1696	5 732	700	3 192	0.070	0.448
1697	6 363	700	3 520	0.069	0.488
1698	5 364	700	3 698	0.068	0.414
1699	4 439	700	3 703	0.067	0.346

Year	Export	Domestic consumption	Production	International price,15 year average	Production
1700	3 040	700	3 477	0.068	0.237
1701	3 191	700	4 315	0.068	0.295
1702	3 190	700	4 251	0.070	0.298
1703	3 304	700	4 576	0.071	0.325
1704	4 256	700	4 474	0.074	0.330
1705	4 034	700	4 413	0.078	0.345
1706	3 947	700	4 678	0.080	0.376
1707	3 916	700	4 628	0.082	0.379
1708	4 408	700	4 975	0.085	0.420
1709	3 989	700	4 705	0.087	0.409
1710	3 871	700	4 332	0.090	0.390
1711	3 117	700	4 085	0.094	0.383
1712	2 185	700	4 193	0.095	0.399
1713	2 911	700	4 249	0.095	0.402
1714	2 994	700	4 220	0.094	0.396
1715	1 135	700	3 598	0.093	0.334
1716	1 242	700	2 998	0.093	0.278
1717	2 273	700	2 900	0.091	0.265
1718	3 424	700	2 803	0.090	0.253
1719	2 222	700	3 153	0.087	0.275
1720	2 563	700	3 214	0.083	0.265
1721	2 860	700	3 239	0.081	0.261
1722	2 001	700	2 703	0.081	0.219
1723	2 255	700	2 551	0.080	0.204
1724	1 051	700	2 681	0.079	0.212
1725	2 037	700	2 655	0.074	0.197
1726	2 644	700	2 690	0.072	0.194
1727	2 727	700	2 709	0.072	0.196
1728	1 583	700	2 624	0.074	0.194
1729	2 072	700	2 578	0.075	0.193
1730	2 426	700	2 534	0.077	0.195
1731	2 433	700	2 532	0.076	0.192
1732	2 757	700	2 547	0.075	0.192
1733	2 450	700	2 523	0.076	0.191
1734	2 220	700	2 499	0.076	0.189
1735	2 060	700	2 605	0.077	0.201
1736		700	2 399	0.077	0.185
1737		700	2 342	0.077	0.181
1738		700	2 355	0.076	0.179
1739		700	2 366	0.077	0.181
1740		700	2 489	0.080	0.199
1741		700	2 615	0.081	0.212
1742		700	2 663	0.082	0.217
1743		700	2 779	0.082	0.227
1744		700	2 690	0.084	0.225
1745	1 748	700	2 369	0.084	0.199
1746	1 867	700	2 425	0.087	0.211

Year	Export	Domestic consumption	Production	International price,15 year average	Production
1747	2 091	700	2 331	0.089	0.208
1748	1 666	700	2 828	0.089	0.251
1749	1 548	700	2 697	0.090	0.241
1750	1 548	700	2 798	0.090	0.251
1751	1 548	700	2 741	0.090	0.248
1752	1 548	700	2 730	0.092	0.250
1753	1 548	700	2 599	0.094	0.244
1754	1 737	700	2 782	0.095	0.264
1755	1 778	700	2 848	0.096	0.272
1756	1 773	700	2 879	0.096	0.277
1757	1 685	700	2 781	0.096	0.267
1758	1 705	700	2 854	0.096	0.275
1759	2 155	700	2 959	0.096	0.285
1760	1 765	700	2 609	0.094	0.245
1761	2 128	700	2 518	0.092	0.231
1762	1 697	700	2 456	0.090	0.220
1763	1 793	700	2 555	0.091	0.233
1764	1 726	700	2 490	0.093	0.231
1765	1 346	700	2 376	0.093	0.220
1766	1 738	700	2 810	0.093	0.261
1767	1 316	700	2 815	0.093	0.261
1768	1 330	700	2 634	0.092	0.241
1769	1 601	700	2 723	0.090	0.245
1770	1 535	700	2 999	0.090	0.271
1771	1 652	700	2 711	0.091	0.245
1772	1 202	700	2 325	0.093	0.216
1773	1 613	700	2 580	0.095	0.246
1774	1 739	700	2 445	0.096	0.236
1775	1 313	700	1 977	0.097	0.192
1776	1 657	700	1 777	0.096	0.171
1777	1 284	700	1 837	0.097	0.178
1778	1 478	700	1 893	0.097	0.183
1779	1 496	700	1 803	0.094	0.170
1780	1 392	700	1 909	0.094	0.179
1781	1 351	700	1 939	0.093	0.180
1782	919	700	1 535	0.092	0.142
1783	1 219	700	1 566	0.093	0.145
1784	1 741	700	1 539	0.093	0.142
1785	1 504	700	1 440	0.090	0.130
1786	1 776	700	1 468	0.090	0.132
1787	1 548	700	1 473	0.088	0.130
1788	1 844	700	1 316	0.085	0.112
1789	1 551	700	1 323	0.084	0.111
1790	1 056	700	1 327	0.083	0.110
1791	782	700	1 460	0.086	0.125
1792	1 128	700	1 666	0.086	0.143
1793	1 109	700	1 707	0.085	0.145

Year	Export	Domestic consumption	Production	International price,15 year average	Production
1794	1 068	700	1 903	0.086	0.164
1795	911	700	1 637	0.086	0.142
1796	421	700	1 544	0.087	0.135
1797	729	700	1 745	0.088	0.154
1798	483	700	1 715	0.088	0.151
1799	753	700	1 753	0.089	0.157
1800	906	700	1 797	0.090	0.162
1801	1 023	700	1 676	0.089	0.149
1802	1 171	700	1 578	0.088	0.139
1803	1 087	700	1 595	0.089	0.143
1804	1 178	700	1 453	0.090	0.131
1805	1 086	700	1 563	0.092	0.144
1806	1 118	700	1 463	0.091	0.133
1807	1 181	700	1 475	0.091	0.134
1808	542	700	1 577	0.092	0.145
1809	904	700	1 579	0.092	0.145
1810	662	700	1 575	0.092	0.145
1811	602	700	1 665	0.093	0.154
1812	843	700	1 579	0.094	0.148
1813	1 115	700	1 710	0.095	0.162
1814	1 008	700	1 634	0.097	0.158
1815	662	700	1 749	0.100	0.175
1816	662	700	1 977	0.103	0.203
1817	1 041	700	1 975	0.105	0.207
1818	1 027	700	1 919	0.105	0.201
1819	1 027	700	1 948	0.106	0.206
1820		700	1 809	0.107	0.193
1821	1 088	700	1 745	0.106	0.185
1822	1 028	700	1 830	0.107	0.196
1823	1 088	700	1 509	0.107	0.161
1824	1 208	700	1 542	0.108	0.167
1825	1 051	700	1 452	0.108	0.157
1826	1 148	700	1 437	0.106	0.153
1827	1 426	700	1 678	0.105	0.176
1828	966	700	1 662	0.103	0.171
1829	1 391	700	1 597	0.098	0.157
1830	1 220	700	1 809	0.096	0.173
1831	803	700	1 890	0.093	0.177
1832	993	700	2 064	0.094	0.194
1833	740	700	1 885	0.097	0.183
1834	867	700	1 402	0.099	0.138
1835	1 017	700	1 584	0.100	0.159
1836	755	700	1 566	0.103	0.161
1837	1 002	700	1 520	0.106	0.161
1838	785	700	1 345	0.108	0.145
1839	906	700	1 313	0.109	0.143
1840			1 358	0.109	0.148

Year	Export	Domestic consumption	Production	International price,15 year average	Production
1841			1 460	0.112	0.164
1842			1 307	0.110	0.144
1843			1 175	0.109	0.128
1844			1 274	0.114	0.145
1845			1 261	0.116	0.146
1846			1 383	0.117	0.162
1847			1 293	0.116	0.150
1848			1 289	0.115	0.149
1849			1 422	0.115	0.163
1850			1 337	0.111	0.149
1851			1 546	0.108	0.166
1852			1 572	0.103	0.162
1853			1 499	0.109	0.163
1854			1 529	0.109	0.166
1855			1 303	0.110	0.144
1856			1 328	0.110	0.146
1857			1 423	0.112	0.159
1858			1 577	0.111	0.175
1859			1 446	0.104	0.151
1860			1 533	0.098	0.150
1861			1 487	0.095	0.141
1862			1 380	0.090	0.124
1863			1 322	0.084	0.110
1864			1 466	0.079	0.115
1865			1 637	0.078	0.128
1866			1 306	0.078	0.102
1867			1 387	0.077	0.106
1868			1 338	0.066	0.089
1869			1 140	0.063	
1870			1 299	0.058	
1871			1 302	0.054	
1872			1 270	0.049	
1873			1 153	0.049	

Table 22: Gold data

Year	Export	Production[38]	Price	Production
	Kg pure gold	Kg pure gold	Koku/kg pure gold	Million koku
1602		544	236	0.128
1603		544	217	0.118
1604		544	201	0.110
1605		544	188	0.102
1606		544	176	0.096
1607		544	170	0.092
1608		544	155	0.084
1609		544	183	0.099
1610		544	185	0.100
1611		544	233	0.127
1612		544	262	0.143
1613		544	262	0.143
1614		544	262	0.143
1615		851	190	0.162
1616		851	190	0.162
1617		851	209	0.178
1618		851	199	0.169
1619		851	190	0.162
1620		851	176	0.150
1621		851	165	0.140
1622		851	154	0.131
1623		851	183	0.155
1624		792	158	0.125
1625		792	219	0.173
1626		792	200	0.158
1627		792	200	0.158
1628		792	182	0.144
1629		792	185	0.147
1630		792	184	0.145
1631		792	182	0.144
1632		792	178	0.141
1633		792	148	0.117
1634		792	124	0.098
1635		792	113	0.090
1636		801	94	0.075
1637		801	83	0.067
1638		801	79	0.064
1639		801	132	0.106
1640		801	132	0.106
1641		801	90	0.072
1642		801	77	0.061
1643		801	116	0.093
1644		616	142	0.088

38 Gold production includes an imputation for the non-Sado mines in applicable years. For detail see the text.

Year	Export	Production	Price	Production
1645		616	146	0.090
1646		616	163	0.100
1647		616	147	0.091
1648		617	158	0.097
1649		617	151	0.093
1650		617	114	0.070
1651		617	130	0.080
1652		563	131	0.074
1653		563	131	0.074
1654		563	110	0.062
1655		527	111	0.059
1656		1 111	106	0.117
1657		1 111	126	0.139
1658		1 125	86	0.096
1659		1 125	79	0.089
1660		1 125	62	0.070
1661		1 108	84	0.093
1662		1 108	101	0.112
1663		1 108	79	0.087
1664		1 108	84	0.093
1665	36	1 108	85	0.095
1666	460	572	79	0.045
1667	666	572	80	0.046
1668	1 704	572	84	0.048
1669	1 522	572	70	0.040
1670	1 161	572	76	0.043
1671	1 596	572	92	0.053
1672	1 037	572	90	0.052
1673	1 053	686	78	0.054
1674	747	686	58	0.040
1675	600	686	68	0.047
1676	302	532	74	0.039
1677	441	532	103	0.055
1678	375	532	96	0.051
1679	309	532	79	0.042
1680	111	532	63	0.034
1681	245	481	56	0.027
1682	0	481	67	0.032
1683	201	481	111	0.053
1684	613	485	105	0.051
1685	6	485	108	0.052
1686	6	347	82	0.028
1687	160	347	79	0.027
1688	224	294	105	0.031
1689	37	294	91	0.027
1690	181	294	87	0.026
1691	326	294	89	0.026
1692	64	294	95	0.028
1693	254	294	75	0.022

Year	Export	Production	Price	Production
1694	151	294	63	0.019
1695	75	294	85	0.025
1696	129	247	61	0.015
1697	10	247	71	0.018
1698	75	247	57	0.014
1699	23	280	85	0.024
1700	255	280	97	0.027
1701	20	280	69	0.019
1702	212	280	61	0.017
1703	195	280	67	0.019
1704	28	533	131	0.070
1705	92	533	146	0.078
1706	57	501	129	0.065
1707	203	501	50	0.025
1708	208	501	80	0.040
1709	208	501	99	0.050
1710	154	501	57	0.029
1711	6	314	65	0.020
1712	264	314	65	0.020
1713	156	314	32	0.010
1714	284	314	25	0.008
1715	273	314	21	0.007
1716	88	24	37	0.001
1717	63	24	48	0.001
1718	71	24	115	0.003
1719	18	24	68	0.002
1720	87	24	50	0.001
1721	107	24	47	0.001
1722	58	24	56	0.001
1723	189	24	92	0.002
1724	53	24	86	0.002
1725	114	24	78	0.002
1726	49	24	81	0.002
1727	151	24	97	0.002
1728	142		108	
1729	134		145	
1730	82		121	
1731	31		113	
1732	117		65	
1733	84		68	
1734	75		100	
1735	87		102	
1736	60		114	
1737	0		119	
1738	0		72	
1739	4		81	
1740	1		74	
1741	1		77	
1742	1		91	

Year	Export	Production	Price	Production
1743	1		46	
1744	31		92	
1745	19		90	
1746	8		80	
1747	37		91	
1748	14		86	
1749	1		91	
1750	14		92	
1751	0		97	
1752	2		112	
1753	0		132	

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