

Guilds, Innovation, and the European Economy, 1400–1800

Edited by

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of viable industrial and commercial alternatives to innovation. Paradoxically, moreover, craft guilds provided resources, such as the transmission of human capital, which constituted a critical basis for the diffusion of an innovation that craft members might personally resist. Taken together, these factors go a long way in explaining why the expansion of early modern manufacture did not lead to the demise of the guilds, but on the contrary, went hand in hand with their persistence and even their multiplication.

7 Guilds, Technology, and Economic Change in Early Modern Venice

Francesca Trivellato

Both the social sciences and popular sentiment tend to identify technological innovation with mechanisation, and oppose it to the protected environment of artisan craft guilds. Recent literature has begun to question this truism in favour of a more nuanced view of the attitudes of guilds towards technological change as part of broader debates on the relation between markets and institutions in pre-industrial Europe.¹ Historians of early modern Italy have also increasingly questioned traditional, static views of craft guilds, but their revisionism has focussed less on the history of technology than on other aspects of guild life and structure.² This chapter contributes new elements to this revisionist work by examining two crucial sectors of the early modern Venetian economy: silk and glass manufacturing. Both trades underwent profound changes between 1450 and 1800, largely in response to the rise of new, nearby and distant competitors. I focus on the seventeenth and eighteenth centuries, when international competition was especially fierce, and I address the question, not whether craft guilds as a rule favoured or opposed technological innovation, but why different guilds at different times selected

¹ Notably S. R. Epstein, 'Property Rights to Technological Knowledge in Premodern Europe, 1300–1800', *American Economic Review* 94 (2004), 382–7; and chs. 2 and 6.

² Little attention is paid to technological aspects in Alberto Guenzi, Paola Massa, and Fausto Piola Caselli (eds.), *Guilds, Markets and Work Regulations in Italy, 16th–19th Centuries* (Aldershot: Ashgate, 1999). A few essays in Paola Massa and Angelo Moioli (eds.), *Dalla corporazione al mutuo soccorso: Organizzazione e tutela del lavoro tra XVIe XX secolo* (Milano: Franco Angeli, 2004), deal with technological change and guild organisation. For a comprehensive reassessment of the problem, see Carlo Marco Belfanti, 'Guilds, Patents, and the Circulation of Technical Knowledge: Northern Italy during the Early Modern Age', *Technology and Culture* 45 (2004), 569–89. Specific works related to this issue include Carlo Poni, 'Archéologie de la fabrique: la diffusion des moulins à soie «alla bolognese» dans les États vénitiens du XVIe au XVIIIe siècle', *Annales ESC* 27 (1972), 1474–96; Renzo Sabbatini, *L'innovazione prudente: Spunti per lo studio di un'economia di ancien régime* (Firenze: Le Lettere, 1996); Luca Molà, *The Silk Industry of Renaissance Venice* (Baltimore: Johns Hopkins University Press, 2000); Francesca Trivellato, *Fondamenta dei Vètrai: Lavoro, tecnologia e mercato a Venezia tra Sei e Settecento* (Roma: Donzelli, 2000), esp. 191–218.

some innovations and not others, and how they reshaped their production and market strategies more generally.

To approach the relationship between guilds and technology we need to deconstruct both terms: craft guilds differed in their labour composition and in their relations with other guilds, the market, and state authorities; technological change, on the other hand, included new tools, techniques, and production processes, but also new products and organisational forms.

As the recent literature has illustrated, a plurality of corporate institutions existed even in the same town and in the same period, and they featured high levels of both horizontal and vertical conflict. To understand why guilds welcomed some innovations and rejected others, we need to examine more closely the context in which they evaluated competitive advantages and opportunity costs. These often arose from political arrangements and market forces that transcended guild influence, including government protectionism, local natural resources, and foreign competition. At the same time, different guild members had different interests at stake. Thus, for example, merchants usually favoured labour-saving innovations against the will of skilled artisans, but this was not always the case.

Why Venice?

In spite of their radical ideological differences, Marxist, neoclassical, and New Institutional economic historians have all ascribed considerable responsibility to craft guilds for early modern Italian 'backwardness'.³ They trace a trajectory according to which guilds fostered innovation at times of economic expansion – Italy in the Middle Ages, the Netherlands during the Golden Age – and promoted exclusionism and technological conservatism at times of depression and decline – Italy in the seventeenth and eighteenth centuries, if not already in the fifteenth and sixteenth centuries.⁴

³ For examples of these respective views, see Ruggiero Romano, 'La storia economica: Dal secolo XIV al Settecento', in *Storia d'Italia* (Torino: Einaudi 1974), vol. II/2, 1813–931; C. H. Wilson, 'Trade, Society, and State', in *The Cambridge Economic History of Europe*, (Cambridge: Cambridge University Press, 1967), vol. IV, 487–575; Douglass C. North and Robert P. Thomas, *The Rise of the Western World: A New Economic History* (Cambridge: Cambridge University Press, 1973).

⁴ Amintore Fanfani, *Storia del lavoro in Italia dalla fine del secolo XV agli inizi del XVIII* (Milano: Giuffrè, 1943), 159–65; David S. Landes, *The Unbound Prometheus: Technological Change and Industrial Development in Western Europe from 1750 to the Present* (Cambridge: Cambridge University Press, 1969), 19, 82, 134, 145; Sidney Pollard, *Peaceful Conquest:*

Venice has long epitomised the disastrous consequences of this pattern. In a still influential essay of 1950, Carlo Cipolla blamed craft guilds for the seventeenth-century 'crisis' of the Italian economy and pointed to Venice as his primary example. In the 1960s and '70s, this interpretation became a central tenet of the historiography on seventeenth-century Venice's political and economic decline.⁵ At the time, the most significant criticism of this paradigm came from Richard Rapp, who argued that the Venetian government rather than the craft guilds was responsible for the city's 'relative', rather than 'absolute', economic decline.⁶ In the 1980s and '90s, attention shifted towards relations between urban and rural manufacturing. It became clear that textile production, for example, was not simply relocated to the countryside as a result of high production costs caused by urban guilds, but that the proto-industrial districts that emerged in various parts of the Veneto mainland, especially after

The Industrialization of Europe, 1760–1970 (Oxford: Oxford University Press, 1981), 104–11; Bo Gustafsson, 'The Rise and Economic Behaviour of Medieval Craft Guilds: An Economic-Theoretical Interpretation', *Scandinavian Economic History Review* 35 (1987), 1; Joel Mokyr, *The Lever of Riches: Technological Creativity and Economic Progress* (Oxford: Oxford University Press, 1990), 191, 258–60; Joel Mokyr, 'Technological Inertia in Economic History', *Journal of Economic History* 52 (1992), 330n17, 331–2; Joel Mokyr, 'The Political Economy of Technological Change: Resistance and Innovation in Economic History', in Maxine Berg and Kristine Bruiland (eds.), *Technological Revolutions in Europe: Historical Perspectives* (Cheltenham, UK: Edward Elgar, 1998), 55–6; Joel Mokyr, *The Gifts of Athena: Historical Origins of the Knowledge Economy* (Princeton: Princeton University Press, 2002), 130n21, 259–60. More balanced judgments were already expressed by Sylvia Thrupp, 'The Guilds', in *The Cambridge Economic History of Europe* (Cambridge: Cambridge University Press, 1963), vol. III, 230–80.

⁵ Carlo M. Cipolla, 'The Decline of Italy: the Case of a Fully Matured Economy', *Economic History Review* 5 (1950), 178–87; Fernand Braudel, Pierre Jeannin, Jean Meuvret, and Ruggiero Romano, 'Le déclin de Venise au XVII^e siècle', in *Aspetti e cause della decadenza economica veneziana nel secolo XVII (Atti del convegno 27 giugno – 2 luglio 1957, Venezia, Isola di San Giorgio Maggiore)* (Venezia: Istituto per la Collaborazione Culturale, 1961), 43–4; Domenico Sella, *Commerci e industrie a Venezia nel secolo XVII* (Venezia-Roma: Istituto per la Collaborazione Culturale, 1968), 121–3. For a particularly gloomy picture of Venetian industrial decline in the eighteenth century, see Bruno Caizzi, *Industria e commercio della Repubblica veneta nel XVIII secolo* (Milano: Banca Commerciale Italiana, 1965). A somewhat dissonant voice was expressed by Frederic Lane, who did not single out guilds as responsible for the downturn of the Venetian economy in the seventeenth century and recognised the continued importance of some production (brocades, lace, glass, and the printing press) in the eighteenth century: Frederic C. Lane, *Venice: A Maritime Republic* (Baltimore: Johns Hopkins University Press, 1973), 424. In contrast, Gino Luzzatto saw signs of guild exclusionism beginning already during the expansive thirteenth to fifteenth centuries, but only in response to short-term negative economic fluctuations: Gino Luzzatto, *Storia economica di Venezia dall'XI al XVI secolo* (Venezia: Centro internazionale della grafica, 1961), 60–72, 118–9, 190–202.

⁶ Richard T. Rapp, *Industry and Economic Decline in Seventeenth-century Venice* (Cambridge: Harvard University Press, 1996).

1670, relied on a highly complex division of labour between town and country.⁷

More recent studies have turned to analyse the Venetian economy's conversion to luxury production in the seventeenth and eighteenth centuries. At the time, Venice was still a major European manufacturing centre and a wealthy city of 120,000 to 160,000 inhabitants.⁸ In the eighteenth century, the city was home to several prosperous businesses, including soap, wax, porcelain making, naval construction, and especially silk weaving, glassblowing, and printing.⁹ Long after its fifteenth-century apogee, the famous Arsenal of Venice continued to be one of the largest industrial sites in Europe and a major urban employer.¹⁰ Meanwhile, craft guilds underwent substantial changes in both their formal and informal

⁷ For an earlier interpretation, which emphasised the opposition between urban guilds and rural putting-out systems, while stressing the integration between rural and urban silk manufacturing in provincial towns like Vicenza, see Salvatore Ciriaco, 'Protoindustria, lavoro a domicilio e sviluppo economico nelle campagne venete in epoca moderna', *Quaderni Storici* 52 (1983), 68 and Salvatore Ciriaco, 'Mass Consumption Goods and Luxury Goods: The De-Industrialization of the Republic of Venice from the Sixteenth to the Eighteenth Century', in Herman Van der Wee (ed.), *The Rise and Decline of Urban Industries in Italy and in the Low Countries (Late Middle Ages – Early Modern Times)* (Louvain: Leuven University Press, 1988), 41–61. For a comparative European perspective, see Sheilagh C. Ogilvie and Markus Cerman (eds.), *European Proto-Industrialization* (Cambridge: Cambridge University Press, 1996). In the 1990s, the concept of 'industrial districts' (see footnote 83) has been applied to describe the development of silk, wool, and other manufacturing activities in specific areas of seventeenth- and eighteenth-century northern and central Italy by Carlo Poni, 'Per la storia del distretto industriale serico di Bologna (secoli XVI–XVIII)', *Quaderni Storici* 73 (1990), 93–167; Walter Panciera, *L'arte matrice: I lanifici della Repubblica di Venezia nei secoli XVIIe XVIII* (Treviso: Canova Editrice, 1996); Walter Panciera, 'Il distretto tessile vicentino (secc. XVII–XVIII)', in Giovanni Luigi Fontana (ed.), *Le vie dell'industrializzazione europea: Sistemi a confronto* (Bologna: Il Mulino, 1997), 477–94; Walter Panciera, 'L'economia: imprenditoria, corporazioni, lavoro', in *Storia di Venezia dalle origini alla caduta della Serenissima*, vol. VIII (Roma: Istituto della Enciclopedia Italiana, 1998), 479–553.

⁸ Data on population from Daniele Beltrami, *Storia della popolazione di Venezia dalla fine del secolo XVI alla caduta della Repubblica* (Padova: Cedam, 1954). The importance of demographic factors in re-evaluating the seventeenth-century crisis of Italian urban manufacturing is emphasised by Domenico Sella, *Italy in the Seventeenth Century* (London: Longman, 1997), 39. On the Venetian developments after 1630, see Luciano Pezzolo, 'L'economia', in *Storia di Venezia dalle origini alla caduta della Serenissima*, vol. VII (Roma: Istituto della Enciclopedia Italiana, 1997), 369–433; Panciera 'L'economia'.

⁹ Panciera, 'L'economia', 506–47.

¹⁰ In 1423 the Arsenal employed more than 6,000 guilded workers (Luzzatto, *Storia economica*, 195). The Arsenal's workforce dropped to 2,343 in 1645, 1,393 in 1696, and 1,751 in 1780 (Beltrami, *Storia della popolazione*, 212). Robert Davis argues that employment in the Arsenal remained stable and absenteeism was actually curtailed substantially during the seventeenth century: Robert C. Davis, *Shipbuilders of the Venetian Arsenal: Workers and Workplace in the Preindustrial City* (Baltimore: Johns Hopkins University Press, 1991), 11–28, but his figures show that there were only between 1,100 and 1,871 active workers at the time: Robert C. Davis, 'Venetian Shipbuilders and the Fountain of Wine', *Past and Present* 156 (1997), 78.

structures,¹¹ while the state sponsored initiatives aimed at balancing corporate privilege and foreign innovation.¹²

When the Venetian Republic fell in 1797, the city's industries were certainly smaller and less vibrant than during the fifteenth and sixteenth centuries. But they were also very different, in terms of guild organisation, labour composition, production techniques, and market outlets. Moreover, some of the city's trades, including glassmaking, had actually expanded. In this chapter, I do not wish to reassess the long-term downturn of the Venetian economy as a whole, but I seek rather to illustrate important features of the economy by looking specifically at the reaction by major craft guilds to technological innovation.

Why Silk and Glass?

Silk and glass were among the most prestigious and largest sectors of the early modern Venetian economy. They were not, strictly speaking, representative of the entire artisan world, but they exemplify larger problems concerning the long-term development of a production system largely controlled by craft guilds.

The manufacturing of silk textiles is usually viewed as an exception to the generalised decline of Italian industries, and of the woolen industry in particular, in the seventeenth century. Italian producers responded to the growing competition of Dutch and English woolen textiles by switching investments towards luxury goods, in particular silk. By 1660, after a depression in the first half of the century, silk cloth production equalled and even outstripped that of a century before. Overall Italian production of silk textiles grew 3.7 times between 1600 and 1780, from 1,200 to 4,400 tons, and the number of active looms increased 15 percent from the early sixteenth to the mid-eighteenth century.¹³ Throughout the seventeenth and eighteenth centuries, the Venetian state was the largest silk producer of the peninsula, and its capital, Venice, led the switch from

¹¹ Andrea Vianello, *L'arte dei calegheri e zavateri di Venezia tra XVII e XVIII secolo* (Venezia: Istituto Veneto di Scienze Lettere ed Arti, 1993); Marcella Della Valentina, 'Manifattura serica, evasione fiscale e contrabbando a Venezia nel Settecento', *Annali dell'Istituto Storico Italo-Germanico in Trento* 24 (1999), 53–86; Trivellato, *Fondamenta*; Marcella Della Valentina, *Operai, mezzadi, mercanti: Tessitori e industria della seta a Venezia tra '600 e '700* (Padova: CLEUP, 2003). Note that Venetian guilds never participated in government.

¹² Roberto Berveglieri, *Inventori stranieri a Venezia (1474–1788): Importazione di tecnologia e circolazione di tecnici artigiani inventori: Repertorio* (Venezia: Istituto Veneto di Scienze Lettere ed Arti, 1994), 167–79; Panciera, 'L'economia'.

¹³ Paolo Malanima, *La fine del primato: Crisi e riconversione nell'Italia del Seicento* (Milano: Bruno Mondadori, 1998), 110, 168–71.

wool to silk cloth production in the seventeenth century.¹⁴ The switch was accompanied by increased competition over quality and product differentiation, and by changes in patterns of consumption that opened up new markets for the so-called populuxe goods, including light silk veils, silk stockings, and cheap damasks.¹⁵

Despite the increased relocation of silk spinning and weaving to provincial towns and small centres of the Venetian territories (Vicenza, Verona, Brescia, Bassano, Treviso, Udine, Castelfranco), silk manufacturing did not desert the capital. In Venice there were about 2,000 silk looms in the 1530s, although not all of these were active. Total numbers fell from 2,200 to 1,800 between 1592 and 1605 (though they hit a peak of 2,400 in 1602), but in the 1680s and '90s they had climbed up to 2,600–2,700.¹⁶ Eighteenth-century documentation usefully lists both the total and the active number of looms – active looms were 1,416 out of 2,103 in 1705, 1,404 out of 1,909 in 1732, and 1,128 out of 1,630 in 1751;¹⁷ by the 1770s, however, the number of looms had decreased to less than 1,000.¹⁸ As opposed to looms, master weavers enrolled in the guild numbered 400 in 1430, 500 in 1493, 1,200 in 1554, 733 in 1672, 1,086 in 1685, 823 in 1705, 1,206 in 1712, 845 in 1732, and 714 in 1751.¹⁹

Glass production experienced a more sustained expansion. Venetian glassmaking remained an essentially urban occupation throughout the early modern period, and expanded in size in the seventeenth and eighteenth centuries. On the island of Murano (situated in the Venetian lagoon about 1.5 km north of the city), the glassblowers' guild counted 162 masters in 1674 and 167 in 1678; a century later, they numbered over 250, though many were unemployed. In 1743, 471 guild members worked at

¹⁴ Malanima, *La fine del primato*, 172, 175–7; Sella, *Commerci e industrie*, 83.

¹⁵ For market segmentation and differentiation, see Poni, 'Archéologie de la fabrique'. The term *populuxe*, which originally referred to cheap imitations of luxury goods (Cissie Fairchild, 'The Production and Marketing of Populuxe Goods in Eighteenth-Century Paris', in John Brewer and Roy Porter (eds.), *Consumption and the World of Goods* (London: Routledge, 1993), 243n6), has come to indicate by extension the lower-end luxury goods that spread among broad segments of the population.

¹⁶ Luzzatto, *Storia economica*, 193; Sella, *Commerci e industrie*, 123–5; Molà, *The Silk Industry*, 17. Molà demonstrates the inaccuracy of previous studies, which maintained that Venetian silk production peaked in the fifteenth century; his analysis substantiates some of the claims in Richard A. Goldthwaite, *Wealth and the Demand for Art in Italy 1300–1600* (Baltimore: Johns Hopkins University Press, 1993), 13–29.

¹⁷ Della Valentina, *Operai, mezzadi, mercanti*, 43.

¹⁸ See Della Valentina ('Manifattura serica', 65), who acknowledges that Venetian silk manufacturing declined in the second half of the eighteenth century, but qualifies the extent of the downturn.

¹⁹ For the fifteenth and sixteenth centuries, see Molà, *The Silk Industry*, 17. For the seventeenth and eighteenth centuries, see Della Valentina, *Operai, mezzadi, mercanti*, 43.

the thirty-one furnaces in the island – 170 of them were masters and 220 simple workers.²⁰ Master mirror makers in Venice grew in number until the 1670s (from 356 in 1595 and 237 in 1603, to 551 in 1639, 712 in 1660, and 809 in 1672), when they began to suffer from French competition. Master window makers never quite reached 100. There were also about 300 master bead makers in the late seventeenth century, and a hundred more in 1754.²¹

Granted the impossibility of finding exact figures about guild enrolment and of the active workforce in particular, glass and silk production together seem to have employed between a third and half of the city's artisans in the late eighteenth century. In 1773, a survey of guild membership counted 6,344 silk weavers (the largest guild in town), 112 silk-stocking makers, 82 silk spinners, 73 silk dyers, and 62 silk merchants; altogether the glassmaking and glass-retailing guilds – the glassblowers, mirror makers, bead makers, window makers and ordinary glass retailers – included 1,766 members. With 8,439 members, the guilds of the silk and glass sectors accounted for nearly 30 percent of the town's corporate labour force of 28,427 individuals.²² However, a comprehensive estimate of Venetian industries carried out in 1808, after the guilds had been abolished, found that 25,326 artisans had been active in Venice in 1780, 6,650 of whom (26 percent) were employed in producing silk cloth of the highest quality (*tessuti auroserici*, silk cloth mixed with gold thread), and 7,662 (30 percent) were active in glassmaking (6,064 of them in bead making).²³

Clearly, to argue, as many have done, that early modern Venetian silk and glass production was in decline is not to tell the whole story. The demise of Venetian silk weaving occurred only in the 1770s. Venetian glassmaking had begun to shift its main focus from blown crystals towards beads and small mirrors a century before, and followed this trend by growing in overall size and, to some extent, in productivity. The process of change in both sectors, largely prompted by international competition

²⁰ Trivellato, *Fondamenta*, 152–4.

²¹ Ibid., 148–9. Seventeenth- and eighteenth-century Venice also numbered between nine and fifteen opticians' workshops; see Daniela Bartolini and Silvia Miscellaneo, 'Prima dell'occhialeria cadarina: la produzione veneziana tra il XVI e il XVIII secolo', in *Punto di vista: Ricerche sulla storia dell'occhiale* (Pieve di Cadore-Lajoux: Fondazione Museo dell'Occhiale-Parc naturel régional du Haut-Jura, 2001), 106–10.

²² Data in Agostino Sagredo, *Sulle consorziate delle arti edificative in Venezia* (Venezia: Tip. Naratovich, 1857), 246–7, 255, 257, 267–70, 272, 274. According to a later survey, in 1797 there were 7,510 guild members in the silk sector and 1,825 in the glass sector; see Massimo Costantini, *L'albero della libertà economica: Il processo di scioglimento delle corporazioni veneziane* (Venezia: Arsenale Editrice, 1987), 34–6.

²³ Data in Costantini, *L'albero*, 56–7.

and new patterns of consumption, was mostly evolutionary but also witnessed some sharp turning points.

The silk and glass industries had a number of important similarities and some significant differences as well – a fact that makes them an interesting case study for our purposes. Silk and glass items were largely export-oriented luxury goods, and both trades were controlled by ancient craft guilds of great relevance for the Venetian state and society. Both industries underwent significant changes in their labour composition and production techniques, but the specificities of each created different conditions for technological change. Human capital was comparatively more important in glassmaking, especially in the first production phases carried out in the Murano furnaces, than in silk weaving.²⁴ In the long run, silk weavers were the least protected and glassblowers the most protected among the city's workforce.²⁵ Moreover, machines had a greater impact on silk weaving than on glassmaking, and the latter remained concentrated in an urban environment. Labour markets in both industries became increasingly segmented, and marginal groups were trained and employed outside guild membership.

Economic historians frequently charge craft guilds with three capital sins: reluctance to lower quality standards of their finished products; failure to cut labour costs; and a general tendency to impose strict technical procedures even when these become obsolete. What follows scrutinises these claims in regard to Venetian silk and glass production between the sixteenth and eighteenth centuries. I begin by showing how guilds proved remarkably receptive to changes in domestic and foreign markets, even when this entailed lowering product quality. I then examine how reforms of male apprenticeship went hand in hand with an expansion of women's work, which brought a reduction in labour costs. I follow this by exploring the impact of intra- and inter-guild conflict on the reception of technological innovation. Finally, I show how guild statutes left room for intra-guild

²⁴ In this chapter I discuss human capital formation but not the circulation of semi- and skilled artisans and entrepreneurs, which is nonetheless an issue of great importance for the history of technical change. Suffice it to note that the Venetian silk industry was comparatively more open to foreign artisans than the glass sector. Guilds in both sectors always obstructed emigration of specialised artisans, but silk producers were possibly less strict in this regard. Compare Molà, *The Silk Industry*, 43–7, with W. Patrick McCray, 'Creating Networks of Skills: Technology Transfer and the Glass Industry of Venice', *Journal of European Economic History* 28 (1999), 300–33.

²⁵ The silk weavers' guild was the first and only guild to be abolished, in 1782; the glassblowers' guild was the last to be dismantled, in 1808. See Giuseppe Tabacco, *Andrea Tron (1712–1785) e la crisi dell'aristocrazia senatoria a Venezia* (Trieste: Istituto di Storia Medievale e Moderna, 1957), 173–85; and Costantini, *L'albero*, 139–51, respectively.

competition on product quality and process, and I discuss what this reveals about the tension between public and private, and individual and collective technical knowledge.

Patterns of Demand and Global Markets

In early modern Venice the silk and glass manufacturing guilds did not aim to preserve high quality standards for luxury goods at any cost. Instead, guild and state regulations adapted to meet new consumption patterns and foreign competition, responding positively to the expansion of local demand for cheap goods (such as household glassware or light silk veils) and promoting specialisation and diversification into niche markets abroad. The chronology of these structural adjustments, however, differed in silk and glass production and was largely dictated by technological changes first introduced abroad. Venetian silk manufacturing expanded its range of products towards lower-quality cloth during the sixteenth century, when other Italian states brought expensive silk textiles on the market. From the 1620s to the 1770s, instead, it specialised in more refined and expensive textiles to compete against the fashionable, cheaper cloth produced in Lyon and Bologna in particular.²⁶ The primacy of Venetian glassmaking, in contrast, which rested on its inimitable blown crystals, only lasted until the mid to late seventeenth century when new products and processes were introduced in Bohemia, England, and France. At that point, Venetian producers switched to making glass beads and small mirrors, articles that required lower capital input and rested on local know-how but still enjoyed great commercial success.

Regulation of the silk industry began in 1256, when the statutes of the silk weavers' guild detailed the characteristics of each kind of fabric in terms of width, length, weight, number of threads, and so forth, and appointed a special committee (*officio dei panni d'oro*) to inspect the final product. In 1457, the Senate updated these specifications (including for dyeing) for five categories of silk fabric: *drappi domestici* for local trade and consumption, *drappi da paragon* and *drappi mezzani* for both local and foreign markets, and *drappi da navegar* and *drappi da fontego* for export alone – a set of distinctions that already signalled a keen awareness of market segmentation. From 1494, merchants were required to register

²⁶ Competition also came from the Veneto mainland, where cheap silk cloth was made and sold without passing through Venice from the early sixteenth century, in defiance of state legislation; Edoardo Demo, *L'anima della città: L'industria tessile a Verona e Vicenza (1400–1550)* (Milano: Unicopli, 2001).

every fabric made by their workers with the guild and have it sealed with official stamps.²⁷ These rules, however, were constantly updated to meet changes in demand, and were also often bypassed when they fell behind market changes.²⁸

Beginning in the fifteenth century, both merchant-producers and silk weavers favoured lowering the quality and enlarging the assortment of goods. State authorities eventually sanctioned product innovation as a rational response to shifts in demand. In 1528, for example, after some reluctance, the Board of Trade endorsed the request to legalise the manufacture of cheap and small silk veils (*poste* and *sottoposte*), which were narrower and used cheaper raw materials than allowed by law. Production of these veils, which were sold both abroad and to a substantial market of middle- and lower-class Venetians, including working-class women, later spread successfully to Bologna and across central and northern Italy more generally.²⁹

In the second half of the sixteenth century, production of cheaper, lower-quality, mixed silk and cotton fabrics expanded substantially in conjunction with 'a transition from a market dominated by quality to a market more and more open to less expensive products'.³⁰ Relaxations of quality standards included the permission to use weft threads to make *drappi mezzani* and, in 1562, to use waste-silk threads in the subsequently

²⁷ Romolo Broglio d'Ajano, 'L'industria della seta a Venezia', in Carlo M. Cipolla (ed.), *Storia dell'economia italiana*, vol. I (Torino: Einaudi, 1959), 226, 240–3; Molà, *The Silk Industry*, 97–8.

²⁸ The specific characteristics of each fabric were legislated in 1612, 1666, 1700, 1744 and 1756; see Marcello Della Valentina, 'Seta, corporazioni e qualità della produzione a Venezia nel Settecento', in Livio Antonielli, Carlo Capra, and Mario Infelise (eds.), *Per Marino Berengo: Studi degli allievi* (Milano: Franco Angeli, 2000), 491n5 (but see the whole essay for the controversies between merchants and weavers over quality control). The approval of altogether new guild statutes by state authorities was a rare occurrence, but existing charters were constantly updated through the integration of court sentences, rulings of the guild's assemblies, and state decrees. Far from fixed norms, guild statutes should be considered as rules-in-progress. Only when major reforms took place, or a new guild was created, were statutes entirely rewritten. Thus the statutes of Venetian silk weavers were codified only in 1265, 1488, and 1754, and those of Murano glassblowers in 1271, 1441, and 1766. On the 'open' character of guild statutes, see Paola Lanaro, 'Guilds Statutes in the Early Modern Age: Norms and Practices: Preliminary Results in the Veneto Area', in Guenzi, Massa, and Piola Caselli (eds.), *Guilds, Markets and Work Regulations*, 191–207.

²⁹ In 1526 about 30,000 *poste* were made in Venice using 45,000 lb of silk thread, the equivalent of over 43 percent of all raw silk used in Florence at the time and nearly 25 percent of the raw silk used in Venice in the 1560s; Luca Molà, 'Le donne nell'industria serica veneziana del Rinascimento', in Luca Molà, Reinhold C. Mueller and Claudio Zanier (eds.), *La seta in Italia dal Medioevo al Seicento: Dal baco al drappo* (Venezia: Marsilio, 2000), 432–6, 440–1.

³⁰ Molà, *The Silk Industry*, 149–50. These norms overrode the thirteenth-century prohibition to thread cotton with silk.

very popular cheap brocades (*brocatelle*). Venetians were also prompt in expanding the palette of colours. Mexican cochineal reached Europe in the early 1540s, and was adopted in Venice already in 1543 with the enthusiastic support of the dyers' guild.³¹ At the same time, high quality standards were maintained for the luxury *panni da paragon*. Thus, the Venetian silk industry increasingly polarised into a more conservative, high-quality sector subject to strict government regulation, and a more dynamic, low-quality sector where regulation could be easily evaded.³² After the plague of 1576 the rate of innovation increased, with government approval forthcoming for the liberalisation of light silk fabrics, such as *ormesini* and taffetas, and production of mixed cloth, such as *rasetti* and *canevazze*, made with a silk warp and a weft of waste silk and flax. The government specified as its only limitation that these cheaper cloths be clearly recognizable as such.³³

In the early seventeenth century, a general setback in the city's economy put an end to this trend. Production of the popular *ormesini bassi* was nearly discontinued, and the overall silk output declined. Producers reacted to the crisis by switching to high-quality *tessuti auroserici*, whose output grew from 25,600 m in 1620 to 76,700 m at the end of the century.³⁴ Venice now invested in the upper end of its silk textiles, although the shift in quality was not incremental. For example, after 1554, masters – who could have a maximum of six looms at home – were permitted to keep two of them (called *telai di grazia*) to weave fabric that they could sell on their own account, as long as they only used raw silk of their own and did not use the silk advanced to them by merchant-producers. Family members, including women, were allowed to work at these two looms. Most *telai di grazia* produced cheap imitations of damask cloth, with fewer silk and gold threads, which sold on domestic markets.³⁵ Still, by the 1760s colourfully designed and expensive *lavori in opera* and *tessuti*

³¹ Ibid., 120–7. In the 1580s, however, the same guild opposed an innovation in black dye (*goro*), arguing that it favoured mercers rather than consumers, but government authorities, persuaded by the tabby makers' guild, stepped in to prevent the loss of lucrative new techniques; Ibid., 134–7, 185. Inter-guild conflict as a factor in technical conservatism is discussed later.

³² Ibid., 147, 152–6, 167–85.

³³ Ibid., 84, 170–7.

³⁴ Sella, *Commerci e industrie*, 46, 67, 131. In 1681, the French consul estimated that 3,000 workers were employed to make *tessuti auroserici*, while a government survey in 1685 counted 1,086 master silk weavers, 463 journeymen, and 2,626 looms; see Pezzolo, 'L'economia', 387, 428n55.

³⁵ In 1766, only 107 out of 238 *telai di grazia* wove luxury goods; Della Valentina, 'Seta, corporazioni e qualità', 493n8. From 1422 (when this system came into existence) to 1554, master weavers were allowed to have only one loom at their disposal; Molà, *The Silk Industry*, 426.

auroserici made up 65–70 percent of the entire Venetian production of silk cloth. However, a decade later the proportion was reversed, and cheaper and simpler *lavori alla piana* accounted for 70 percent of the city's output – a drastic turnaround dictated by the Russo-Ottoman war in the eastern Mediterranean and the rising competition of Asian silk textiles, which marked the definitive decline of Venetian silk production.³⁶

Changes in the Venetian glass industry in the early modern period were likewise largely demand-driven.³⁷ In the last quarter of the seventeenth century, challenges to Venetian leadership as the world's major glass producer affected the manufacturing of blown crystal objects and larger mirrors in particular. As a result, Venetian glass production shifted from crystal glassware towards small mirrors and glass beads, which were in high demand, the former in the Ottoman Empire, the latter in West Africa and North America. In 1780, out of 1,670 tons of Sicilian ash purchased by the Murano guild, only 190 were used to make crystal glass, 715 to make windowpanes and mirror plates, and as many as 765 to make glass beads and enamel. Moreover, the majority of mirror plates were small in size, including a popular type of mirror that measured 25 × 19 cm and was largely sold in the Levant and North Africa. Shifts in product mix led to a sharp increase in output. By the second half of the eighteenth century, production was twice what it was two centuries earlier, a time that is generally considered to have been the high point of the Murano industry. In 1592, twenty-four furnaces were active in Murano, and consumed about 572 tons of soda ash every year. In the last thirty years of the eighteenth century, thirty to forty furnaces were open, and the annual consumption of ash (in the 1760s) was nearly 1,200 tons.³⁸

Reformers, travellers, and diplomats of the time were impressed by the success of Venetian glass beads, especially in colonial markets.³⁹ Glass

³⁶ Della Valentina, 'Manifattura serica', 67–71; Della Valentina, *Operai, mezzadi, mercanti*, 140–1.

³⁷ I emphasise the role of *foreign* demand, because glass was predominantly an export industry and because export data are more substantial (for glass exports in the late eighteenth century, see Trivellato, *Fondamenta*, 229–45). W. Patrick McCray, *Glassmaking in Renaissance Venice: The Fragile Art* (Aldershot: Ashgate, 1999) stresses the importance of new patterns of domestic consumption to explain technical changes in Venetian glassmaking, but does not support his thesis with solid evidence.

³⁸ Gino Corti, 'L'industria del vetro di Murano alla fine del secolo XVI in una relazione al granduca di Toscana', *Studi Veneziani* XIII (1971), 649–51, for data about 1592; Trivellato, *Fondamenta*, 226–34, for data about the eighteenth century.

³⁹ After travelling to Murano in 1728, Montesquieu noted: 'Il se fait un grand commerce en Europe de certaines perles de verre qui se font à Murano & se façonne à Venise, qui s'envoient en Italie & dans le reste même de l'Europe, pour les Sauvages & Nègres.' Charles Montesquieu de Secondat, *Oeuvres complètes*, ed. by André Masson, 3 vols (Paris: Nagel, 1950), vol. II, 995. In 1752, the French consul expressed his government's interest

bead manufacturing was introduced in Austria, England, France, and Portugal, and European states competed intensely in this sector. Yet only Venice and Amsterdam made glass beads in substantial quantities, and Venice supplied European colonial powers, especially England and Portugal, with goods that acquired enormous value overseas. In Africa, glass beads were traded for gold, ivory, other precious goods, and even slaves, while in North America they were exchanged for beaver pelts. The Royal African Company and the Hudson Bay Company were among the main traders of glass beads; the latter was even nicknamed "Hudson Bay Bead" for its habit of listing beaver fur prices in bunches of seed beads.⁴⁰ The Savary brothers' famous *Dictionnaire universel du commerce* explained that Venetian *conterie* (seed-beads, Fr. *rassade*) were some of the best merchandise to trade with 'les Sauvages du Canada & les Negres de Guinée', and suggested that the price of 612 Black men in West Africa was 1.2 tons of glass beads.⁴¹

Labour Formation and Composition

Having seen how craft guilds did not always fight to maintain high quality standards, let us now address their alleged unwillingness to cut labour costs. However, given the scarcity of available data about wages across time and sectors, we need to approach this issue indirectly by examining changes in labour relations within and around craft guilds.

in these items, and estimated the annual production of Venetian glass beads at a little more than one million *ducati*: Jean Georgelin, *Venise au siècle des lumières* (Paris-Le Havre: Mouton-École des Hautes Études en Sciences Sociales, 1978), 182.

⁴⁰ On the Netherlands, see Karlis Karklins, 'Seventeenth Century Dutch Beads', *Historical Archaeology* 8 (1974), 62–82; Jan Baart, 'Glass Bead Sites in Amsterdam', *Historical Archaeology* 22 (1988), 67–75. On Canada, see W. C. Orchard, *Beads and Beadwork of the American Indians* (New York: Museum of the American Indian-Heye Foundation, 1929), 87–9; Douglas MacKey, *The Honourable Company: A History of the Hudson's Bay Company* (New York: The Bobbs-Merrill Company, 1936), 85; Ann M. Carlos and Frank D. Lewis, 'Trade, Consumption, and the Native Economy: Lessons from York Factory, Hudson Bay', *Journal of Economic History* 61 (2001), 1045. On Africa, see K. G. Davies, *The Royal African Company* (London: Longmans, Green, and Co, 1957), 175–87; James A. Rawley, *The Transatlantic Slave Trade: A History* (New York: Norton, 1981), 34–5; David Richardson, 'West African Consumption Pattern and Their Influence on the Eighteenth-century English Slave Trade', in Henry A. Gemery and Jan S. Hogendorn (eds.), *The Uncommon Market: Essays in the Economic History of the Atlantic Slave Trade* (New York: Academic Press, 1979), 303–30.

⁴¹ Jacques Savary des Bruslons and Philemon Louis Savary, *Dictionnaire universel de commerce*, 2 vols (Paris: chez Jacques Estienne, 1723), vol. I, 1481, and II, 1273. At the cost of about 38 *ducati* per 100 Venetian pounds, 1,543 *ducati* of *conterie* were necessary to purchase 612 slaves. A Black man was thus valued at 2.5 *ducati* at a time when an unemployed Murano glass master received a dole of 70 *ducati* a year.

The transfer of skills and practical knowledge was a primary function of medieval and early modern guilds, and apprenticeship the chief means through which this function was fulfilled. In Venice, guilds generally included three almost exclusively male groups: apprentices, journeymen, and masters. The apprentices' starting age, the length of the first two stages in an artisan's career and the rites of passage from one stage to the other varied from guild to guild. Apprenticeship rules were radically modified by numerous guilds in the 1670s in response to severe economic crisis and growing foreign competition.⁴² In 1673, silk weavers extended the apprenticeship from five to seven years, and the journeymanhood from five to six years. Five years later, they limited the number of apprentices a master could employ to one or two, depending on the kind of fabrics he produced. Rising international competition was invoked to justify these measures, and the Senate approved them to appease the guild's masters.⁴³ Between 1672 and 1675 the three guilds that controlled the second phase of bead and mirror making presented similar cases, and banned all new apprenticeships for ten years.⁴⁴ From 1685 to 1690, the Murano glassblowers also refused admission to new apprentices and raised enrolment fees.⁴⁵ In 1710, silk weavers abolished all apprenticeship restrictions, but by then the guild's practices had been transformed to favour the admittance of the guild masters' sons.⁴⁶ In sum, Venetian guilds closed their ranks, allowed masters' sons to enrol as masters without passing a test and upon payment of a tax, and generally loosened restrictions for the employment of masters' family members – in appearance, a typically conservative, rent-seeking response to economic hardship.⁴⁷ Yet, there is no clear evidence that labour costs in Venetian silk manufacturing increased or were higher than in provincial towns.⁴⁸ For, at the same time that guild

⁴² It is not clear why these reforms occurred in the 1670s, although this was a difficult period for the city's economy. It may have also been a reaction to the suspension of all residency requirements for guild apprentices following the plague of 1630–1: ASV, *Senato terra*, registro 106, fol. 451r.

⁴³ Della Valentina, *Operai, mezzadi, mercanti*, 114–5. In 1755, the length of apprenticeship was again five years.

⁴⁴ Trivellato, *Fondamenta*, 164. The provision was renewed after the decade had elapsed.

⁴⁵ *Ibid.*, 71–2.

⁴⁶ Della Valentina, *Operai, mezzadi, mercanti*, 118.

⁴⁷ Richard Mackenney, 'The Guilds of Venice: State and Society in the longue Durée', *Studi Veneziani* 34 (1997), 15–43. This process is reflected in the language of Italian guild statutes, in which a medieval ethic based on notions of equity and distributive justice gave way to a more exclusive hierarchy of privilege; Lanaro, 'Guilds Statutes', 202–3.

⁴⁸ The vast majority of silk weavers worked for wages. Wage tariffs were drafted in 1696, 1707, and 1722, but the Venetian silk merchants refused to apply them, claiming that the infinite variety of cloth and differences in individual productivity made wage standardisation impossible. The silk weavers' guild thus failed to protect its members' salaries. In 1781, the salaries of Venetian silk weavers were equal to (if not lower than) those paid in

hierarchy was becoming more rigid, it was also expanding employment of illicit or semi-licit labour – wage labourers, including women, became an integral part of the guild's world despite being formally excluded from it.

A gendered division of labour had always existed in the Venetian silk industry. In the fourteenth and fifteenth centuries, women worked as winders and warpers, and some were also involved in silk weaving, though mostly within the male master's household.⁴⁹ Female silk winders included some in subordinate roles and others who subcontracted work to other women.⁵⁰ Nevertheless, women's upward mobility was very limited, and in the course of the late Middle Ages, in conformity with a general European pattern, women's positions in Venetian guilds deteriorated further. Young girls were increasingly forbidden from entering formal apprenticeship, and the parallel advantages in terms of career opportunities given to masters' sons emphasised the patriarchal nature of the guild organisation.⁵¹ In Venice, this process gave rise to the creation of a

Padua and Vicenza; the latter was a particularly competitive centre of silk production at the time (Della Valentina, *Operai, mezzadi, mercanti*, 94–108). Wage levels and individual productivity were strongly correlated in the Murano glass furnaces of the seventeenth century; Francesca Trivellato, 'Salaires et justice dans les corporations vénitienes au 17e siècle: Le cas des manufactures de verre', *Annales HSS* 54 (1999), 245–73.

⁴⁹ Broglio d'Ajano, 'L'industria', 228–30. After 1410, female winders were required to undertake a formal three-year apprenticeship, in response to a temporary industrial downturn; *ibid.*, 241. In the previous decades, about two hundred women worked as winders in Venice without apprentice contracts: Luca Molà, *La comunità dei lucchesi a Venezia: Immigrazione e industria della seta nel tardo medioevo* (Venezia: Istituto Veneto di Scienze Lettere ed Arti, 1994), 192–3.

⁵⁰ This division of labour was fully recognised, and a system that allowed illiterate women to keep accounts with merchant-producers was legalised in 1420; Molà, 'Le donne', 427–9.

⁵¹ See e.g. Martha C. Howell, *Women, Production, and Patriarchy in Late Medieval Cities* (Chicago: Chicago University Press, 1986); Merry E. Wiesner, *Working Women in Renaissance Germany* (New Brunswick, NJ: Rutgers University Press, 1986); David Herlihy, *Opera Muliebria: Women and Work in Medieval Europe* (New York: McGraw-Hill, 1990); Katrina Honeyman and Jordan Goodman, 'Women's Work, Gender Conflict, and Labour Markets in Europe, 1500–1900', *Economic History Review* 44 (1991), 608–28; Daryl M. Hafer, 'Women Who Wove in the Eighteenth-century Silk-Industry of Lyon', in Ead (ed.), *European Women and Preindustrial Craft* (Bloomington: Indiana University Press, 1995), 42–66; Elizabeth Musgrave, 'Women and the Craft Guilds in Eighteenth-Century Nantes', in Geoffrey Crossick (ed.), *The Artisan and the European Town, 1500–1900* (Aldershot: Scolar Press, 1997), 151–71; Sheilagh Ogilvie, *A Bitter Living: Women, Markets, and Social Capital in Early Modern Germany* (Oxford: Oxford University Press, 2003). On Venice, see Luigi Dal Pane, *Storia del lavoro in Italia dagli inizi del XVIII al 1815* (Milano: Giuffrè, 1944); Anna Bellavitis, 'Donne, cittadinanza e corporazioni tra Medioevo ed età moderna: ricerche in corso', in Nidia Filippini, Tiziana Plebani, and Anna Scattigno (eds.), *Corpi e storia: Donne e uomini dal mondo antico all'età contemporanea* (Roma: Viella, 2002), 87–104; Anna Bellavitis, 'Le travail des femmes dans les contrats d'apprentissage de la Giustizia vecchia (Venise, XVIe siècle)', in Isabelle Chabot, Jérôme Hayez, and Didier Lett (eds.), *La famille, les faemmes et le quotidien (XIVe-XVIIIe siècle): Textes offerts à Christiane Klapisch-Zuber* (Paris: Publications de la Sorbonne, 2006), 181–95.

tripartite gender segmentation of the labour market, well documented in silk weaving in the late fifteenth and sixteenth centuries and in the making of semi-finished glass beads from the mid-seventeenth century: male masters and their sons had the full range of privileges; their wives, widows, and daughters held limited rights in the craft; and women unrelated to male guild members were left unprotected and mostly confined to the least desirable jobs, although hierarchical differences developed within this segment of the labour market as well.⁵²

In the eighteenth century, the Venetian government increasingly recognised the de facto expansion of women's participation in silk weaving outside formal apprenticeship contracts. Initially, it made some exceptions to guild restrictions on female work.⁵³ In 1754, a general reform of the Venetian silk weavers' guild admitted women to guild membership, and even allowed them to become masters and operate their own workshop.⁵⁴ At this date, the silk weavers' guild comprised 344 wives, daughters, and widows of guild masters, and 1,128 women who were not officially enrolled but worked as weavers. Thus, women accounted for 65 percent of a total of 2,256 guild workers.⁵⁵ Nonetheless, they were still second-rate members, for they could not serve as guild officials, vote in the guild's assembly, or own *telai di grazia* – a restriction that limited their income. Twenty years after women were admitted to the guild, only 10 percent of Venetian silk weaving workshops were operated by women, and most had only one or two looms as opposed to the upper limit of six. Women instead became increasingly numerous among apprentices, who were paid much lower salaries than their male peers.⁵⁶

⁵² A short-lived exception to this pattern was the silk-stocking guild, created in 1683, which forbade women from working at the loom only in 1704: Walter Panciera, 'Emarginazione femminile tra politica salariale e modelli di organizzazione del lavoro nell'industria tessile veneta nel XVIII secolo', in Simonetta Cavaciocchi (ed.), *La donna nell'economia secc. XIII-XVIII (Atti della "Ventunesima Settimana di Studi" dell'Istituto Internazionale di Storia economica «F. Datini»)*, Prato, 10–15 aprile 1989 (Firenze: Le Monnier, 1990), 585–96.

⁵³ Women were banned from the silk loom from 1482: Molà, 'Le donne', 425. In 1688–89, the Senate agreed to allow fifty women to work at the loom, against the opinion of the silk weavers' guild. The *Consoli dei mercanti* unsuccessfully forbade this practice in 1710, 1718, and 1728, and twenty-three more women were officially admitted to work at the loom: Panciera, 'Emarginazione femminile', 594.

⁵⁴ Panciera, 'Emarginazione femminile', 591–6.

⁵⁵ Della Valentina, *Operai, mezzadi, mercanti*, 131.

⁵⁶ *Ibid.*, 134–8. There were no women's guilds in early modern Italy on a par with those found, albeit exceptionally, in Paris, Le Havre, Rouen, and Cologne during the seventeenth and eighteenth centuries. On the seamstress guild formed in Paris in 1675, see Judith G. Coffin, 'Gender and the Guild Order: The Garment Trades in Eighteenth-Century Paris', *Journal of Economic History* 54 (1994), 768–93; Claire H. Crowston, *Fabricating Women: The Seamstresses of Old Regime France, 1675–1791* (Ithaca: Cornell University Press, 2001).

This situation was by no means unique to Venice. From the late sixteenth century onwards, women became indispensable in silk manufacturing everywhere in Italy.⁵⁷ At the same time, female employment was by and large confined to the least-paid occupations and the making of the least prestigious fabrics.⁵⁸ In eighteenth-century Bologna, women dominated manual, as opposed to mechanical, silk winding and twisting. They also outnumbered men in the weavers' guild, but specialised in light veils (*opera bianca*) and mixed cloth made of residual threads like *bavelle*, while men wove the more complex brocades, damasks, taffetas, velvets, and satins (*opera tinta*).⁵⁹ Throughout the eighteenth century, Venetian women wove predominantly poor-quality silk fabrics, but they also occasionally wove richer *drappi in opera*.⁶⁰

In the Murano glass furnaces, highly skilled workmanship was critical, and the glassblowers' guild consequently exerted strict control over training. There too, however, especially after the plague of 1630–31, we observe growing friction between the corporate hierarchy and its recruitment base. Several immigrants from Friuli, in the eastern part of the Venetian territorial state, were hired as semi-skilled workers in the Murano furnaces and some moved up the socio-economic ladder.⁶¹ At the same time, starting from 1660, merchant-producers were forced to pay an annual

⁵⁷ Jordan Goodman, 'Cloth, Gender and Industrial Organization: Towards an Anthropology of Silkworkers in Early Modern Europe', in Simonetta Cavaciocchi (ed.), *La seta in Europa secc. XIII-XX (Atti della "Ventiquattresima Settimana di Studi" dell'Istituto Internazionale di Storia economica «F. Datini»)*, Prato, 4–9 maggio 1992 (Firenze: Le Monnier, 1993), 229–45.

⁵⁸ In mid-sixteenth century Genoa, the salary of a male weaver accounted for 67 percent of total labour costs, but the salary of a female winder accounted for only 12 percent: Paola Massa Piergiovanni, 'Technological Typologies and Economic Organisation of Silk Workers in Italy, from the XIVth to the XVIIIth Centuries', *Journal of European Economic History* 22 (1993), 546–7. Seventeenth-century Florence was exceptional insofar as women dominated all phases of silk production, accounting for 84 percent of the city's silk workforce in 1662–63. Although piece wages did not differ between men and women, women wove cheaper, coarser cloth and were therefore paid on average less: Judith C. Brown and Jordan Goodman, 'Women and Industry in Florence', *Journal of Economic History* 40 (1980), 78, 79n18.

⁵⁹ Poni, 'Per la storia', 95–6, 124; Carlo Poni, 'Tecnologia, organizzazione produttiva e divisione sessuale del lavoro: il caso dei mulini da seta', in Angela Groppi (ed.), *Il lavoro delle donne* (Roma-Bari: Laterza, 1996), 271–6; Alberto Guenzi, 'La tessitura femminile tra città e campagna: Bologna, secoli XVII-XVIII', in Cavaciocchi (ed.), *La donna*, 247–59.

⁶⁰ Women did not weave velvet cloth (Della Valentina, *Operai, mezzadi, mercanti*, 41) – a result of labour market discrimination rather than of women's lower skill or productivity.

⁶¹ The Murano guild was excluded from the 1631 decree (see note 42), but non-native workers were admitted as auxiliaries in jobs that did not require glassblowing: Luigi Zecchin, *Vetro e vetrai di Murano*, 3 vols (Venezia: Arsenale Editrice, 1987–90), vol. I, 185, and vol. II, 48.

subsidy to unemployed master glassblowers.⁶² These policies may have raised labour costs, but paradoxically, by tightening access to the masters' ranks, they also undermined the craft guilds' technical hierarchies – for journeymen and simple workers were now employed to perform tasks that were theoretically a master's prerogative and were only partially compensated for their qualifications. In 1743, sixteen out of ninety-nine journeymen in the Murano furnaces were officially listed as 'working as masters', and 202 workers (*operai*) had no specified qualifications.⁶³

The growing erosion of artisan career paths was much more obvious in the secondary phases of bead and mirror making. During the seventeenth century, poor immigrants from Friuli increasingly specialised in making small mirrors, and women's employment in bead making expanded. These two groups became pivotal in the development of an urban putting-out system that sustained the growth of export-oriented industries.⁶⁴

Young men from Friuli were well represented among apprentice mirror makers in the seventeenth century.⁶⁵ Yet in 1675, as we saw, this guild blocked the admission of new apprentices. When the ruling was renewed for four years in 1681, it came with a request to control mirror quality more strictly, implying that employing immigrants from Friuli had allowed for cuts in labour costs at the expense of quality. Seventy-five years later, however, a de facto monopoly of the smallest mirrors was granted to the Friulan workers, giving them a second-rank corporate identity. This regulation notwithstanding, civil lawsuits indicate that the immigrants received very poor wages.⁶⁶

Women in glass bead making operated largely at the fringes of the guild system. This manufacturing, though a Venetian speciality since the Middle Ages, boomed in the seventeenth century in connection with the slave and colonial trades. The limitations placed on women by guild statutes coincided, as they had done in silk spinning and weaving, with the development of a large market for waged female labour. Young and old women, trained informally, came to control specific operations such as the sorting and cutting of glass rods, as well as the final stage of stringing

⁶² Trivellato, 'Salaires et justice', 257–8, 262; Trivellato, *Fondamenta*, 68–70.

⁶³ In a different list of the same year, 22 journeymen are recorded as 'working as masters'; Trivellato, *Fondamenta*, 152n63.

⁶⁴ In eighteenth-century Vienna, the artisan labor force similarly comprised a small number of stable masters and large groups of unstable waged workers; Josef Ehmer, 'Worlds of Mobility: Migration Patterns of Viennese Artisans in the Eighteenth Century', in Crossick (ed.), *The Artisan*, 172–99. For putting-out in urban economies, see Carlo Poni, 'Proto-Industrialization, Rural and Urban', *Review* 9 (1985), 305–14.

⁶⁵ Andrea Zannini, 'Flussi d'immigrazione e strutture sociali urbane: I bergamaschi a Venezia', *Bollettino di demografia storica* 19 (1993), 210.

⁶⁶ Trivellato, *Fondamenta*, 155–69.

the beads on cotton and silk threads. They also contributed to lamp bead making. As their involvement in bead manufacturing increased, their participation in the labour market became more complex. In the eighteenth century there is evidence of a putting-out system controlled by a few women who received large commissions from male merchant-producers and sub-contracted the work to other women. For the most part, however, deprived of all guild protection to an even greater extent than male immigrants, women represented a reserve of cheap labour that shrank and expanded according to economic fluctuations. In 1752, the French consul noted that about 2,500 people worked in the Venetian glass bead industry, a number that greatly exceeded the figures of guild enrolment; in 1779, the seed bead makers' guild officially acknowledged employing 1,400 women for stringing beads.⁶⁷ Lower salaries and the almost total lack of protection for women and immigrants from Friuli allowed Venetian production of small-sized mirrors and glass beads to stay internationally competitive and even to increase.

Guild Conflict and Technological Innovation

Claims that craft guilds were averse to technological change usually represent them as homogeneous institutions or draw a sharp distinction between merchant and craft guilds, on the assumption that merchant guilds alone encouraged innovations, especially labour-saving ones. In fact, most craft guilds were highly diversified and conflict-ridden institutions, and merchant-producers also failed to innovate when structural conditions rendered technological change economically disadvantageous.

The Venetian silk weavers' and glassblowers' guilds were both established in the second half of the thirteenth century, in 1265 and 1271, respectively. During the more than five centuries of their existence, both institutions evolved significantly. On the one hand, the gap between merchant-producers and wage labour increased over time and generated vertical conflicts within and outside the guild. On the other hand, new guilds were born in response to increased market specialisation, and struggles arose over their respective sphere of operation. Both intra- and inter-guild conflict – the former particularly marked in the silk industry, the latter in glassmaking – influenced attitudes towards technological innovation.

Medieval Venetian silk manufacturing received a substantial boost after 1314 with the arrival of artisans and entrepreneurs fleeing political

⁶⁷ *Ibid.*, 171–87.

turmoil in Lucca, which was then the European leader in the sector.⁶⁸ The subsequent growth of the silk industry in Venice led to the creation of new guilds. By 1350 merchant-producers had their own independent guild named *corte della seda* and later *officio della seta*; a few years before, in 1347, a new silk weavers' guild had been created specialising in velvet weaving and distinct from the original *samitari* formed in 1265. Following more than a century of expansion, the two weavers' guilds merged in 1488 into the *arte dei tessitori*, which nevertheless maintained an internal partition through the eighteenth century. In addition, a dyers' guild existed since at least the thirteenth century.⁶⁹

During the second half of the sixteenth century, Venetian authorities and silk producers promoted the use of mechanical throwing-mills, still manually operated but capable of producing a fine thread for making cloth similar to Bologna's successful *organzini*.⁷⁰ In 1594, Iseppo Giovan Perin Mattiazzo was granted a ten-year privilege for building a new hydraulic mill on the Venetian mainland, analogous to the mills in Bologna that produced a high-quality, thin warp known as *orsoglio*.⁷¹ These hydraulic mills cut labour costs while improving quality, but to operate required tidal forces not present in the Venetian lagoon. When Mattiazzo's privilege expired in 1604, Ottavio Malpigli obtained exclusive rights to build a similar mill in Padua, where the tides were stronger. Both the silk merchants and weavers supported this innovation and only the Venetian silk spinners' guild – for obvious reasons – opposed it.⁷²

Inter- and intra-guild relations also changed in the Venetian glass industry, giving rise to different attitudes vis-à-vis technological change. In

⁶⁸ Broglio d'Ajano, 'L'industria', 231–2; Maureen Fennell Mazzaoui, 'Artisan Migration and Technology in the Italian Textile Industry in the Late Middle Ages (1100–1500)', in Rinaldo Comba, Gabriella Piccinni, and Giuliano Pinto (eds.), *Strutture familiari, epidemie, migrazioni nell'Italia medievale* (Napoli: Edizioni Scientifiche Italiane, 1984), 519–34; Molà, *La comunità*.

⁶⁹ Molà, *La comunità*, 73, 167–82; Molà, *The Silk Industry*, xvii.

⁷⁰ Molà, *The Silk Industry*, 194–6; Roberto Berveglieri and Carlo Poni, 'L'innovazione nel settore serico: i brevetti industriali della Repubblica di Venezia fra XVI e XVIII secolo', in Molà, Mueller and Zanier (eds.), *La seta in Italia*, 484. In 1543, 550 spinning machines were in operation; 200 were used for local production, and 350 were also at the disposal of foreign merchants: Molà, *The Silk Industry*, 77.

⁷¹ *Ibid.*, 191 (this patent was issued by the *Provveditori di Comun*, see note 86). Hydraulic mills for spinning and throwing silk operated in Bologna from the fourteenth century; they spread to Vicenza and Verona in the 1440s and '50s: Demo, *L'anima della città*, 127. In the sixteenth century, a new device mechanised silk winding as well. The impact of this innovation has been emphasised by Poni, 'Archéologie', but others have downplayed its significance; Flavio Crippa, 'Il torcitoio circolare da seta: evoluzione, macchine superstiti, restauri', *Quaderni Storici* 73 (1990), 187, and Flavio Crippa, 'Dal baco al filo', in Molà, Mueller and Zanier (eds.), *La seta in Italia*, 18–22.

⁷² Poni, 'Archéologie', 1479–82.

1291 the government ordered all glass kilns to be moved to Murano to avoid the risk of fire in the city. Subsequently, a geographical division of labour emerged between the island and the Venetian town centre that gave rise to a distinctively hierarchical specialisation between the crafts. At the top of the ladder were the Murano glassblowers, who prepared finished blown objects as well as semi-finished rods and plates. The secondary preparation of windowpanes, mirrors, and various types of beads was left to guilds based in Venice that depended on Murano for the supply of semi-finished goods. Between the fourteenth and eighteenth century, the Venetian glass sector was thus organised in a system of four or five guilds.⁷³

The most effective labour-saving innovation in the history of pre-industrial European glassmaking was introduced in France for the production of large mirrors. In 1665–66 Colbert attracted some Murano glassworkers to Paris and set up the *Manufacture Royale des Glaces de Miroirs*, which aimed to produce mirrors on a larger scale than in Venice. The real turning point, however, occurred in 1688, when a new mirror-making technique was patented. This cast-plate process consisted of pouring the melted glass on a large surface and subsequently polishing it. In contrast to crown mirrors made in Venice, where the glass was blown into cylinders and then manually stretched into rectangular shapes, the new French method made it possible both to make much larger and regularly shaped plates, and to cut production time in half and significantly reduce labour costs by replacing skilled artisans with unskilled workers.⁷⁴

In Murano, the French cast-plate method of mirror making was not adopted until the mid-nineteenth century. Technological conservatism was the result of both rent-seeking and economically rational behaviour. Master glassblowers, who zealously guarded their interests, could make their voice heard at both the guild and state level, and they were able to ban all imports of foreign mirrors – including the large French ones not available in Venice. Furthermore, no Venetian merchant-producer ever tried to adopt the cast-plate technique because such a venture required substantially larger investments and scale of production compared to existing

⁷³ Bead makers split from crystal carvers to form their own guild in 1318. Their guild split into two (seed-bead and lamp-bead makers) after 1647. An independent mirror makers' guild was created in 1570. The window makers' guild existed from at least 1564. The guild of 'ordinary' glass retailers, never very influential, was founded in 1436 and abolished in 1768: Trivellato, *Fondamenta*, 136–40.

⁷⁴ James Barrelet, *La verrerie en France de l'époque gallo-romaine à nos jours* (Paris: Larousse, 1953), 81–2; Warren Scoville, *Capitalism and French Glassmaking, 1640–1789* (Berkeley: University of California Press, 1950), 40; Claude Pris, *Une grande entreprise française sous l'Ancien-Régime: La Manufacture Royale des Glaces de Saint-Gobain (1665–1830)*, 2 vols (New York: Arno Press, 1981), vol. I, 312.

industries, all to produce a commodity that would have had to compete with the French on the international markets. Instead, Venetian mirror manufacturers concentrated on markets in small mirrors and beads where they could count on low capital outlays and a cheap labour force, and the opportunity costs of trade were far lower. Indeed, judging from the ratio of raw material to number of glass kilns, productivity in Murano increased substantially after 1670. Comparable strategic responses occurred in silk manufacturing in the same period: in Padua and Milan, for example, merchant-producers (rather than weavers) opposed the introduction of English silk-stocking looms because a cheap and sizeable workforce of men, women, and children was already available.⁷⁵ Master glassblowers, in turn, did not always resist labour-saving innovations – in Murano they welcomed the introduction of horse-operated mills for grinding siliceous pebbles to make glass paste; the operation was previously entrusted to unskilled labourers, who were unable to put up much resistance.⁷⁶

Conflict, whether within or among guilds, was a basic feature of the corporate world. In the 1670s, thanks to their *telai di grazia*, a group of silk weavers controlled up to 30 percent of the town's output in popu-luxe cloth. By rule, these masters could only weave raw or semi-finished silk they owned, but in fact they often worked on commission for Jewish, Armenian, Turkish, and Greek merchants, who were not allowed to enrol in the merchant guild but were active in overseas, especially Levantine, trade. The sub-contracting system revolving around the *telai di grazia* thus became an avenue of upward mobility. In 1725, following prolonged strife between silk weavers and merchants, the latter raised the barrier to entry into their guild,⁷⁷ and, for the whole eighteenth century, Venetian silk merchants opposed lower quality standards that might favour independent weavers who operated *telai di grazia*.⁷⁸

Inter-guild conflict also affected the degree of acceptance of technological innovation. In 1712, the Senate issued a patent to a Florentine

⁷⁵ Carlo Marco Belfanti, 'La calza a maglia: moda e innovazione alle origini dell'industria della maglieria (secoli XVI-XVII)', *Società e Storia* 69 (1995), 496–8. In 1570 the Venetian government rejected a 'device aimed at drastically reducing the number of female laborers employed at winding and doubling silk or at spinning other textile fibers', to protect the jobs of non-guilded women: Molà, *The Silk Industry*, 198.

⁷⁶ Trivellato, *Fondamenta*, 200–1.

⁷⁷ Between 1725 and 1754 it became necessary to have owned a silk workshop in Venice for at least ten years, and foreigners had to pay an extra 200 ducats in order to enter the silk merchants' guild; Della Valentina, *Operai, mezzadi, mercanti*, 88.

⁷⁸ This pattern of subcontracting carried on despite an official ban in 1705: Della Valentina, *Operai, mezzadi, mercanti*, 92–4. In 1762, Turkish merchants commissioned cheap damasks that they sold for only 8–10 lire per *braccio*, even though the lowest current price was 16–17 lire; *ibid.*, 90. On conflicts over quality standards between silk weavers and merchants, see Della Valentina, 'Seta, corporazioni e qualità'.

dyer, Cosimo Scatini, allowing him to import a new black dye to Venice at a time when black silk fabrics were at the height of fashion. The dyers' guilds supported the concession, which was meant to create a new plant that would dye the guild's entire output and employ all its workers, but repeated opposition by the silk merchants, who feared outside competition, finally led the Senate to restrict Scatini's privileges.⁷⁹

As these examples suggest, during the eighteenth century Venetian silk merchants as a group behaved rather conservatively, and may well have led to the industry's decline. At thirty to fifty, their numbers were sufficient to defend their interests effectively, but not large enough to maintain adequate investments: about half of them operated less than ten looms, and only two or three had more than fifty.⁸⁰ A few more enterprising merchants did try, however, to keep pace with Lonnais silk manufacturing, which owed its supremacy both to the seasonal update of fashionable design and to continuous improvements of the looms.⁸¹ One innovator was Pietro Manzoni, who in 1771 brought a French technician, Joseph Durand, to Venice to build a new loom that simplified drawn composition. Durand took his expertise to Venetian silk weavers for a cash payment and a share of the city's market, and met with very positive responses among silk weavers. The experiment ultimately failed not because of guild opposition, but because of the lack of proficient designers in Venice.⁸²

Guild Statutes, Patents, and Secrecy

The presence in Venice, as in most European towns, of a multifaceted and pervasive corporate world created an 'industrial atmosphere'.⁸³ The existence of numerous, frequently interconnected guilds helped to integrate spatially and functionally dispersed activities (provision of raw materials, brokerage, marketing), and created dense networks of economic relations that reduced transaction costs.⁸⁴ It also generated and diffused technological knowledge through apprenticeship, informal access to the labour market and interpersonal exchanges. It is, of course, the case that the specificity of pre-industrial crafts rested uniquely on their 'secrets', the

⁷⁹ Roberto Berveglieri, 'Cosimo Scatini e il nero di Venezia', *Quaderni Storici* 52 (1983), 167–79.

⁸⁰ Della Valentina, *Operai, mezzadi, mercanti*, 89, 142.

⁸¹ See Chapter 6.

⁸² Della Valentina, *Operai, mezzadi, mercanti*, 164–8.

⁸³ The expression is borrowed from Alfred Marshall via a scholar of Italian 'industrial districts'; see Giacomo Becattini, *Mercato e forze locali: Il distretto industriale* (Bologna: Il Mulino, 1984), 47 (in English, see Giacomo Becattini, *Industrial Districts: A New Approach to Industrial Change* [Cheltenham: Edward Elgar, 2004]).

⁸⁴ See Chapter 1.

unwritten, cumulative know-how of master artisans. But how secret were these 'secrets'? It is often assumed that guild statutory norms protected secrets from outsiders, and that state authorities granted patents to individual inventors as a way of bypassing such restrictions. Many examples reviewed so far nuance this dualism, showing how patents of invention and guild privileges were not necessarily incompatible. What remains to be fully understood is the relation between collective and individual technical knowledge within guilds themselves.

Venice was the first state in Europe to pass a law, in 1474, which protected the material and intellectual rights of inventors and established the antecedents of modern patents, albeit in the absence of an international overseeing authority.⁸⁵ Between 1474 and 1788, the Venetian Senate issued at least 1,904 patents of invention, of which 104 (5.5 percent) concerned new types of silk fabric and 63 (3.3 percent) textile mills in general, including spinning machines. In the sixteenth century, most projects consisted of machines, while later silk fabrics were patented more frequently. Machines for unwinding cocoons, silk winding and doubling, and silk bleaching or dyeing processes also appeared.⁸⁶

Patents were also instruments to bypass guild monopolies. Barred from Venetian guilds, foreigners – including artisans and entrepreneurs from other Italian states as well as Germans, French, Dutch, and English – often used them with this goal in mind.⁸⁷ In some cases, however,

⁸⁵ Giulio Mandich, 'Le privative industriali veneziane (1450–1550)', *Rivista di diritto commerciale* part I (1936), 511–47; Roberto Berveglieri and Carlo Poni, 'Three Centuries of Venetian Patents 1474–1796', *Acta historiae rerum naturalium nec non technicarum* 17, Special issue (1982), 381–93. On patents of invention in early modern Europe, see *Les brevets: Leur utilisation en histoire des techniques et de l'économie (Table ronde CNRS, 6–7 décembre 1984)* (Paris: Éditions du CNRS, 1985); Christine MacLeod, *Inventing the Industrial Revolution: The English Patent System, 1660–1800* (Cambridge: Cambridge University Press, 1988); the monographic issue on "Patents and Inventions" of *Technology and Culture* 4 (1991); Liliane Hilaire-Pérez, *L'invention technique au siècle des Lumières* (Paris: Albin Michel, 2000); Luca Molà, 'Il mercato delle innovazioni nell'Italia del Rinascimento', in Mathieu Arnoux and Pierre Monnet (eds.), *Le technicien dans la cité en Europe occidentale, 1250–1650* (Rome: École Française de Rome, 2004), 215–50.

⁸⁶ Berveglieri, *Inventori stranieri*, 38. Berveglieri has analysed all patents issued by the Senate alone for the entire period from 1474 to 1788. Other Venetian magistrates, however, also issued patents of invention independently. Molà, who examined those granted by all Venetian authorities for silk manufacturing in the sixteenth century, found that the first patent was given in 1535, only four were issued before 1564, and most proponents submitted their projects in the 1580s when competition over silk production among Italian states intensified: Molà, *The Silk Industry*, 189. On Venetian patents concerning silk, see *ibid.*, 190–7, 320–30, and Berveglieri–Poni, 'L'innovazione', 484–95.

⁸⁷ Of the 1,904 patents of inventions issued by the Senate between 1474 and 1788, two hundred (10.5 percent) were granted to foreigners: Berveglieri, *Inventori stranieri*, 20–2. Some entrepreneurs patented the same invention in different states: Molà, *The Silk Industry*, 204–14.

patented knowledge was appropriated by guilds.⁸⁸ In 1612, an English entrepreneur imported to Venice a new silk-stocking loom, probably the one invented by William Lee in 1589. Silk stockings were consumer goods, and in the following decades several entrepreneurs tried to operate such looms in Venice. In 1683, a new guild for the making of silk stockings was founded on the basis of an innovation patented by a foreigner.⁸⁹

The Venetian glass industry featured greater protectionism than the silk industry. The 'secrets' of Murano glassmaking were considered a state affair: stealing them, whether by exporting skills or raw materials, was severely punished. The question here is not whether draconian norms did or did not prevent violations – they frequently did not – but rather to what extent these 'secrets' were shared by guild members, and how much competition existed among individual artisans and producers in strictly technological terms.

In most early modern Italian towns, guild statutes seldom regulated production processes in detail.⁹⁰ Moreover, legislation generally focussed on final products rather than on the manufacturing process. Its objective was quality control, and it also enforced this goal by imposing rules on apparently secondary features like the supply of raw materials and access to labour markets.⁹¹ In Venetian silk manufacturing, guild statutes prescribed in detail the characteristics of all kinds of fabrics. These norms were constantly renegotiated, and when they were evaded, as we saw, abusive practices often translated into new quality standards. It was, however, difficult to monitor the output of glassmaking according to fixed standards. In the Murano guild, therefore, technological prescriptions were minimal, and they were even loosened over time. The first guild statutes, written in 1271, contained only three technological standards. First, the number of openings in each kiln was limited to three. Second,

⁸⁸ Belfanti ('Guilds, Patents', 580) speaks of a 'two-speed system' in which the Venetian state speeded the introduction of innovations and the guilds followed by adopting them. Molà argues that sixteenth-century Venetian silk manufacturing guilds rarely opposed patents of invention, and generally put them to work very rapidly: Molà, *The Silk Industry*, 30–47, 199–201. Berveglieri, *Inventori stranieri*, 23, argues instead that Venetian guilds opposed foreign inventors.

⁸⁹ Panciera, 'Emarginazione femminile', 592; Berveglieri–Poni, 'L'innovazione', 490–4. Murano glass workers often received silk stockings in part remuneration; Trivellato, 'Salaires et justice', 255.

⁹⁰ Angelo Moioli, 'I risultati di un'indagine sulle corporazioni nelle città italiane in età moderna', in Massa and Moioli (eds.), *Dalla corporazione al mutuo soccorso*, 30. See also Sheilagh Ogilvie, *State Corporatism and Proto-Industry: The Württemberg Black Forest, 1580–1797* (Cambridge: Cambridge University Press, 1997), 345–8; and Chapter 2.

⁹¹ Ogilvie, *State Corporatism*, 352–3; see also Philippe Minard, 'Les communautés de métier en France au XVIII^e siècle: une analyse en termes de régulation institutionnelle', in S. R. Epstein, H. G. Haupt, Carlo Poni, and Hugo Soly (eds.), *Guilds, Economy and Society* (Seville: Universidad de Sevilla y Fundación El Monte, 1998), 109–19.

beech and alder were the only types of firing wood allowed. Third, the use of ferns to make a north European type of potash-glass was forbidden.⁹² The new statutes issued in 1441 maintained only the first and second requirements.⁹³ Finally, the statutes of 1766 simply prohibited the use of 'illegal ashes' taken from brick kilns, urged furnace owners to sell firewood at reasonable prices, and banned the production of poor-quality goods that endangered the guild's reputation – but provided no further specifications.⁹⁴

The generic character of technical instructions in the glassblowers' statutes made room for change and intra-guild competition. The disappearance of the limit to three openings per furnace led to an increase in productivity: in the eighteenth century many furnaces had six or seven openings, with each opening corresponding to at least one crucible in which raw materials were melted. Whenever guild statutes were silent, experimentation could legitimately take place. Patents of invention document such experimentation in Venetian glassmaking rather poorly. Most patents concern instruments and machines rather than processes, and thus fail to illuminate change in chemical industries. Indeed, the most important sources for studying technological innovation in Venetian glassmaking are private recipe books and petitions to obtain exclusive economic privileges, which often followed a different administrative routine than brevets. These documents also testify to the intense competitive interaction amongst the artisan elite of Murano.⁹⁵

It is sometimes assumed that guild and state control allowed price competition but prevented competition on quality.⁹⁶ Craft guilds are more accurately defined as oligopolistic rather than monopolistic entities that

⁹² Giovanni Monticolo, *I capitolari delle arti veneziane sottoposte alla Giustizia e poi Giustizia Vecchia dalle origini al MCCCXXX*, 3 vols (Roma: Istituto Storico Italiano, 1905–1914), vol. II/1, 61–98. The number of openings per kiln was raised to 4 between 1305 and 1441.

⁹³ Biblioteca del Civico Museo Correr, Venice, *Mss. IV*, no. 26, fols 10r, 12r, 16r.

⁹⁴ Luigi Zecchin, *Il capitolare dell'arte vetraria muranese del 1766* (Venezia: Camera di Commercio Industria e Agricoltura di Venezia, 1954), 47, 139–40.

⁹⁵ Recipe books were so precious that they were included in women's dowries, and theft from rival furnaces was not unknown: Trivellato, *Fondamenta*, 203. Two recipe books have been published: Luigi Zecchin, *Il ricettario Darduin: Un codice vetrario del Seicento trascritto e commentato* (Venezia: Arsenale Editrice, 1986); Cesare Moretti and Tullio Toninato (eds.), *Ricettario vetrario del Rinascimento: Trascrizione da un manoscritto anonimo veneziano* (Venezia: Marsilio, 2001). About seventy have been identified in private collections but remain unpublished.

⁹⁶ Richard T. Rapp, 'The Unmaking of the Mediterranean Trade Hegemony: International Trade Rivalry and the Commercial Revolution', *Journal of Economic History* 35 (1975), 514–5, bases this argument on the questionable premise that 'Venetian glass' was an unchangeable product. Mokyr repeats, with no supporting evidence, the common allegation that guilds obstructed innovation by regulating prices and prescribing strict rules of production: see Mokyr, 'The Political Economy', 56, and Mokyr, *The Gifts of Athena*, 259.

permitted diversification and competition. In Murano, all furnaces were concentrated along one street, and the circulation of technical knowledge was fast. Keeping a 'secret' was not easy. However, even shared technical change did not preclude competition by producers in devising new products and procedures. When speaking of the 'secrets' of the Venetian glass industry, we should thus consider their public, collective aspects as well as its private, individual side.⁹⁷

Venetian primacy in glass manufacturing from the fifteenth to the late seventeenth century was based on the use of specific, purified raw materials and highly skilled labour. A crystal glass of unprecedented transparency was developed in Venice in the first half of the fifteenth century by employing purified vegetable ashes as a fluxing agent.⁹⁸ No other fluxing materials were officially allowed into Murano until the early eighteenth century. These ashes derived from burning seashore plants that were very costly, as the best were brought from Syria and Egypt, while others came from Sicily, Spain, and Malta. Once filtered, these ashes could be turned into a form of nearly pure sodium carbonate that still included some calcium magnesium oxides, which luckily were necessary components of glass paste. The vitrifying agent was obtained from quartziferous pebbles of the Ticino and Adige rivers; the ground stones produced a powder with silica content up to 98 percent.⁹⁹

During the seventeenth century, Venetian crystal glass was challenged by revolutionary inventions made in England and Bohemia. In 1615, coal rather than wood became the only fuel allowed in English glass furnaces, which could therefore achieve substantially higher temperatures.¹⁰⁰ In 1676, a lead-based crystal or flint glass was patented in England. In Bohemia, in the same year, Johann Kunckel obtained a crystal

⁹⁷ For a discussion of the interaction in Venetian glassmaking between state protection of craft knowledge, which was considered 'communal property', and competition between individual glassmakers, in which recipe books played a decisive role, see Pamela Long, *Openness, Secrecy, Authorship: Technical Arts and the Culture of Knowledge from Antiquity to the Renaissance* (Baltimore: Johns Hopkins University Press, 2001), 89–91.

⁹⁸ The Murano master Angelo Barovier was traditionally credited with this invention around 1450: Zecchin, *Vetro e vetrai*, vol. I, 199–211, 220–4. New evidence shows that he perfected a technique that was discovered earlier in the century: David Jacoby, 'Raw Materials for the Glass Industries of Venice and the Terraferma, about 1370–about 1460', *Journal of Glass Studies* 35 (1993), 65–90. In any event, the invention became shared knowledge among most Murano glass producers in the space of a few decades.

⁹⁹ On glass technology in early modern Europe, see R. J. Charleston and L. M. Angus-Butterworth, 'Glass', in Charles Singer (ed.), *A History of Technology* (Oxford: Clarendon Press, 1957), vol. III, 206–44. On Venetian technology, see Tullio Toninato, 'La sezione tecnologica', in *Mille anni di arte del vetro a Venezia* (Venezia: Albrizzi, 1982), 9–13, and McCray, *Glassmaking*, 49–65, 96–121.

¹⁰⁰ William Hyde Price, *The English Patents of Monopoly* (Boston: Houghton, Mifflin and Company, 1906), 72; Eleanor S. Godfrey, *The Development of English Glassmaking, 1560–1640* (Oxford: Clarendon Press, 1975), 150–5.

glass using potash in place of soda. Both these new products could compete with Venetian crystal glass in terms of quality, while their production costs were significantly reduced because of the cheaper raw materials they required.¹⁰¹

Spurred by this competition, from the 1690s or even before, Murano merchant-producers intensified the search for new, cheaper, and sometimes better raw materials. Quartziferous pebbles were partially replaced by a kind of sand (*saldame*) that was not as pure and rich in silica but was much less expensive and saved on labour costs by eliminating all grinding operations. Levantine ashes were by far the most expensive raw material used in Venetian glassmaking. English and Bohemian competitors succeeded in removing or reducing the amount of this ingredient from the crystal formulas. Venetians followed suit by producing potash-based crystal in the early eighteenth century.¹⁰² The recipe book belonging to Ettore Bigaglia (1628–1694) also reports the use of potassium nitrate a few years earlier to make an English type of crystal glass. Bigaglia, who controlled one of the largest production units on Murano, derived greater advantages from technological innovation, but the use of saltpetre spread in the following decades among the major Murano producers, who petitioned the government to acquire large quantities of this material at a reduced price (as an essential component of gunpowder, saltpetre was a state-controlled product). Nonetheless, sodium-base ashes remained the fundamental ingredient of Venetian glass throughout the eighteenth century; for this reason, in the 1760s and '70s the state encouraged local scientists to find substitutes in lagoon plants.¹⁰³ In sum, Venetian glass

¹⁰¹ Charleston and Angus-Butterworth, 'Glass', 221–4; Christine MacLeod, 'Accident or Design? George Ravenscroft's Patent and the Invention of Lead-Crystal Glass', *Technology and Culture* 28 (1987), 776–803. Innovations in Bohemia and England apparently owed a lot to the diaspora of Venetian artisans to northern Europe and to the circulation of the first printed glassmaking manual, written by the Florentine abbot Antonio Neri and published in 1612: Antonio Neri, *Arte vetraria 1612*, ed. by Rosa Barovier Mentasti (Milano: il Polifilo, 1980).

¹⁰² The production of potash-based crystal in Venice, conventionally dated to 1737 and attributed to Giuseppe Briati (1686–1772), was introduced at least two decades earlier. See Trivellato, *Fondamenta*, 116–23.

¹⁰³ Walter Panciera, 'Ancien Régime e chimica di base: la produzione del salnitro nella Repubblica veneziana (1550–1797)', *Studi Veneziani* XVI (1988), 45–92; Cesare Moretti and Tullio Toninato, '«Cristallo» e «Vetro di piombo» da ricettari del '500, '600 e '700', *Rivista della Stazione Sperimentale del Vetro* 17 (1987), 31–40; Tullio Toninato and Cesare Moretti, 'Ricettari Muranesi (XVI–XX secolo)', *Rivista della Stazione Sperimentale del Vetro* 22 (1992), 197–206; W. Patrick McCray, Z. A. Osborne, and W. D. Kindery, 'Venetian Girasole Glass: An Investigation of Its History and Properties', *Rivista della Stazione Sperimentale del Vetro* 25 (1995), 19–35; Tullio Toninato, 'Tradizione e innovazione nelle materie prime del vetro muranese: la testimonianza di alcuni ricettari ottocenteschi', in *La chimica e le tecnologie chimiche nel Veneto dell'Ottocento*

makers progressively adopted new vitrifying and fluxing agents in order to cut production costs while maintaining the high quality of their products. The Murano guild never opposed capital-saving process innovations of this sort, and the new raw materials introduced in the late seventeenth century (especially *saldame*) probably increased productivity as well.

The pattern of technological change in early modern Venetian glassmaking found its rationale in the structure of production costs. From a few surviving budgets and post mortem inventories of Murano furnaces, we gather that physical capital (furnaces, crucibles, hardware, and, where they existed, grinding wheels) made up a small fraction of the overall value of the business. For this reason, mechanisation played only a minor role in innovation. In addition, the estimated expenditures of a new company formed by Murano masters and owners in 1779 inform us on three important points.¹⁰⁴ First, raw materials and fuel comprised more than 72 percent of the total cost of finished crystal objects and between 66 and 87 percent of the production costs of semi-finished mirror plates and bead rods. Second, making large mirror plates cost about 1.5 times more than small mirror plates, defined here as those smaller than 68 cm × 51 cm. Third, glass canes were the second least expensive goods after windowpanes, and labour costs weighed least on this product. In the case of glass beads and mirrors, the reported costs concerned only the initial operations, as only glass rods and rough plates were prepared in the Murano furnaces and were then passed on to other guilds for the finishing operations in Venice. These guilds, as we saw, employed many female and immigrant workers. It is thus not surprising that technical change in glassmaking was directed towards the search for cheaper raw materials, and that production of small mirrors and glass beads expanded in the second half of the seventeenth and throughout the eighteenth centuries thanks to the established know-how of a cheap labour force.

Guilds in Context

Economic historians pay increasing attention to the institutional settings in which technical change took place. Many also admit that technological inertia is often the result of rational behaviour.¹⁰⁵ Yet they persist in

(Venezia: Istituto Veneto di Scienze Lettere ed Arti, 2001), 295–356; Angelo Bassani, 'Gli scienziati veneti e le ceneri di roscano: gli studi di Marco Carburì, Pietro e Giovanni Arduino e Anton Maria Lorgna', *Studi Veneziani* 44 (2002), 157–240.

¹⁰⁴ Although the government rejected the project, many records of it survive; see ASV, *Censori*, busta 40.

¹⁰⁵ Paul A. David, 'Understanding the Economics of QWERTY: The Necessity of History', in William N. Parker (ed.), *Economic History and the Modern Economist* (Oxford: Basil

condemning craft guilds as technophobic. More specifically, this widespread condemnation refers to Italian craft guilds after 1450 (or 1600, depending on the interpretation), while medieval guilds are absolved, or even praised, for having fostered innovation. But why would guilds have turned against innovation? This question usually remains implicit.¹⁰⁶ Perhaps rightly so, because if we were to address it in any detail, we would have to acknowledge that conventional portrayals of technophobic guilds do not stand up to scrutiny. After all, many different guilds existed – different in terms of labour composition, economic functions, and political standing – and they changed as the economic and political circumstances in which they operated also evolved. In other words, context mattered a great deal.¹⁰⁷

By examining guilds' responses to technical innovation in Venetian silk and glass production, I have highlighted the slow but constant processes of adaptation induced by demand and foreign competition. Guild regulations were neither overly restrictive nor inflexible. In most instances, guilds proved receptive to novelties that would increase productivity, lower production costs, and introduce new goods – including when these were patented or imported by foreigners. Guilds were generally committed to enforcing minimum quality standards, but they were also formed by entrepreneurs and masters who aimed for a better living and ideally for lucrative returns. Venetian silk and glass manufacturing showed a remarkable ability to adapt to new patterns of demand, including when such patterns required shifting production towards lower-quality goods such as cheap and light silk cloth in the sixteenth century or glass beads and small mirrors in the eighteenth century. Guilds promoted such adjustments especially, but not exclusively, when they only required organisational changes rather than radical technical innovations. In both glass and silk manufacturing, the production unit of single master artisans evolved into an urban putting-out system with limited economies of scale. Moreover, an expansion of the non-corporate workforce, and women's wage work in particular, kept labour costs low. As a result, Venetian glass

Blackwell, 1986), 30–49; Joel Mokyr, 'Innovation and Its Enemies: The Economic and Political Roots of Technological Inertia', in Mancur Olson and Satu Kähkönen (eds.), *A Not-So-Dismal Science* (Oxford: Oxford University Press, 2000), 61–91.

¹⁰⁶ For an explicit formulation, see Enrico Sestan, 'Le corporazioni delle arti in Italia', in *Arti e corporazioni nella storia d'Italia (Mostra, 25 giugno – 17 luglio 1966)* (Spoleto: Centro di Studi sull'Alto Medioevo, 1966), 15–7. Charles R. Hickson and Early A. Thompson, 'A New Theory of Guilds and European Economic Development', *Explorations in Economic History* 28 (1991), 132, 146–7, argue that guild monopolies and restrictions increased as a result of growing political functions during the fourteenth and fifteenth centuries.

¹⁰⁷ See Chapter 6.

production in the second half of the eighteenth century was larger than it had been two centuries earlier, and productivity had also increased. From the mid-seventeenth century, silk spinning and weaving expanded in the rural areas and provincial towns of the Venetian mainland, but silk weaving all but disappeared from the town center.

Inter- and intra-guild conflict dictated attitudes towards technological innovation. In Murano, master artisans were more conservative than furnace owners. In contrast, in silk manufacturing, masters proved more innovative than merchant-producers but did not enjoy the same political support. When we analyze technical conservatism on the part of some guilds or guild components, it is also important to look at the competitive advantages available and the opportunity costs that a specific innovation might entail. The structure of the labour market could favour or prevent the introduction of labour-saving innovations. Geographical conditions and availability of natural resources were independent variables that could severely restrict the expansion of urban manufacturing. In 1644, Iseppo d'Abbaco tried to build a hydraulic silk mill in Venice, hoping to operate it by harnessing power from the shifting tides in the lagoon. The experiment failed not because of guild protectionism but because of the lack of sufficient waterpower.¹⁰⁸ In the 1790s, Giorgio Barbaria (1741–1801) attempted to produce English-type glass bottles in Venice, but the absence of coal and the greater profitability of glass beads stymied his efforts.¹⁰⁹

In the early modern period, craft guilds rarely held political power in European towns. They nonetheless persisted as an institutional form with astonishing continuity. This stability has both social and economic reasons. On the one hand, craft guilds generally proved much more malleable than historians have previously admitted. They continued to regulate the labour market, limit the impact of free riders, and coordinate production processes. At the same time, as parallel informal economies developed in urban artisan sectors, craft guilds often conceived of these as complementary rather than antagonistic, and in many cases they sponsored them. The adaptability and diversity of craft guilds kept them alive and permitted them to coexist with and even take advantage of a galaxy of precarious workers, including women excluded from guild membership. On the other hand, guilds constituted a pivotal institution for the organisation and governance of social hierarchies. Their primary task was to harmonise, enforce, and symbolically sanction – legally, economically, and symbolically – those inequalities that their societies believed to be 'natural'. Wages in the glass furnaces of seventeenth-century Murano,

¹⁰⁸ Poni, 'Archéologie', 1482; Berveglieri and Poni, 'L'innovazione', 490.

¹⁰⁹ Trivellato, *Fondamenta*, 247–63.

for example, contrary to widespread assumptions about the rigidity of pre-industrial wages, were more commensurate with individual skills and productivity than with ranking in guild membership: journeymen who earned more than some masters working in the same plant were not unheard of. By contrast, only masters were entitled to an unemployment benefit. The same guild thus developed a competitive scale for wages and a welfare system that aimed at compensating masters at the expense of journeymen, based on the notions of equity rather than equality that upheld socio-economic stratification at the time.¹¹⁰

Contemporary notions of order and hierarchy included gender and religious discrimination. In her recent, important work, Sheilagh Ogilvie argues that early modern craft guilds were suboptimal economic institutions because they discriminated against women, religious minorities, and other vulnerable but productive groups. She thus attempts to debunk what she perceives to be a new wave of idealisation of pre-industrial communitarian institutions, and guilds, in particular, among historians and social scientists.¹¹¹ It is certainly undeniable that the barring of Jews, women, foreigners, and other groups from craft guild membership was economically inefficient and proved detrimental to economic development as a whole. Craft guilds were, as Ogilvie points out, very much part of the patriarchal and hierarchical social world that they helped regulate. But this particular observation, however valuable, does not mean that guilds were therefore entirely regressive institutions whose exclusionary social practices inevitably impeded economic development. In this chapter, I have sought to examine how guilds operated not in relation to a normative and arguably impossible ideal of economic and social progress, but within the parameters of the social hierarchies they contributed to create and maintain. In the silk and glass sectors of seventeenth- and eighteenth-century Venice, women increasingly worked for wages for guild masters and merchant-producers while being deprived of the welfare and symbolic status that guilds conferred on their members. In Venice as in Württemberg – the region studied by Ogilvie – craft guilds exploited women's subordinate status, yet such discriminatory practices did not automatically turn them into indiscriminate rent-seeking institutions or into bastions of technical conservatism. The variety of responses outlined

¹¹⁰ Trivellato, 'Salaires et justice'.

¹¹¹ Ogilvie, *A Bitter Living*; Sheilagh Ogilvie, 'How Does Social Capital Affect Women? Guilds and Communities in Early Modern Germany', *American Historical Review* 109 (2004), 325–359; Sheilagh Ogilvie, 'Guilds, Efficiency and Social Capital: Evidence from German Proto-Industry', *Economic History Review* 57 (2004), 286–333; Sheilagh Ogilvie, 'The Use and Abuse of Trust: Social Capital and its Development by Early Modern Guilds', *Jahrbuch für Wirtschaftsgeschichte* 1 (2005), 15–52.

here reveals the extent to which the interests of guild leadership determined the course of action, but also emphasises the constraints and opportunities created by wider economic and political contexts. In the end, the specificity of technical change in different urban manufacturing sectors and the variety of local conditions led to a plurality of solutions, and innovation often took the form of new products, new labour organisation, and new processes of production.