Building Accounts, Monumental Construction Projects and Labour Rates in the Classical and Hellenistic Periods

Jari Pakkanen

This is author's final version of the paper.
Pakkanen, J. (2023) 'Building Accounts, Monumental Construction Projects and Labour Rates in the Classical and Hellenistic Periods', in S. Barker, C. Courault, J.Á. Domingo & D. Maschek (eds.), *From Concept to Monument. Time and Cost of Construction in the Ancient World. Papers in Honour of Janet DeLaine*, Oxford: Archaeopress, pp. 266–285.

For any citations, please refer to the published paper:
https://www.archaeopress.com/Archaeopress/Products/9781789694222

Introduction

The conservative design of the Classical and Hellenistic buildings and the use of durable materials mean that the volumes of construction materials can often be reconstructed reliably enough to be used as the basis of labour cost calculations.[1] In addition, a range of preserved detailed building accounts provide a wealth of information which can be used for studying the *chaîne opératoire* and economics of Greek construction.[2] Following Janet DeLaine's ground-breaking *The Baths of Caracalla* (1997) there has been a tendency to incorporate and compare data and labour rates in a considered way from a range of different contexts, which has also been taken up in the sphere of ancient Greek construction.[3] Ann Brysbaert's SETinSTONE project has already moved the field of building cost analyses of Greek Late Bronze Age architecture to a new level. The project's publications demonstrate the importance of collecting labour rates from different contexts to analyse prehistoric construction projects and the use of three-dimensional digital documentation techniques for calculating the building material volumes in econometric studies of ancient construction.[4] The evaluation of the costs of the Classical shipshed complexes at Zea, one of the two military harbours of Athens, was part of my contribution to the project *Shipsheds of the Ancient Mediterranean*, and it presents a range of comparative labour rates from Greek, Roman and New World contexts.[5] These trends are also evident in a series of papers presented in 2018 at the 19th International Congress of Classical Archaeology with the theme *Archaeology and Economy in the Ancient World*.[6]

In this paper, I analyse in detail how a comparison between the unfinished column blocks of the colossal Hellenistic temple of Apollo at Didyma and the information from the building accounts can be used to gain a detailed picture of the labour rates and costs of the project. The principal places mentioned in this study are summarised in the maps presented in Figure 1. Bernard Haussoullier's analysis of the expenses of constructing a column of the temple of Apollo is an early example of how the cost rates from the early 2nd century BCE inscriptions can be used to estimate building costs of ancient architecture.[7] In the full publication of the Didyma building accounts, Albert Rehm presented a

[1] Pakkanen 2013, 56–72. Cf. also Salmon 2001, 195.

[2] For example, series of building accounts have been preserved related to the Classical projects in Attica, Delphi and Epidauros and Hellenistic building on Delos and at Didyma and Lebadeia. For overviews of Greek building inscriptions, see Scranton 1960; Hellmann 1999; Feyel 2006; Pitt 2016. For economic studies using the accounts, see e.g. Haussoullier 1926, 127–138; Stanier 1953; Rehm 1958, 62–64; Burford 1969; Haselberger 1985a; Clark 1993; Davies 2001; Pakkanen 2013.

[3] Pakkanen 2013; Brysbaert 2013; 2015; Lancaster 2019.

[4] For overviews of the project and further references, see Brysbaert 2017; in press; Brysbaert *et al.* 2018. On the role of three-dimensional digital field documentation methods employed in the project, see the contributions by Brysbaert and her two project members in Pakkanen *et al.* 2020, 4–9.

[5] Pakkanen 2013. For further information on the project, see the Acknowledgements at the end of this paper.

[6] See publication of the panel 'Building BIG – constructing economies: from design to long-term impact of large-scale building projects' in Pakkanen and Brysbaert, in press. Of further presentations on Greek econometrics in the conference, the experimental work carried out by Jean-Claude Bessac and Silke Müth on quarrying and constructing the city walls of Messene as part the project on the city wall is an important contribution to the field; Müth and Bessac 2018.

[7] Haussoullier 1926, 127–138.

revised version of the calculations,[8] and his study is the basis of the analysis presented below. From the point of view of labour cost studies, perhaps the most important aspect of the inscriptions is that they give the precise actual costs of the early 2nd-century BCE building phase. Study of the blocks makes possible comparison of the volume of the stone ordered from the quarries with the actually delivered blocks. The level of daily wages of skilled craftsmen at Didyma is not known with certainty, so a wider appraisal of the wage and price levels in the Classical and Hellenistic period provide a framework for comparing the costs of construction projects.

The remains and accounts of the temple of Asklepios at Epidauros provide a good comparative basis from a smaller building using less expensive limestone. Alison Burford's monograph on the building accounts demonstrates the scale of economic and social information that can be derived from the inscriptions, but rather curiously, she ignores the relevant data in Georges Roux's architectural study of the temple of Asklepios.[9] Therefore, Sebastian Prignitz's new study of the building accounts and rereading of several of the prices of the contracts gives an opportunity to restudy the labour rates for quarrying, transport and construction of the temple.[10]

Basing econometric calculations on the principle of estimating minimum costs is a sensible approach since in many cases the sources are not able to provide an exact date or duration of a project, and delays would have easily been created by bottlenecks in the delivery of materials and construction.[11] However, since the Greek building accounts record the actual costs of monumental building projects, it is possible to compare the labour rates derived from the inscriptions with the minimum costs as is done in this paper.[12] Giovanni Pegoretti's 19th-century handbook of architectural labour rates has been used extensively in estimating the manpower requirements of ancient Roman construction[13] and I compare his production rates with Greek architectural and inscriptional data from the Classical and Hellenistic periods. In the concluding section, R.S. Stanier's estimate for the cost of stonework of the Parthenon at Athens[14] is revaluated in light of the analyses on quarry and construction rates presented in the paper. Even though the labour rates here are mainly expressed in terms of drachmas because they are derived from the building accounts, I have given the silver weights of the different standards and the probable daily wages of skilled craftsmen to facilitate cross-cultural comparisons. The length of the working day is taken as ten effective hours.[15]

Temple of Apollo at Didyma

The 28 building inscriptions of the Hellenistic temple of Apollo at Didyma provide a detailed picture of the organisation and costs of the Hellenistic building project. Rehm's analyses are based on a detailed study of the accounts and what was known about the temple architecture by the 1940s.[16] In this study the inscriptional evidence on the quarrying of material for and construction of the column is compared with the new work carried out by Lothar Haselberger as part of his discovery of the Hellenistic work drawing of the shaft profile on the cella wall of the temple and study of the unfinished temple column.[17] Currently, it is possible to form a clear picture of the construction project in the sanctuary of Apollo due to the detailed research on the quarries in the region, the temple, the surrounding landscape and the inscriptions (Figure 2).[18]

---

[8] Rehm 1958, 62–64.

[9] Roux 1961; Burford 1969. Burford did have access to Roux's work; see e.g. 54 n. 2. For references to the architectural data she misses from Roux's monograph, see sub-section 'Quarries' below.

[10] Prignitz 2014.

[11] Cf. DeLaine 1997, 105–106.

[12] See also Pakkanen, in press.

[13] Pegoretti's handbooks were first published in 1843–1844, but I use here the 2nd revised edition of 1863–1864. On the use of Pegoretti's labour rates, see DeLaine 1997, 104–105.

[14] Stanier 1953.

[15] Cf. DeLaine 1997, 106. The use of a 10-hour day has the added advantage that person-hours can conveniently be calculated by multiplying the presented figures by 10.

[16] Rehm 1958.

[17] Haselberger 1980; 1983; 1985b.

[18] On the quarries, see Borg and Borg 2002a; 2002b; Attanasio *et al*. 2006; Toma 2020; on the temple, see Knackfuss 1941; Haselberger 1980; 1983; on the landscape and procession from Miletos to Didyma: Herda 2006; Slawisch and Wilkinson 2018; on the inscriptions, see Rehm 1958.

Haselberger's new measurements of the two bottom drums of the unfinished column allow for a comparison of the actual dimensions with the diameter information inscribed on the drums, the Hellenistic shaft profile drawing and the finished fluted drums.[19] The data on the column and the inscriptions are summarised in Figure 3. The figure is largely based on Haselberger's shaft profile drawing[20] but with new additions. The length of the foot-unit, 296.4 ± 0.4 mm, is known on the basis of the design drawings on the cella wall which include a scale drawing the shaft profile with entasis.[21] The vertical dimension of the shaft is scaled down by the factor of 16 so that one dactyl corresponds to one foot. The two lowest drums have the same inscribed dimension of 7 ft, so 2.072–2.078 m. The measured diameters of the blocks are 2.113 and 2.100 m,[22] so the figure inscribed on the block indicates that finished drums with diameters of 7 ft could be carved out of the two blocks, they are not indications of the actual diameters of the drums. The inscription on the drum in the middle of the shaft (Drum 10) is very precise and it gives the dimensions down to half a dactyl (6 + 1/4 + 1/8 + 1/16 + 1/32 ft) but the calculated diameter is clearly less than what is required for the shaft at this point because of the convex entasis curve. The most likely interpretation is that the architect and the masons took advantage of the extra layer of quarry stone left all around the drum – the block was most probably initially intended for use higher up in the shaft, but the extra layer of stone of at least 2 cm made it possible to use the drum lower down. On Drum 8 the minimum thickness of the extra stone is 5 cm. It can also be suggested that the building accounts very likely record the size of the block ordered from the quarry and, therefore, the dimension used to calculate the block volume in cubic feet to pay for the quarrying and transport of the block. The use of very small foot divisions all the way down to a half-dactyl on the drums themselves (1/2 dactyl = *c.* 9.3 mm) has a parallel in the precisely recorded dimensions and costs of the building accounts: for example, in *Didyma* II 39.24 the combined surface area of two Ionic capitals is given as [3]77 1/4 square feet and the price of dressing the blocks as 1886 drachmas 1 obol 6 chalkous. Table A1 in the Appendix summarises the costs per column block where the rates in the inscriptions are given per cubic foot. This makes it possible to derive the drachma rates per cubic metre of the delivered blocks from the prices recorded in the inscription. Table A2 in the Appendix summarises the information on the work which was calculated based on the surface area of the blocks rather than the volume.

The measured sizes of the plinths at Didyma are very close to 9 ft × 9 ft × 1.5 ft (measured 2.69 m × 2.69 m × 0.45 m), so I have taken 121.5 cubic feet as the ordered quarry size of the block. In many cases the plinth is made of two separate blocks which both originally had a protective mantle. Based on Hubert Knackfuss's profile drawing of the lower part of the unfinished column and the known bottom diameter of the shaft[23] it is possible to derive the width of the plinth with its extra layer of quarry stone and estimate the difference between the designed and delivered size. The width of the delivered plinth block is 2.754 m, so the thickness of the extra mantle is in this case *c.* 3 cm. Based on the drums, the extra layer was at least 2 cm, so this figure is used for the dimensions where the actual dimension cannot be measured such as the finished horizontal contact surfaces of the blocks in Tables A1 and A2. The layer was likely thicker than this in most cases, but this estimate gives a minimum estimate for the quarry size of the blocks.

The radius of the spira varies slightly, but Knackfuss gives several examples in his documentation. For example, the finished block with a radius of 1.311 m and the unfinished spira[24] of 1.336 m are both very close to a designed radius of 4.5 ft, so these dimensions are used for calculating the designed and delivered sizes. The height of the finished block is 0.423 m. In the unfinished standing column, the torus and the lowest convex part of the shaft, the apophyge, are carved as one block.[25] The radius of the torus is 1.222 m and the height of the block 0.346 m. The ordered radius was most likely 4 ft (1.186 m). Combining the torus with the lower part of the shaft is not unique to this column, but the height of these blocks varies, as does the drums. The marble beds of the Milesian quarries

[19] Haselberger 1983, 115–121. On the columns, see also Knackfuss 1941, 82–95.

[20] Haselberger 1983, fig. 5.

[21] Haselberger 1980, 193; 1983, 117; Rehm's (1958, 44 n. 2) foot-standard is not quite correct at 0.294 m, so his analyses need to be slightly adjusted. Knackfuss (1941, 62) suggests that the unit is 0.29845 m.

[22] Haselberger 1983, 116–117.

[23] Knackfuss 1941, pl. 44, Z.337.4; for the diameter as 2.111–2.114 m, see Haselberger 1983, 116–117.

[24] Knackfuss 1941, pl. 44, Z.337.3–4.

[25] Haselberger 1983, pl. 25.

had difficulties delivering the larger blocks needed for the column drums[26] and this is also the best explanation for the higher price of the drums compared to the plinths (5.5 and 4 drachmas per cubic foot). The lower price is used systematically in Table A1 for blocks which have a height of less than 0.5 m.[27] Dimensions of the drums are indicated in Figure 3. The reading of the dimension inscription on Drum 9 is uncertain and I have suggested that it could be 6 1/4 ft (Haselberger's suggestion is 6 1/8 ft). The designed radius of the top drum with an apophyge is known on the basis of the preserved capitals.[28] The size of a finished capital is quite accurately 7 ft × 8.5 ft × 3 ft (measured dimensions 2.056 m × 2.548 m × 0.906 m),[29] so the estimated designed volume of the capital was very likely 178.5 cubic feet or 4.64 m^3. These dimensions are confirmed by the building accounts where the size of an Ionic capital delivered from the quarry is recorded.[30] The total ordered volume of quarry stone for the column can be calculated as 63.2 m^3 and the minimum actually delivered volume as 69.6 m^3, so at least 10% extra material was taken from the quarries to the sanctuary. With column drums it was also possible to take advantage of this extra stone by placing them further down in the shaft than initially planned, so it was not necessary that the surplus material was just carved away in all cases. The figures indicate that the volume of the ordered blocks was between 84–94% of the delivered quarry material.

The horizontal surfaces of the column blocks had to be finished before lifting and positioning, and the top part of the neck drum and the capital were already completed on the ground (the dimensions used in the volume calculations of the top Drum 1 are indicated in Figure 3 with light grey). The reduced volume of these blocks is also given in Table A1 and this is used to calculate the costs of lifting and positioning of the blocks given in the table. Due to the more finished state of the blocks, the difference between the designed and actual volume for the erection of the column are quite small. The only exception is the capital which was substantially reduced in volume due to the extruding volutes.

The inscriptions at Didyma give very precise prices for the different sections of the transport of stone from shipping from Ioniapolis to Panormos to hauling of the blocks from the harbour to the sanctuary (see Figure 2).[31] The price for the land transport from Panormos to the temple of Apollo is given as 2 drachmas per cubic foot. The length of the distance can be measured as 4.0 km and the height difference between the sea-level and the sanctuary is 74 m, so on average the road slopes gently at 1.1 degrees. Using the calculated volumes of stone, the total price for the quarry stone of the column can be calculated as 4856 drachmas; a total of 63.2 m^3 of stone was ordered and paid, and at least 69.6 m^3 of stone was actually delivered. Using these figures, the price of land transport for one cubic meter of quarry stone can be calculated as 19.2 drachmas per kilometre for the volume of ordered stone and as 17.4 drachmas per kilometre for the stone actually delivered (Table 1). The topography in the delta of the Meander River has drastically changed since antiquity because of silting (Figure 2), but also from the building accounts it is clear that marble was shipped directly from Ioniapolis to Panormos, so the modern Lake Bafa Gölü was in antiquity an open gulf of the Mediterranean (the Gulf of Latmos). The distance of sea transport from Ioniapolis to Panormos can be measured as 41 km, so the rate of 1 drachma 4 obols per cubic foot can be calculated to correspond to a cubic metre rate of 1.6 drachmas per kilometre for the ordered stone and 1.4 drachmas for the delivered blocks. The inscription also gives rates for loading (1 obol per cubic foot) and unloading (1 obol 6 chalkous) of the blocks in the harbours and moving of the blocks in the harbour at Panormos (1 obol per cubic foot). In addition, Rehm estimates that the cost of transport from the quarry to the harbour at Ioniapolis was 1 drachma per cubic foot (half the rate of transport from the harbour to the sanctuary) and at the sanctuary from the workplace to the temple 1 obol per cubic foot.[32]

---

[26] Borg and Borg 2002a, 275.

[27] Rehm (1958, 64) employs the lower cubic foot price only for the plinth.

[28] Approx. 0.930 m; Knackfuss 1941, Z.417, Z.429.

[29] Knackfuss 1941, pl. 52; Rehm 1958, 44.

[30] Rehm (1958, 45) presents a detailed argument why the recorded size of 175 1/8 1/16 ft^3 and the price do not match in *Didyma* II 39.53: the size must be emended to 178 1/8 1/16 ft^3.

[31] Rehm 1958, 63–64.

[32] Rehm 1958, 64.

Table 1. Temple of Apollo at Didyma. Cost rates as outlined in the inscriptions and based on ordered sizes and actually delivered blocks (likely day wage of a skilled craftsman: 2 Alexandrian/Attic drachmas per day; *c.* 4.3 g of silver per drachma)

1. task	2. rate	3. rate ordered	4. rate delivered
Quarry stone (H < 0.5 m)	4 dr./ft^3	153.6 dr./m^3	131.8 dr./m^3
Quarry stone (H $\geq$ 0.5 m)	5 3/6 dr./ft^3	211.2 dr./m^3	192.4 dr./m^3
Land transport		19.2 dr./(km $\times$ m^3)	17.4 dr./(km $\times$ m^3)
Loading to ship	1/6 dr./ft^3	6.4 dr./m^3	5.8 dr./m^3
Sea transport		1.6 dr./(km $\times$ m^3)	1.4 dr./(km $\times$ m^3)
Unloading from ship	1/6 + 6/72 dr./ft^3	9.6 dr./m^3	8.7 dr./m^3
Lifting & positioning	1 dr./ft^3	38.4 dr./m^3	38.0 dr./m^3
Fine dressing	2 dr./ft^2	22.8 dr./m^2	21.6 dr./m^2
Fluting	2 dr./ft^2	22.8 dr./m^2	22.2 dr./m^2
Carving Ionic capital	5 dr./ft^2	56.9 dr./m^2	54.5 dr./m^2

Table A2 in the Appendix summarises the data related to the surface area of the column blocks. Fine dressing of the base and horizontal surfaces, fluting of the drums and carving of the capital were all paid by the size of the treated area rather than volume. For each block, the table lists the surface area as it was ordered and delivered, the rates of carving and the ratio between the ordered and actually delivered rates. Rehm's suggestion of adapting the price of carving the Ionic capital, 5 drachmas per square foot,[33] also for fine dressing of the vertical surfaces of the plinth, spira and column shaft is surely exaggerated, as we will also see below in the section comparing the labour rates. The volume of removed stone in the carving of the Ionic capital was significantly more than what was required for other parts of the column, so I have used the rate of 2 drachmas per square foot for the rest of the column. The difference between the rates for the designed and actual total areas of the blocks is quite small at *c.* 96%. The horizontal surfaces of each block were finalised before erecting the column, as were any vertical sections for which the final carving would have been difficult. Fluting of the column was typically one of the final phases of construction, thus protecting the delicate vertical fillets of the shafts when the heavy entablature blocks were being lifted.

Based on the volumes, surface areas and rates presented in Tables A1–A2, the cost of a single column of the temple of Apollo can be summarised as follows:

Quarrying and rough shaping of the blocks for transport	12,952 dr.
Transport (land 8,093 dr., sea 5,058 dr.)	13,152 dr.
<u>Construction (erecting 2428 dr., dressing 6757 dr.)</u>	<u>9,185 dr</u>.
Total	35,288 dr.

Quarrying and transport are both *c.* 37% of the sum and the cost for construction makes up the remaining 26% of the *c.* 35,300 drachmas. The total sum is 9% smaller than Rehm's estimate of 38,800 drachmas. The principal reason is that he adapts the rate paid for the Ionic capital also for the vertical surfaces of the column.

Wages and Prices in Classical and Hellenistic Periods

The building accounts give a detailed picture of the construction costs in drachmas in early 2nd-century BCE Didyma, and in order to relate it to earlier building projects on the Greek mainland and also later comparative material, a glimpse at the prices and wages in the wider Hellenistic period is in place. The best time series on commodity prices in the Hellenistic world comes from Babylon where from the late Achaemenid period onwards astronomers meticulously recorded astronomical and meteorological data in Akkadian, but also e.g. the amount of barley and sesame one shekel could buy in the market.[34] The most consistent Hellenistic economic data in the Aegean is from the sanctuary of

[33] Rehm 1958, 64.

[34] Slotsky 1992; 1997; Grainger 1999; van der Spek 2000; 2002; Temin 2002; Pirngruber 2017.

Apollo on Delos.[35] The administrators kept records of the income and expenditure of the temple and inscribed on stone e.g. the prices and quantities of olive oil, pigs, firewood and barley.[36] Gary Reger correctly emphasises the local conditions and limited scale of the market on Delos,[37] but it is worthwhile contrasting the two data sets from the opposite ends of the Hellenistic world. Figure 4 presents how many grams of silver were needed to buy 10 kilograms of barley and Figure 5 the price of 10 litres of sesame seeds in Babylon, the main oil plant, and olive oil on Delos.[38] The effect of instability at the end of the reign of Alexander and his death in June 323 BCE at Babylon, and the following wars of succession are clearly visible in both time series from Babylon. The scale of the y-axes on the two images are different to make room for the high olive oil prices on Delos, but the quick change in the agricultural prices at Babylon in late 320s BCE is evident in both time series. For example, within six months the price of barley had risen to a level four times higher than the previous year, and it takes a quarter of century of turmoil before the prices return to approximately 4th-century levels at the consolidation of the Seleucid dynasty. The prices in the 3rd and 2nd centuries are marked by some seasonal variation and several clear peaks probably due to bad harvests,[39] but the main characteristic of this period is its high degree of stability. Severe price fluctuations are again visible at the end of the 2nd and early 1st centuries.

The barley prices on Delos are mostly higher than in Babylon (Figure 4), but when expressed in terms of grams of silver, the discrepancies between the two different markets are quite reasonable. Delos is a small island which depended on regionally produced imported grain[40] and Babylon is located in the highly fertile Euphrates valley with high volume of production. The spot prices in 250 BCE show the range of seasonal variation on Delos, but the principal trend in Figure 4 is one of constancy over the hundred years of recorded prices (the circles indicate the individual recorded prices and the solid lines the general trend in Figures 4–5). The time series on the price of olive oil on Delos is longer and more detailed than on barley (Figure 5). In early 3rd century there is a sharp fall in the general trend followed by marked stability in the latter half of the records. Reger analyses the early 3rd-century fall on Delos and he notes that the extreme fluctuations at the end of the 4th century very likely reflect the economic disruption caused by warfare and dependency on imported oil.[41] He argues that the stabilisation of the prices during the 3rd century was probably due to planting of local and regional olive orchards, but it could also be a reflection of the more stable economic and political climate in the Aegean.[42]

Figure 6 presents the data on day wages in the Aegean. Most of the data is based on Athens[43] but relevant data from Delos, Delphi and Epidauros[44] and on mercenaries has been added.[45] The data covers the period from the mid-5th century to the end of 2nd century BCE, and the wage scale (the y-axis) is given in grams of silver because of the different regional currencies.[46] The longest time series

[35] Reger 1993; 1994.

[36] Reger 1994, 127–188.

[37] Reger 1994, 49–83.

[38] The time series for Delos is based on Reger 1994 and for Babylon on data in van der Spek 2002 (the online spreadsheet). For the commodities, including the translation of the Akkadian ideogram *samaššammū* as sesame seeds rather than sesame oil in the context of the *Astronomical Diaries*, see Slotsky 1992, 56–223; 1997, 23–42. For a summary of recent discussions of the commodities with references, see Pirngruber 2017, 9 n. 13. The general trends for Delos are produced using semiparametric smoothing in statistical package Survo MM; cf. Mustonen 1992, 174–175.

[39] Temin (2002) uses time series analysis methods to demonstrate that the prices indeed market prices and that they change as would be expected of ‘random walks’ responding to weather conditions.

[40] Reger 1994, 83–126.

[41] Reger 1994, 155–169.

[42] Cf. Reger 1994, 253–264.

[43] Loomis 1998, 261–323.

[44] Glotz 1913, 214–215; Lacroix 1914, 307; Larsen 1959, 408–412; Burford 1969, 140 n. 4; 1972, 141; Prignitz 2014, 177.

[45] Griffith 1935, 295–306; Pritchett 1971, 22.

[46] For the different drachma standards, the commonly accepted mass of 4.3 g/dr. is used for the Attic in the conversions and 6.1 g/dr. for the Aiginetan. For a summary of the multiple monetary standards of the Greek world, see Psoma 2015; on the problem of defining the mass of the Athenian drachma, see Pakkanen 2011, 161 n. 28.

on per diem payments is for citizen soldiers, sailors and mercenaries.[47] In relation to construction, the compensations paid to architects are relatively well known,[48] but the status of an architect suggests that in several cases the compensation should rather be regarded as an acknowledgement of having filled the civic duties of a citizen rather than a living wage.[49] In Figure 6 data for four different groups are presented:

1. Public officeholders at Athens (plus-sign);
2. Soldiers, sailors and mercenaries (asterisk);
3. Architects, overseers and construction project administrators (circle);
4. Craftsmen and manual workers (cross).

The two groups related to building projects received nearly systematically higher daily compensations than officeholders at Athens or the military in the wider Aegean basin, but the deviations in the level of pay the architects received is especially wide. In the 3rd century BCE there is a clear cluster at 1.5–2 Attic drachmas based on the inscriptions from Delos (marked in Figure 6). Three different linear trends are fitted to the data using the Linreg-module in Survo MM.[50] Overall, there is a slowly rising trend in the data: clear clustering can be observed in the late 5th century with most of the data coming from Athens, but this pattern breaks up in the Late Classical period (blue line in Figure 6). The linear trend of the per diem payments for soldiers and sailors is nearly flat (green line). The sharper slope in the day wages of the craftsmen is largely due to the high payments they received at Eleusis in late 4th century before stabilising to 1.5–2 Attic drachmas on Delos (red line). Walter Scheidel presents a wider analysis of the long-term unskilled labourer wages expressed in terms of litres of wheat.[51] His 31 data points are mostly from the Eastern Mediterranean and Mesopotamia ranging from 1800 BCE to 1300 CE. He observes that the Athenian daily wages and to a lesser degree the Delian ones belong to the 'higher income band' and they are approximately at the same level as median wheat wages in Europe in 1500–1800 CE.[52]

Even though this quick comparison of consumer prices and wages does not give a direct answer to what was the possible daily payment of a construction worker in early 2nd century Didyma, the inscriptional evidence and stabilisation of the economy in the 3rd century points towards accepting the recorded levels of payments from Delos as a guideline. Cities in the Greek world minted their own coinage, but the sanctuaries of Apollo both on Delos and at Didyma used Attic (Alexandrian) drachmas in their accounting.[53] I will in the following use 2 Attic drachmas as day wage for a skilled worker and 1 drachma for a manual labourer, at least at this initial stage of converting the recorded expenses to person-days of labour at Didyma.

Comparison of Labour Rates

The rates at Didyma based on the volume calculations are summarised in Table 1. The higher rate gives the price based on the ordered block sizes and the lower one is based on the actual delivered volume of stone. The price of quarry stone is separated into two different categories based on the maximum height of the required blocks.

Quarries

Prignitz's new work on the Epidaurian inscriptions makes possible a fresh look into the quarry, transport and construction rates in 4th-century north-eastern Peloponnese.[54] Table 2 presents a summary of selected quarry, transport and construction costs on limestone based on the contracts

[47] Pritchett 1971, 3–29; Loomis 1998, 32–61, 266–269.

[48] Glotz 1913, 214–215; Lacroix 1914, 307; Burford 1969, 140 n. 4; 1972, 141.

[49] Burford 1969, 138–145; 1972, 141–142; Coulton 1977, 23–29.

[50] Mustonen 1992, 168–170.

[51] Scheidel 2010.

[52] Scheidel 2010, 452–454.

[53] Rehm 1958, 40; Reger 1994, 12–13.

[54] Prignitz 2014.

recorded in the building accounts of the temple of Asklepios (*IG* IV^2 102).[55] The temple was built at the beginning of the 4th century BCE.[56] Prignitz has reinterpreted several contract sums in the accounts[57] and the stone quantities presented in the table are recalculated based on Roux's work on the temple.[58] Price rates, stone volumes and surface areas given by Burford in her monograph should not be relied on:[59] for example, she only includes one of the three steps for the volume of the krepis and stylobate, and her cella stone volume is copied directly from Stanier's analysis.[60] Stanier did his work before the publication of Roux's monograph and, for example, he interprets the foundation widths of the cella as the thickness of the wall itself (1.48 and 1.55 m) even though these foundations carried both the cella wall and the interior colonnade; his wall height is too low, but this is not enough to compensate for the exaggerated thickness of the walls, so he ends up overestimating significantly the total volume of the cella stone, resulting in highly incorrect rates both in his and Burford's work.

Table 2. Temple of Asklepios at Epidauros. Cost rates based on contract prices in the inscriptions and reconstructed stone volume (probable day wage of a skilled craftsman: 1 Aiginetan drachma per day; *c.* 6.1 g of silver per drachma)

Construction task and quantity	Q, T & C	Q & T	Quarry	Transport	Construction
1. Local limestone for foundations of peristasis, 176 m^3	4068 dr. 23.1 dr./m^3				
2. Local limestone for foundations of cella, 96 m^3	1385 dr. 14.4 dr./m^3				
3. Corinthian stone for *peristasis* from steps to pediments, 258.7 m^3		5700 dr. 22.0 dr./m^3			
4. Construction of visible steps & stylobate, 66.9 m^3					888 dr. 13.3 dr./m^3
5. Construction of colonnade & entablature, 191.8 m^3					3068 dr. 16.0 dr./m^3
6. Corinthian stone for cella (half), 135.1 m^3		6167 dr. 45.6 dr./m^3			
7. Corinthian stone for cella (other half), 135.1 m^3			4437–4455 dr. 32.8–33.0 dr./m^3	1712–1730 dr. 12.7–12.8 dr./m^3	
8. Construction of the cella, 270.2 m^3					3209–3500 dr. 11.9–13.0 dr./m^3
9. Fluting of exterior and interior columns, 574.5 m^2					1336 dr. 2.3 dr./m^2

Local soft limestone was considered sufficient for the foundations but not for the visible parts of the temple of Asklepios, and it was inexpensive: the whole process of quarrying, transport, cutting to shape and assembling cost only *c.* 14–23 drachmas per cubic metre (rows 1 and 2 in Table 2). The higher rate of *c.* 23 drachmas per cubic metre for the exterior peristyle foundations could possibly be a result of preparing the whole temple area for construction. The usual Greek practice of constructing the exterior colonnade of temples before the cella[61] is also attested by the order of the account entries for the temple of Asklepios. The ground area of the peristyle foundations is in any case almost twice as large as the cella foundations (120 and 64 m^2). The change to Corinthian suppliers instead of local ones was very likely linked to the quality of the stone and the guaranteed supply from the established quarries.

The rates based on the construction contracts for the visible steps and the stylobate, the exterior order and the cella reveal that there should not be any great discrepancies in my calculated volumes of the different parts of the temple. The rate for the exterior order, 16.0 drachmas per cubic meter, is

[55] The drachma prices per cubic metre presented in the table are calculated by dividing the contract price given in the inscription by the volume of building stone derived from the reconstruction of the temple of Asklepios.

[56] Prignitz 2014, 248–249 argues for a date of 400–390 BCE.

[57] Prignitz 2014, 18–85.

[58] Roux 1961, 83–130.

[59] Burford 1969, 248–250.

[60] Stanier 1953.

[61] Coulton 1977, 66–67.

slightly higher than for the krepis of the temple, 13.3 drachmas per cubic metre (rows 4 and 5 in Table 2). Construction of the columns and the exterior entablature is more difficult than the steps, so a higher rate would have been justifiable. Some final numbers of the cost of the contract for cella construction are missing,[62] but the space available indicates that the total minimum sum of the missing characters is nine drachmas and the maximum 300 drachmas, so the contract was for 3209–3500 drachmas (row 8 in Table 2). The calculated rate is 11.9–13.0 drachmas per cubic metre, so it is in the same range as the krepis rate. In the contracts of the Corinthian quarry stone for the exterior and the cella[63] (rows 3, 6–7 in Table 2) the difference between the rates for contracts 3 and 6 is striking: the rate for the first contract is less than half of the latter. It is possible that Lykios from Corinth underestimated the difficulties in transporting the stone over sea and land to Epidauros, so the later contractors demanded a substantially higher price. Other explanations could be that some of the stone for the upper parts of the exterior entablature was delivered as part of the cella contract or that the smaller cella wall blocks needed more quarry work to cut to size, though this extra cost was offset by the easier transport of the smaller blocks. The temple is the first monumental building in the sanctuary, so there were quite possibly some initial problems in the temple design and the *chaîne opératoire* of the building project. Therefore, I will in the following combine the data of the four different contracts related to the quarrying and transport of Corinthian stone.

Some of the last figures for the cost of quarrying and transport are missing from the two separate contracts for the second half of the cella stone: however, the total would have been the same as for the first half, 6167 drachmas, so based on the space for the missing characters,[64] the contract for quarrying was 4437–4455 drachmas and for transport 1712–1730 drachmas. Circa 72% of these two contract prices was, therefore, for quarrying and *c.* 28% for transport (row 7 in Table 2). Assuming this ratio applies to the two other contracts (rows 3 and 6 in Table 2), the average for the temple quarry stone comes to *c.* 24.6 drachmas per cubic metre[65] and for the combined sea and land transport to *c.* 9.5 drachmas per cubic metre. On the same lines of the inscription as the discussed contracts, the architect of the project, Theodotos, is recorded as having received his conventional annual payment of one Aiginetan drachma a day.[66] The daily wage of a skilled craftsman can with relatively high degree of certainty be taken to be at the same level,[67] so the calculated rates can also be expressed as person-days, 24.6 person-days per cubic metre for quarrying and 9.5 person-days for transport. This opens up the possibility of comparing the inscriptional data with Pegoretti's labour cost rates to gain an understanding of the possible amount of work involved behind the Epidaurian contracts.[68] Corinthian oolitic limestone is very good material for construction. It is highly homogenous, and the size and shape of extracted blocks were determined by the intended use rather than discontinuities in the matrix, so wastage could also be kept to a minimum. A channel was cut around the stone and the most unpredictable part was breaking the lower surface of the block from the bedrock. Due to lamination of the limestone, the lower surfaces could require significant trimming of the lower face.[69] Keeping in line with the total cost estimate of a single column at Didyma, it is possible to analyse the work involved in quarrying the limestone drums of a single column of the temple of Asklepios. Roux proposes that the shaft was constructed of ten drums with an average height of 0.54 m; the lower shaft diameter was *c.* 0.92 m and the upper 0.606 m.[70]

For quarrying limestone, Pegoretti gives rates of 17.5–33.3 h/m^3 for one skilled quarryman assisted by two labourers, 56–224 h/m^3 of skilled labour for roughing out the shape of the blocks and 2.4–8.0 h/m^2 for rough dressing of the block surfaces.[71] Assuming a day rate of one Aiginetan drachma for the

[62] *IG* IV^2 102.20–21; Prignitz 2014, 22, 46–47.

[63] *IG* IV^2 102.3–4, 12–17; Prignitz 2014, 22, 44–46.

[64] *IG* IV^2 102.14–17; for the space for missing characters, see Prignitz 2014, 22.

[65] For comparison, the price of Corinthian quarry stone based on mid-4th century building accounts from Delphi is 16–26 dr./m3; Roux 1966, 289–290.

[66] *IG* IV^2 102.7.

[67] Cf. *IG* I^3 475 and 476, the Erechtheion building accounts of 409–407 BCE; for detailed analyses of the accounts and wages, see Loomis 1998, 99, 105–108.

[68] Pegoretti 1863–1864. These volumes are the 2nd edition revised by A. Cantalupi. On the use of Pegoretti in the context of Roman construction projects, see DeLaine 1997, 104–106.

[69] Hayward 2013, 66–68.

[70] Roux 1961, 93; for the upper diameter, see Pakkanen 1998, app. D, table D1.

[71] Pegoretti 1863, 166–167, 280–281, 338, 466; cf. Russell 2013, 30–31, table 2.1. Russell gives Pegoretti's minimum rate for roughing out limestone as 56.9 h/m^3, but in Pegoretti 1863, 338 it is 56.00 h/m^3.

skilled quarryman and half of that for his assistants, and a ten-hour effective working day, the cost of the first phase of quarrying one cubic metre comes to 1.8–3.3 person-days of skilled and 3.5–6.7 person-days of unskilled labour, or a total of 3.5–6.7 Aiginetan drachmas per cubic metre.[72] With good planning how the quarrying is carried out,[73] only the lower surfaces of the drums would have required roughing out. Estimating an average thickness of 0.1 m for this layer, *c.* 20% of the final volume of the drums would have been removed, resulting in a rate of *c.* 1.1–4.5 dr./m^3.[74] Pegoretti's rough dressing of the drums is based on a rate per square metre, but in order to compare the rate with the inscription, it must be converted to a cubic metre rate. In this particular case the rate for the drums comes to 2.1–7.2 dr./m^3, but smaller blocks have a higher surface area per cubic metre, so their rate would be higher. Summing up the three phases, the rate for the drum blocks can be estimated as 6.8–18.3 dr./m^3. Considering the very high total volume of extracted material from the quarries at Corinth[75] and homogeneity of the material, it is likely that the labour rate at Corinth would have been towards the lower end of the range. Even considering additional costs for tools, equipment and their maintenance, harbour dues and also a possible quarry lease paid to the polis,[76] the average price of 24.6 drachmas per cubic metre paid for the stone by the sanctuary at Epidauros would have left a healthy profit margin for the entrepreneur. Assuming that the maximum quarry costs at Corinth could be kept at 12 drachmas per cubic meter, it can be estimated that the contractor was paid at least 2.1 times more than the daily wages for the extraction of the blocks. Returning back to the first contract on quarrying and transport of stone for the exterior of the temple (row 3 in Table 2), based on Pegoretti's labour rates it could have been a profitable deal, but there would have been little margin for error.[77] Also, the risks for the quarry contractor at Corinth would also have been substantially lower than for the transport contractor, as we will see further on.

A similar comparison can be carried out with the cost of quarry stone at Didyma. Pegoretti's rate for marble quarrying is 40 h/m^3 for a skilled quarryman with two assistants, 248.7–350.0 h/m^3 for roughing out and 9.0–12.5 h/m^2 for rough dressing.[78] Using the daily wage of two Attic drachmas for skilled and one drachma for unskilled, the cost of quarrying comes to 16 dr./m^3. The volume of the quarry stone needing to be roughed out depends on the type of stone and for marble the wastage tends to be more than for homogenous limestones, so I use 25% in the following calculations.[79] This results in a range of 12.4–17.5 dr./m^3. Using the total column block volumes and surface areas at Didyma (Tables A1–A2) to estimate the rate for rough dressing the quarry blocks results in a rate of 7.4–10.2 dr./m^3. The total range for the work quarrying the column blocks at Didyma based on Pegoretti comes to 35.8–43.7 dr./m^3. The lower end of the actually paid rate based on the building accounts and delivered stones, 131.8 dr./m^3 (Table 1), is 3.7 times higher than the lower end of the range based on Pegoretti's figures. This applies to the blocks with a height of less than 0.5 m. The upper end of the range at Didyma, 192.4 dr./m^3, is for the larger blocks, and compared to the upper end of Pegoretti's range, it is 4.4 times larger. The paid rate at Didyma is 3.7–4.4 more than what

[72] Hayward 2013, 68 estimates that quarrying a 1.4 m^3 block of Corinthian limestone takes *c.* 25 hours of labour. However, his estimate is based on quarrying marble and Burford's (1969, 247) estimate that Pentelic marble takes five times as long to work as 'poros' limestone. This might well be the case with dressing the stone, but Pegoretti's (1863, 166–167) *quarry* rates are only 1.2–2.3 times higher for marble than limestone.

[73] For the limestone drums in the quarries at Selinous, see e.g. Martin 1965, 148.

[74] The average radius of a drum in the temple of Asklepios is r = 0.382 m, so the removed volume can in this case be calculated as $10 \times \pi r^2 \times 0.1$ m $\approx$ 0.457 m^3. This is 18.5% of the total volume of the shaft of 2.47 m^3.

[75] 4,000,000–4,500,000 m^3; Hayward 2013, 64.

[76] Burford 1969, 172–175.

[77] The minimum cost of quarrying is 6.8 dr./m^3 $\times$ 258.7 m^3 $\approx$ 1759.2 dr.; the later rates for land transport at Epidauros were certainly much higher: using the Tholos rate of 2.25 Aig. dr./(km$\times$m^3), the cost would have been 2.25 dr./(km$\times$m^3) $\times$ 15 km $\times$ 258.7 m^3 $\approx$ 8731 dr., higher than the whole contract price; for the rates of land transport, see the next sub-section. A rough estimate for the minimum price can be estimated on the basis of oxen-days. Assuming that the maximum load per yoke was one tonne and that the return trip from the harbour to sanctuary could be made in a day, it took minimum 258.7 m^3 $\times$ 2.6 tonnes/m^3 $\times$ 1 oxen-day/tonne = 673 oxen-days; on loads of 500–1000 kg for a single yoke at Epidauros, see Burford 1969, 186–188. In late 4th century, the cost of an oxen-day was *c.* 4 Attic dr. (see nn. 81–82 below for references), so for work carried out earlier in the century, it is unlikely that the price would have been less than 2 Aig. dr. per day. The combined minimum cost of quarrying and land transport comes to 3105 dr., leaving less than half for the operating costs of the quarries and sea transport.

[78] Pegoretti 1863, 167, 280–281, 392; cf. Russell 2013, 30–31, table 2.1. For an evaluation of the cost of different marbles in Asia Minor and their use in building in the Roman period, see Barresi 2003, 151–204.

[79] Cf. Corcoran and DeLaine 1994, 270.

would be expected on the basis of Pegoretti's labour rates and the daily wage calculations. Based on Pegoretti's data, Corcoran and DeLaine calculate the Roman quarry rate of medium-grained white marble as 26 denarii per Roman cubic foot which translates to 32.9 dr./m^3 using the Didyma day wages, so their calculations produce a little lower figure than my minimum estimate based on Pegoretti.[80] Their minimum estimate for the full production costs of Proconnesian marble is based on 15th–16th century CE costs at Luna and it comes to 50 denarii/ft^3, or 63.2 dr./m^3 in terms of the Didyma prices. This is only 33–48% of the actual quarry stone prices paid at Didyma and in line with the data from Corinth and Epidauros. These calculations point towards adding at least 50–100% on top of Pegoretti's quarry rates for additional costs such as supervision, tools, their maintenance, higher level of wastage and moving the large blocks in the quarry. Even with the additional costs, there is enough of a margin for the profit of the contractor. However, these calculations of the quarry costs support that the analysis of the daily wages presented in the previous section can produce a reasonable estimate for the daily wage level of the 2nd-century BCE construction project at the sanctuary of Apollo at Didyma.

Land Transport

A very significant part of the construction project expenses was generated from moving of the large limestone and marble blocks into the sanctuaries. The costs of land transport of marble column drums using oxen from the Pentelic quarries to Eleusis are known in detail from a preserved building account.[81] Stanier calculates the price of the transport of an average column drum of *c.* 2.84 m^3 as 344 drachmas, but he slightly underestimates the ground distance from the quarries. The distance from the foot of the Pentelic mountain to the sanctuary at Eleusis is *c.* 33 km, so his average rate per cubic metre can be recalculated as *c.* 3.7 drachmas per kilometre. Kevin Clinton argues that in addition to the per diem price of 4 drachmas per yoke, there was an additional cost of 1 drachma per half-day.[82] The smallest recorded payment is 228 drachmas,[83] so accepting Clinton's analysis, the journey to Eleusis would have been carried out in two days by 28 yokes,[84] resulting in a minimum rate per cubic metre of 2.3–2.9 Attic drachmas per kilometre.[85]

However, there was no attempt to minimise the transport costs at Eleusis. The number of oxen yokes varied, and the smallest number used was most likely 24 and the highest 38,[86] resulting in loads of only 170–330 kg per yoke. The incentive of the administrators at Eleusis was quite likely to make certain that all yokes and their drivers turning up were given a chance to take part, thus ensuring that a sufficient number of beasts were always present when required. At Epidauros, the transport of 71 Pentelic marble coffers for the Tholos from the harbour to the sanctuary, a distance of 15 km on a cart road rising to 360 metres above sea level (*c.* 1.4-degree slope), cost 25 drachmas a piece. Burford gives the mass of a single coffer as 1997 kg,[87] so the rate for cubic metre can be calculated as 2.3 Aiginetan drachmas per kilometre, or in terms of the Attic drachma, 3.2 drachmas per kilometre.[88]

[80] Corcoran and DeLaine 1994, 270. 26 den. / 61 den./person-day $\times$ 2 dr./person-day $\times$ (0.296 ft/m)^3 $\approx$ 32.9 dr./m^3.

[81] *IG* II^2 1673 (333/2? BCE); for discussions of the inscription, see Stanier 1953, 70–71; Burford 1960, 13–15; Clinton 1971, 102–113; Raepsaet 1984; Loomis 1998, 109–110.

[82] Clinton 1971, 106–107; cf. Burford 1960, 13–15; Loomis 1998, 109–110, esp. n. 14.

[83] *IG* II^2 1673.81.

[84] 28 $\times$ 2 days $\times$ 4 dr./day + 2 days $\times$ 2 dr./day = 228 dr. DeLaine (1997, 108) gives the minimum speed for heavily laden oxen pair as 1.67 km/h, and with multiple yokes the speed would have been slower; however, the load per yoke at Eleusis was low, so even assuming a minimum speed of 1.5 km/h, it would have been possible to reach the sanctuary in two days of 11 hours (2 $\times$ 11 h $\times$ 1.5 km/h = 33 km). Bevan (2013, 6) gives a summary of travel speeds and loads for Greek and Roman contexts: his wagon speed is 2–4 km/h and load 200–1000 kg.

[85] The mass of the column drums at Eleusis is 6.5–8.0 tonnes (Burford 1960, 6), so their volume was 2.4–3.0 m^3: 228 dr./ (2.4 m^3 $\times$ 33 km) $\approx$ 2.87 dr./(m^3$\times$km); 228 dr./ (3.0 m^3 $\times$ 33 km) $\approx$ 2.33 dr./(m^3$\times$km).

[86] Clinton 1971, 103–107; Loomis 1998, 109 n. 14.

[87] Burford 1969, 186.

[88] 1775 dr. / (71 $\times$ (1997 kg / 2700 kg/m^3) $\times$ 15 km) $\approx$ 2.25 Aig. dr./(m^3$\times$km); 6.1 g / 4.3 g $\times$ 2.25 Aig. dr. $\approx$ 3.2 Attic dr.

Burford estimates the distance as 7 miles,[89] but the more evenly sloped cart road is longer, so the rate per kilometre here is lower than hers. It is possible to compare this rate with DeLaine's land transport cost of 0.52 kastrensis modii / (tonne × Roman mile): her rate is 85% of the daily wage of a skilled workman,[90] and expressed in terms of a Roman mile, the rate at Epidauros is 124% of the daily wage of one Aiginetan drachma,[91] so it is higher but still within a comparable range. Because of the lighter mass of the coffers, far fewer oxen yokes would have been required than at Eleusis, but the contractor was not able to deliver the blocks on time. Megakleidas was paid 1775 drachmas for the transport, but he subsequently had to pay a fine of 1080 drachmas because of delay.[92] Using multiple yokes results in loss of efficiency,[93] and taking into consideration the mass of the heavy cart needed, Burford estimates that up to eight yokes would have been needed to pull the heavy blocks.[94] If the Epidaurian farmers were compensated at the same level as the Attic ones, the day-wage of a yoke and the driver would have been 2.8 Aiginetan drachmas and only the single day of transport from the harbour to the sanctuary would have been compensated for, not the return trip. This level of compensation would have basically made little chance for Megakleidas to make a profit,[95] so it is likely that he either paid less per yoke or tried to use fewer yokes, or even attempted to get away with both means of reducing the costs at the same time. The speed of transport would have depended on the number of yokes and carts available, so in this instance his attempt to get more out of the contract failed and he quite certainly ended up with a significant loss.

The land transport rates at Didyma are approximately five times higher than the average rate of 3.7 drachmas per cubic metre in Attica, and based on the analysis of the previous section, the daily wages of skilled workmen were probably at the same level at Eleusis and at Didyma. There are some larger blocks at Didyma, but in general they are of similar size, so that is not a sufficient explanation for the difference. At Eleusis, only the working days were covered by the payments and the income was only supplementary to the farmers turning up at the Pentelic mountain. Additional costs of the operation such as loading and unloading the blocks were not included in the price, and even the cost of the drinking troughs for the oxen was covered separately;[96] the heavy carts were also provided by the sanctuary.[97] The transport price at Epidauros is the total price paid to the contractor before the middle of the 4th century BCE. The daily wages paid a little later at Eleusis were very high, so Megakleidas probably paid less to the yokes and should have been able to make a decent profit from the contract. It is difficult to find a specific reason why the land transport rates are as high as they are at Didyma by comparison with data from Eleusis and Epidauros, but organisation of transport could have been quite different at Didyma than at either one of the other places and required a higher level of compensation to cover all related costs.[98]

Carving Final Surfaces and the Cost of a Column

Comparison of the rates for column fluting at Epidauros and Didyma with Pegoretti's labour figures is rather straight-forward. Based on the contract price and the estimated surface area of the exterior, in-antis and interior columns, the rate at Epidauros was 2.3 dr./m^2 (Table 2). Russell's analysis of Pegoretti's labour constants gives the fluting rate for limestones as 7–26 h/m^2,[99] so converted using the daily rate of one Aiginetan drachma per person-day, the range comes to 0.7–2.6 dr./m^2. The actually paid compensation at Epidauros is within the range, so it is possible that the contract price mainly included the daily wages of the stone masons, the tools and their maintenance. The rate for

---

[89] Burford 1969, 190.

[90] DeLaine 1997, 210–211. Rate: 0.52 KM / 0.61 KM ≈ 0.852.

[91] 25 dr. / (1.997 tonne × 15 km / 1.481 miles/km) ≈ 1.236.

[92] *IG* IV^2 103, 198–199, 231–232. See also Prignitz 2014, 113–115.

[93] See e.g. DeLaine 1997, 108.

[94] Burford 1969, 186–187.

[95] 4 Attic dr. × 4.3 g / 6.1 g ≈ 2.82 Aig. dr.; 8 × 2.82 Aig. dr. ≈ 22.6 Aig. dr., and the price Megakleidas received was 25 Aig. dr.

[96] *IG* II^2 1673.21.

[97] *IG* II^2 1673.11–43; Burford 1969, 252–253.

[98] For example, if the contractor had to provide and maintain the carts for heavy transport.

[99] Russell 2013, table 2.1.

fluting marble columns can be calculated as 28.8–40.7 h/m^2,[100] so for using the estimated skilled wages of 2 Alexandrian (Attic) drachmas a day at Didyma, the range is 5.8–8.1 dr./m^2.[101] At the temple of Apollo, the most probable rate for fluting of 22.2–22.8 dr./m^2 (Table 1) is 2.7–3.9 times higher than based on the estimated labour, so the compensation must have included substantial additional operational costs and a margin for profit on top of the salaries. The height of the Ionic capital at Didyma is higher than the maximum height given by Pegoretti, but the increase in his figures is based on a linear trend of the height,[102] not the surface area or volume as would be expected, so calculating a 'Pegorettian' labour estimate for the size of the Didyma capital is uncomplicated.[103] The person-hours can be converted into a rate of 12.5–17.2 dr./m^2 for the Didyma capital using its finished size in the calculations.[104] The rate for carving the capital is specified in the inscription as 5 dr./ft^2, so the paid rate of 56.9 dr./m^2 is 3.3–4.6 times higher than what can be estimated on the basis of Pegoretti's labour costs. This is in line with the analysis of the quarry costs, so 50–100% should be added on top of Pegoretti's marble carving rates for the additional costs such as tools and their maintenance, supervision and making a profit. It is also possible that the craftsmen contracted to carry out the fluting and capital carving were highly valued specialists and paid at a higher rate than other masons. The recorded expenses for the temple certainly would have allowed such a rate.

Based on the Didyma building accounts, the total cost of quarrying, transporting, erection and final carving of a single Ionic marble column of the temple of Apollo would have been *c.* 35,300 drachmas. The total volume of the material was 63.2 m^3, so using the day wage of a skilled labourer, the final rate for the project comes to *c.* 280 person-days per cubic metre.[105] For one limestone column of the temple of Asklepios at Epidauros, the total cost can be estimated as 177 drachmas.[106] The overall rate comes to *c.* 66 person-days per cubic metre, so building at a reasonable scale and employing less expensive materials, the rate for a single column at Epidauros can be calculated as less than a quarter of the one at Didyma. Using marble in monumental building was also about making a statement that no costs were spared in these projects.

Cost of Stonework for the Parthenon

If used diligently, the labour cost rates based on a comparison of Greek building account inscriptions and 19th-century architectural manuals can provide a way for realistic estimations of costs for monumental construction. The benefit of the inscriptions is that they document actually occurred costs, so studies are not only limited to estimating the minimum level of finance for the projects. To give an example of how comparative rates can be used to suggest a cost range for stone work of a specific building, I will present a revaluation of Stanier's estimate for the Parthenon at Athens (447–432 BCE).[107] In his calculations, 68% of his total cost comes from the quarrying, erecting and dressing of the stone. Taking the above analyses as a guideline, the minimum quarry rates are largely based on Pegoretti but take into account the operational costs, and the maximum rates are based on Didyma but adjusted to the 5th-century Athenian daily wage of one drachma a day (Table 3). The

[100] Russell 2013, table 2.1.

[101] Burford's (1969, 246) modern comparanda for fluting the Pentelic marble columns in rebuilding of the Stoa of Attalos in the 1950s result in very high labour rates of 150 and 267 person-hours/m^2. These rates are 3.7 and 6.6 times higher than Pegoretti's maximum rate, so they are not useful for estimating realistic ancient labour costs.

[102] Pegoretti 1863, 397; cf. Russell 2013, table 2.3.

[103] Minimum 0.90 m / 0.80 m $\times$ 1042.67 h $\approx$ 1173.0 h and maximum 0.90 m / 0.80 m $\times$ 1440 h = 1620 h.

[104] 1173.0 h / 10 h/person-day $\times$ 2 dr./person-day $\times$ (2 $\times$ 2.056 m $\times$ 2.548 m + 2 $\times$ 2.548 m $\times$ 0.906 m + 2 $\times$ 2.056 m $\times$ 0.906 m) $\approx$ 12.47 dr./m^2; 1440 h / 10 h/person-day $\times$ 2 dr./person-day $\times$ (2 $\times$ 2.056 m $\times$ 2.548 m + 2 $\times$ 2.548 m $\times$ 0.906 m + 2 $\times$ 2.056 m $\times$ 0.906 m) $\approx$ 17.22 dr./m^2.

[105] 35,288 dr. / 63.22 m^3 / 2 dr./person-day $\approx$ 279.2 person-days/m^3.

[106] Volume of the shaft and capital is *c.* 2.70 m^3 and surface area *c.* 13.9 m^2. The rates are 24.6 dr./m^3 for quarrying, 9.5 dr./m^3 for transport, 16.0 dr./m^3 for construction, 2.3 dr./m^2 for fluting and 0.66 dr./m^2 for stuccoing. Stuccoing of the peristyle order is not separately listed in the building accounts, but it is quite possible that the task was part of the contract Philargos undertook for 615 dr. (*IG* IV^2 102.79–80). If so, the rate for stuccoing the surfaces of the peristyle columns, entablature and the exterior of the cella wall comes to 615 dr. / 926.6 m^2 $\approx$ 0.664 dr./m^2. Prignitz (2014, 43–75) does not discuss under which contract stuccoing of the exterior order should fall.

[107] Stanier 1953.

rates for the limestone foundations are taken directly from the Epidauros inscriptions.[108] The costs for fine dressing are based on the Didyma inscriptions, and in order to keep comparisons between Stanier's calculations and the new rates as simple as possible, I have not adjusted any of the surface area or volume information nor have I estimated minimum figures for fine dressing of the blocks.

Table 3. Stonework of the Parthenon on the Athenian Acropolis. Cost rates (2–5): dr./m^3; volume (6): m^3; cost (7): Attic drachmas. Stanier's figures are given in parentheses in the table (day wage of a skilled craftsman: 1 Attic drachma per day; *c.* 4.3 g of silver per drachma)

1.	2. fine dressing	3. quarrying	4. constr.	5. combined rate	6. volume	7. cost
Walls	–	30.0–65.9 (153.5)	19.0 (16.5)	49.0–84.9 (170.0)	2849	139,601–241,880 (484,188)
Pavement	–	30.0–65.9 (153.5)	19.0 (11.0)	49.0–84.9 (164.5)	1389	68,061–117,926 (228,421)
Foundations	–	(25.6)	(9.3)	14.4–23.1 (34.9)	3251	46,814–75,098 (113,330)
Colonnade	25.37 (35.75)	30.0–65.9 (154.3)	19.0 (68.8)	74.4–110.4 (258.8)	3704	275,466–408,440 (958,521)
+ Fine dressing of walls & pavement, 7065 m^2 at 10.8 dr./m^2 (16.35 dr./m^2)						76302 (115513)
Total						606244–919646 (1899973) dr. = 101.0–153.3 (316.7) talents

The readjustment of Stanier's rates shows that he has overestimated the cost of stonework for the temple. The range calculated here comes to 610,000–920,000 person-days instead of Stanier's much higher 1,900,000 person-days (Table 3). Expressed in Attic drachmas, the more likely range is 100–150 talents instead of 320 talents as estimated by Stanier. This brings down the total price of the Parthenon to 250–310 talents, significantly less than Stanier's 470 talents.[109] Further revaluation of the costs is beyond the scope of this paper, but considering the tendency towards high rates in Stanier's study, it is likely that the lower sum of 250 talents estimated here is closer to the maximum price of the Parthenon, not the minimum.[110] Also, the Athenian practice of directly compensating the craftsmen rather than through a contractor, as is evident in the Erechtheion accounts, would have been an additional factor in reducing the overall costs compared to Epidauros and Didyma.[111]

Conclusions

The comparative analysis of the blocks of the unfinished column of the Hellenistic temple of Apollo at Didyma and the data on costs, rates and volumes in the building accounts makes it possible to calculate separate labour rates for quarrying, transport and construction of both the ordered *and* delivered material (Table 1). The total cost of a single column can be estimated as *c.* 35,300 drachmas (or c. 17,600 person-days of skilled labour working effectively ten hours a day). Quarrying and transport comprise both *c.* 37% of the total costs, and these two categories were more expensive than the actual construction of the column at *c.* 26% of the total. The new data on the cost of contracts and estimates of the building material volume of the temple of Asklepios at Epidauros allow the estimation of more reliable cost rates for quarrying of Corinthian limestone, for sea and land transport from Corinth to Epidauros and for construction at the temple site (Table 2). The difference in the scale of the two enterprises is striking: the volume of one column at Didyma is *c.* 63.2 m^3 and at Epidauros only *c.* 2.7 m^3. The total column cost at Epidauros can be estimated as 177 drachmas, and since the day wage of a craftsman was most probably in the range of one Aiginetan drachma, this labour cost is almost exactly one hundredth of the person-days at Didyma. Quarrying made *c.* 38% of

[108] Stanier (1953, 70) argues that the drachma rates from Epidauros can be used for 5th-century since the difference between the weight of Aiginetan and Attic drachmas matches the rise of prices.

[109] For a more general evaluation of the cost of major building programmes at Athens compared to income and expenses, see Pakkanen 2013, 72–74.

[110] Stanier (1953) estimates the cost of stone transport as 48 talents, ceiling, roof and gates as 65 talents, pedimental sculptures and acroteria as 17 talents, cella wall frieze as 12 talents and metopes as 10 talents.

[111] *IG* I^3 475 and 476; cf. Loomis 1998, 105–108.

the costs, and even though the distance by sea and land is the same as at Didyma, transport was only 14% of the total, thus leaving 48% for construction. The reduced level of costs for quarrying and transport clearly made Corinthian limestone a viable option for building in the north-eastern Peloponnese and at Delphi. In terms of person-days per cubic metre, the differences between the two projects are equally remarkable: the colossal scale, use of marble through-out and relatively high transport costs result at Didyma in a rate more than four times as expensive per cubic metre as at Epidauros with imported Corinthian limestone and building at a 'human' scale.

When used carefully, combining data from the buildings themselves, the preserved building accounts and 19th-century architectural manuals can result in realistic estimations for the total costs of monumental construction.[112] The principle of estimating minimum labour costs is in general a sensible approach since in most cases it is very difficult to set the level for reasonable or maximum costs. However, because the Classical and Hellenistic building accounts list the specific payments made to the craftsmen, architects and contractors, it is possible to derive the actual labour cost rates from the inscriptions and compare them with Pegoretti's 19th-century handbook and later scholarship using his rates. The analysis of the quarry and fine dressing rates from Epidauros and Didyma strongly supports the idea that employing Pegoretti's data also for Greek contexts produces meaningful comparisons: it opens up the possibility of looking into the profits made by the contractors and evaluating the level of skilled daily wages for projects where these data were not recorded in antiquity. For example, using Pegoretti's labour rates for the work in the quarries provides a minimum baseline for estimating the number of required person-days, including roughing out the shape of the blocks before transport. Comparing these figures with data from the building inscriptions provides a possibility of estimating the general operational costs of the ancient quarries. The high costs at Didyma can be the combined result of expensive contracts for the transport of marble blocks, entrepreneurs making substantial profits from the works and the need to pay high enough prices for the times when the work was not progressing. Based on the analyses presented in this paper, the criticism that Pegoretti's figures produce too high labour estimates for ancient monumental building cannot be supported. In the concluding section of this paper, I present a revaluation of the cost of stonework for the Parthenon on the Athenian Acropolis based on a comparison with labour rates from Didyma and Epidauros (Table 3). The more realistic estimate of 100–150 Attic talents is only one third to half of Stanier's suggestion.

Acknowledgements

This study started its life as the joint paper 'Econometrics in Greek Architecture: Review and Current Trends' with Ann Brysbaert. It was presented at the Oxford conference in January 2020 honouring Janet DeLaine's defining contribution to the field of labour cost studies. Developing the ideas and discussions during the conference resulted in two separate papers and both of these are presented in this volume.[113] Special thanks are due to Ann for being able to sound the ideas and for her feedback. I am also grateful to Caroline Waerzeggers for her quick reply to my query regarding the commodity prices in Babylon. This paper picks up on several issues presented in the footnotes of my contribution to the project *Shipsheds of the Ancient Mediterranean*.[114] The conference and its publication provided the opportunity of updating and formulising these ideas more thoroughly, so I wish to thank the organisers and Janet for the inspirational occasion.

[112] On the use of market prices in Attica for estimating the cost of Classical and Hellenistic housing, see Pakkanen, in press. On the documentation and estimation of building volumes for private houses, see also Pakkanen *et al.* 2020, 2–3.

[113] For her contribution, see Brysbaert, in press.

[114] Blackman *et al.* 2013; the project was co-directed by Boris Rankov, David Blackman and the author of this paper and funded by the Leverhulme Trust in 2003–2007.

Bibliography

Attanasio, D., M. Brilli, and N. Ogle 2006. *The Isotopic Signature of Classical Marbles*. Rome: L'Erma di Bretschneider.

Barresi, P. 2003. *Province dell'Asia Minore. Costo dei marmi, architettura pubblica e committenza*. Studia Archaeologica 125. Rome: L'Erma di Bretschneider.

Bevan, A. 2013. Travel and interaction in the Greek and Roman World. A review of some computational modelling approaches, in S.E. Dunn and S. Mahony (eds) *The Digital Classicist 2013:* 3–24. Bulletin of the Institute of Classical Studies Supplement 122. London: Instiitute of Classical Studies.

Blackman, D., B. Rankov, K. Baika, H. Gerding and J. Pakkanen, 2013. *Shipsheds of the Ancient Mediterranean*. Cambridge: Cambridge University Press.

Borg, B.E. and G. Borg 2002a. The History of Apollo's Temple at Didyma, as told by marble analyses and historical sources, in L. Lazzarini (ed.) *Interdisciplinary Studies on Ancient Stone. ASMOSIA VI Proceedings of the Sixth International Conference of the Association for the Study of Marble and Other Stones in Antiquity, Venice, June 15–18, 2000:* 271–278. Padova: Bottega d'Erasmo.

Borg, B.E. and G. Borg 2002b. From Small quarries to large temples. The enigmatic source of limestone for the Apollo temple at Didyma, W-Anatolia, in L. Lazzarini (ed.) *Interdisciplinary Studies on Ancient Stone. ASMOSIA VI Proceedings of the Sixth International Conference of the Association for the Study of Marble and Other Stones in Antiquity, Venice, June 15–18, 2000:* 427–436. Padova: Bottega d'Erasmo.

Brysbaert, A. 2013. Set in Stone? Socio-economic Reflections on Human and Animal Resources in Monumental Architecture of Late Bronze Age Tiryns in the Argos Plain, Greece. *Arctos* 47: 49–96.

Brysbaert, A. 2015. Set in stone? Technical, socio-economic and symbolic considerations in the construction of the Cyclopean-style walls of the Late Bronze Age Citadel at Tiryns, Greece, in C. Bakels and H. Kamermans (eds), *Excerpta Archaeologica Leidensia, Analecta Praehistorica Leidensia* 45: 69–90. Leuven: Peeters.

Brysbaert, A. 2017. SETinSTONE: an impact assessment of the human and environmental resource requirements of Late Bronze Age Mycenaean monumental architecture. *Antiquity* 91.358, e4: 1–7.

Brysbaert, A., in press. Labouring during the Aegean Late Bronze Age. In this volume.

Brysbaert, A., V. Klinkenberg, A. Gutiérrez Garcia-M. and I. Vikatou (eds) 2018. *Constructing Monuments, Perceiving Monumentality and the Economics of Building. Theoretical and Methodological Approaches to the Built Environment*. Leiden: Sidestone Press.

Burford, A. 1960. Heavy transport in Classical antiquity. *The Economic History Review* 13: 1–18.

Burford, A. 1969. *The Greek Temple Builders at Epidauros. A Social and Economic Study of Building in the Asklepian Sanctuary, during the Fourth and Early Third Centuries B.C.* Liverpool: Liverpool University Press.

Burford, A. 1972. *Craftsmen in Greek and Roman Society.* London: Thames and Hudson.

Clark, M.G. 1993. The Economy of the Athenian Navy in the Fourth Century B.C., Unpublished D.Phil. thesis, Oxford University.

Clinton, K. 1971. Inscriptions from Eleusis. *Archaiologike Ephemeris* 1971: 81–136.

Corcoran, S. and J. DeLaine 1994. The unit measurement of marble in Diocletian's Prices Edict. *Journal of Roman Archaeology* 7: 263–273.

Coulton, J.J. 1977. *Greek Architects at Work. Problems of Structure and Design.* London: Elek Books.

Davies, J.K. 2001. Rebuilding a temple: the economic effects of piety, in D.J. Mattingly and J. Salmon (eds) *Economies beyond Agriculture in the Classical World*: 209–229. Leicester–Nottingham Studies in Ancient Society 9. London: Routledge.

DeLaine, J. 1997. *The Baths of Caracalla. A Study in the Design, Construction, and Economics of Large-Scale Building Projects in Imperial Rome.* Journal of Roman Archaeology Supplement 25. Portsmouth (RI): Journal of Roman Archaeology.

Feyel, C. 2006. *Les Artisans dans les sanctuaires grecs aux époques classique et hellénistique à travers la documentation financière en Grèce.* Bibliothèque des écoles françaises d'Athènes et de Rome 318. Athens: Ecole française d'Athènes.

Glotz, G. 1913. Les salaires à Délos. *Journal des savants* 11: 206–215.

Grainger, J.D. 1999. Prices in Hellenistic Babylonia. *Journal of the Economic and Social History of the Orient* 42: 303–350.

Griffith, G.T. 1935. *The Mercenaries of the Hellenistic World.* Cambridge: Cambridge University Press.

Haselberger, L. 1980. Werkzeichnungen am jüngeren Didymeion. Vorbericht., *Istanbuler Mitteilungen* 30: 191–215.

Haselberger, L. 1983. Bericht über die Arbeit am jüngeren Apollontempel von Didyma. Zwischenbericht. *Istanbuler Mitteilungen* 33: 90–123.

Haselberger, L. 1985a. Befestige Turmgehöfte im Hellenismus auf den Kykladeninseln Naxos, Andros und Kea. Unpublished PhD dissertation, Technische Universität, Munich.

Haselberger, L. 1985b. The Construction plans for the Temple of Apollo at Didyma. *Scientific American* 253: 126–133.

Haussoullier, B. 1926. Inscriptions de Didymes. Comptes de la construction du Didymeion IV. *Revue de philologie, de littérature et d'histoire anciennes* 50: 125–152.

Hayward, C. 2013. Corinthian stone exploitation and the interpretation of inscribed building accounts. in K. Kissas and W-D. Niemeier (eds) *The Corinthia and the Northeast Peloponnese. Topography and History from Prehistoric Times until the End of Antiquity.* Athenaia 4: 63–78. Munich: Hirmer.

Hellmann, M.-C. 1999. *Choix d'inscriptions architecturales grecques.* Lyon: Maison de l'Orient et de la Méditerranée – Jean Pouilloux.

Herda, A. 2006. *Der Apollon-Delphinios-Kult in Milet und die Neujahrsprozession nach Didyma: ein neuer Kommentar der sog. Molpoi-Satzung.* Milesische Forschungen 4. Mainz: Philipp von Zabern.

Knackfuss, H. 1941. *Die Baubeschreibung.* Didyma 1. Berlin: Gebr. Mann.

Lacroix, M. 1914. Les Architectes et entrepreneurs à Délos de 314 à 240. *Revue de philologie, de littérature et d'histoire anciennes* 38: 303–330.

Lancaster 2019. To House and defend: the application of architectural energetics to southeast Archaic Greek Sicily, in L. McCurdy and E.M. Abrams (eds) *Architectural Energetics in Archaeology. Analytical Expansions and Global Explorations:* 95–113. London: Routledge.

Larsen, J.A.O. 1959. Roman Greece, in T. Frank (ed.) *An Economic Survey of Ancient Rome* 4*:* 259–498. Paterson (NJ): Pageant Books.

Loomis, W.T. 1998. *Wages, Welfare, Costs and Inflation in Classical Athens.* Ann Arbor: University of Michigan Press.

Martin, R. 1965. *Manuel d'architecture grecque.* Paris: A. et J. Picard.

Mustonen, S. 1992. *SURVO. An Integrated Environment for Statistical Computing and Related Areas.* Helsinki: Survo Systems.

Müth, S. and J.-C. Bessac 2018. Economical challenges of building a Geländemauer in the middle of the 4th c. BC: the city wall of Messene as an example. 19th International Congress of Classical Archaeology. Cologne/Bonn, 22–26 May 2018. Viewed 25 March 2020, <https://www.aiac2018.de/programme/sessions/session3/panel24/papers/mueth/>

Pakkanen, J. 1998. *The Temple of Athena Alea at Tegea. A Reconstruction of the Peristyle Column.* Publications by the Department of Art History at the University of Helsinki 18. Helsinki: Department of Art History at the University of Helsinki.

Pakkanen, J. 2011. Aegean Bronze Age weights, chaînes opératoires, and the detecting of patterns through statistical analyses, in A. Brysbaert (ed.) *Tracing Prehistoric Social Networks through Technology: a Diachronic Perspective on the Aegean:* 143–166. London: Routledge.

Pakkanen, J. 2013. The economics of shipshed complexes: Zea, a case study', in D. Blackman, B. Rankov, K. Baika, H. Gerding and J. Pakkanen, *Shipsheds of the Ancient Mediterranean:* 55–75. Cambridge: Cambridge University Press.

Pakkanen, J. and A. Brysbaert (eds), in press. *Building BIG – Constructing Economies: from Design to Long-Term Impact of Large-Scale Building Projects (Panel 3.6), Proceedings of the 19th International Congress of Classical Archaeology*. Heidelberg: Propylaeum.

Pakkanen, J., A. Brysbaert, D. Turner and Y. Boswinkel 2020. Efficient three-dimensional field documentation methods for labour cost studies: case studies from archaeological and heritage contexts. *Digital Applications in Archaeology and Cultural Heritage* 17, e00141: 1–10.

Pegoretti, G. 1863–1864. *Manuale pratico per l'estimazione dei lavori architettonici, stradali, idraulici e di fortificazione per uso degli ingegneri ed architetti*. Biblioteca scelta dell'ingegnere civile 13. 2nd edn rev. by A. Cantalupi, 2 vols. Milan: Galli e Omodei.

Pirngruber, R. 2017. *The Economy of Late Achaemenid and Seleucid Babylonia.* Cambridge: Cambridge University Press.

Pitt, R.K. 2016. Inscribing construction: the financing and administration of public building in Greek sanctuaries, in M.M. Miles (ed.) *A Companion to Greek Architecture:* 195–205. Malden (MA): Wiley Blackwell.

Prignitz, S. 2014. *Bauurkunden und Bauprogramm von Epidauros (400–350): Asklepiostempel, Tholos, Kultbild, Brunnenhaus.* Vestigia 67. Munich: Verlag C.H. Beck.

Pritchett, W.K. 1971. *The Greek State at War* 1. Berkeley: University of California Press.

Psoma, S.E. 2015. Choosing and changing monetary standards in the Greek world during the Archaic and the Classical periods, in E.M. Harris, D.M. Lewis and M. Woolmer (eds) *The Ancient Greek Economy. Markets, Households and City-States:* 91–115. Cambridge: Cambridge University Press.

Raepsaet, G. 1984. Transport de tambours de colonnes du Pentélique a Éleusis au IVe siècle avant notre ère. *L'Antiquité Classique* 53: 101–136.

Reger, G. 1993. The Public purchase of grain on independent Delos. *Classical Antiquity* 12: 300–334.

Reger, G. 1994. *Regionalism and Change in the Economy of Independent Delos, 314–167 B.C.* Berkeley: University of California Press.

Rehm, A. 1958. *Die Inschriften.* Didyma 2. Berlin: Gebr. Mann.

Roux, G. 1961. *L'architecture de l'Argolide aux IVe et IIIe siècles avant J.-C.* Bibliothèque des Ecoles Françaises d'Athènes et de Rome 199. Paris: De Boccard.
Roux, G. 1966. Les comptes du IV^{e} siècle et la reconstruction du temple d'Apollon à Delphes. *Revue archéologique:* 245–296.

Russell, B. 2013. *The Economics of the Roman Stone Trade.* Oxford: Oxford University Press.

Salmon, J. 2001. Temples the measures of men: public building in the Greek economy, in D.J. Mattingly and J. Salmon (eds) *Economies beyond Agriculture in the Classical World*: 195–208. Leicester–Nottingham Studies in Ancient Society 9. London: Routledge.

Scheidel, W. 2010. Real wages in early economies: evidence for living standards from 1800 BCE to 1300 CE. *Journal of the Economic and Social History of the Orient* 53: 425–462.

Scranton, R.L. 1960. Greek architectural inscriptions as documents. *Harvard Library Bulletin* 14: 159–182.

Slawisch, A. and T.C. Wilkinson 2018. Processions, Propaganda, and Pixels: Reconstructing the Sacred Way Between Miletos and Didyma. *American Journal of Archaeology* 122: 101–143.

Slotsky, A.L. 1992. The Bourse of Babylon: An Analysis of the Market Quotations in the Astronomical Diaries of Babylonia. Unpublished PhD dissertation, Yale University.

Slotsky, A.L. 1997. *The Bourse of Babylon. Market Quotations in the Astronomical Diaries of Babylonia.* Bethesda (MD): CDL Press.

Stanier, R.S. 1953. The Cost of the Parthenon. *The Journal of Hellenic Studies* 73: 68–76.

Temin, P. 2002. Price behavior in ancient Babylon. *Explorations in Economic History* 39: 46–60.

Toma, N. 2020. Milet, Türkei. Marmorprovenienz und bauwirtschaftliche Paradoxe (nach Vorarbeiten 2018 und 2019). *e-Forschungsberichte des Deutsches Archäologisches Institut*s 2020.1: 117–123.

van der Spek, R.J. 2000. The Effect of war on the prices of barley and agricultural land in Hellenistic Babylonia, in J. Andreau, P. Briant and R. Descat (eds), *Économie antique. La guerre dans les économies antiques:* 293–313. Saint-Bertrand-de-Comminges: Museé archéologique départemental de Saint-Bertrand-de-Comminges.

van der Spek, R.J. 2002. Commodity prices in Babylon 385–61 BC. Viewed 27 March 2020, <http://www.iisg.nl/hpw/babylon.php> and datafile <http://www.iisg.nl/hpw/babylonia.xls>.

Figures

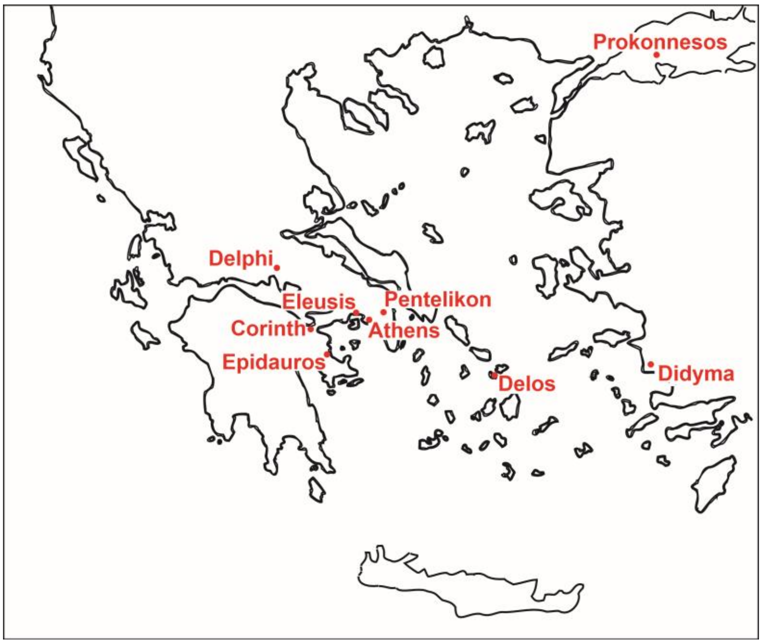

Figure 1. Map of principal sites mentioned in the text.

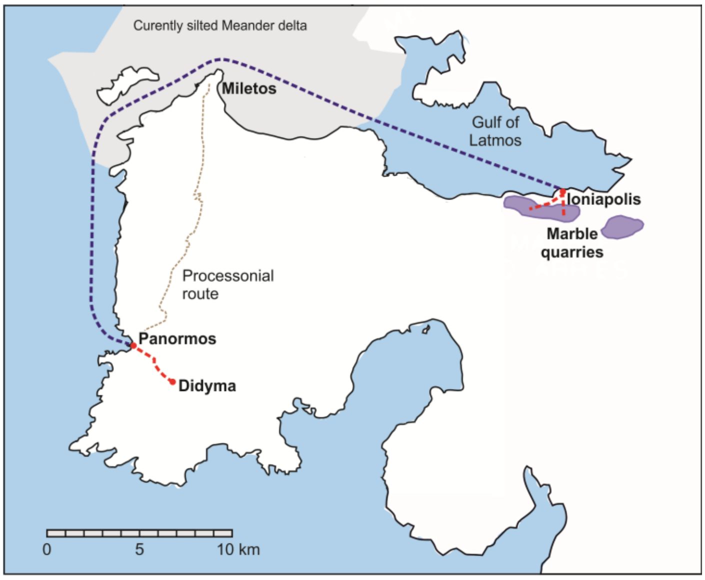

Figure 2. Transport of marble from the quarries to the sanctuary of Apollo at Didyma (based on Borg and Borg 2002a, fig. 3; Slawisch and Wilkinson 2018, fig. 3).

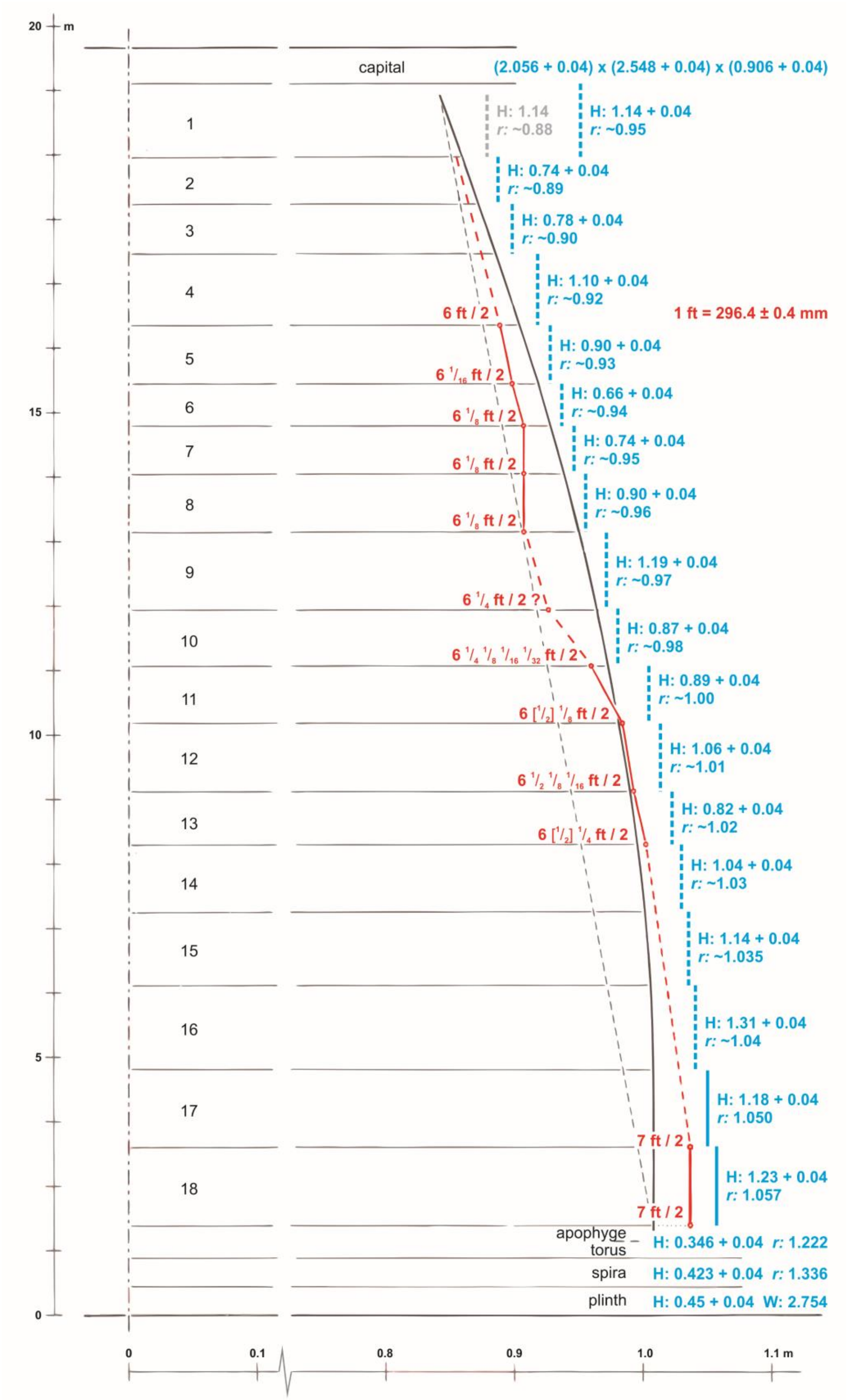

Figure 3. Details of the unfinished column of the temple of Apollo at Didyma column. The dimensions inscribed on the drums are indicated with red and actual dimensions in blue (revised from Haselberger 1983, fig. 5).

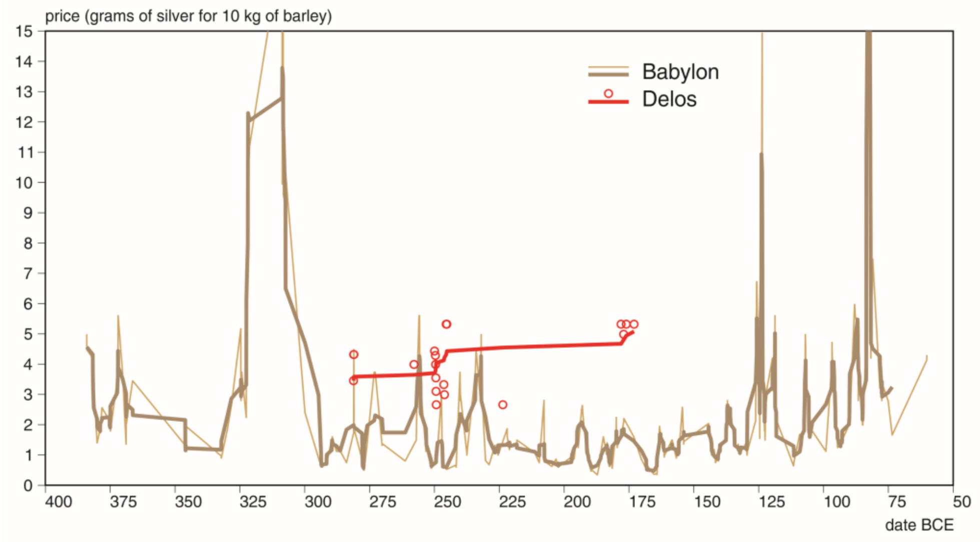

Figure 4. Price time series of barley at Babylon and Delos. The continuous lines for Babylon indicate the spot prices (thin light brown line) and the five-term moving average (thick brown line). The circles give the spot prices for Delos and the continuous curve the general trend (thick red line).

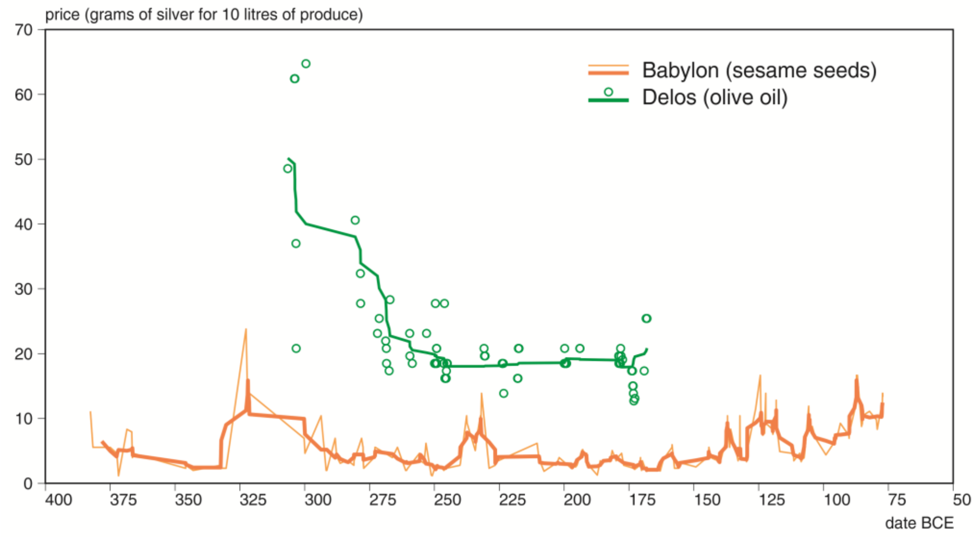

Figure 5. Price time series for sesame at Babylon and olive oil on Delos. The continuous lines for Babylon indicate the spot prices (thin light orange line) and the five-term moving average (thick orange line). The circles give the spot prices for Delos and the continuous curve the general trend (thick green line).

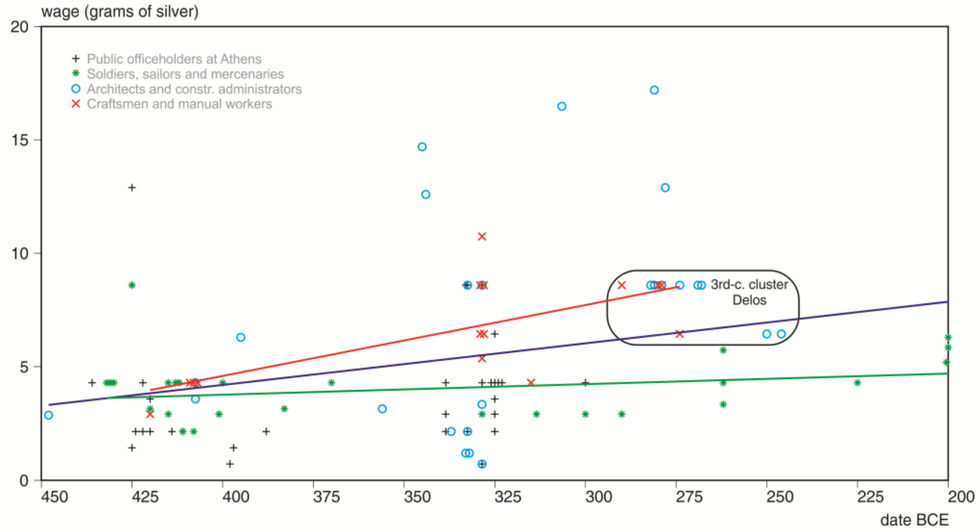

Figure 6. Wages in the Aegean in 450–200 BCE. The lines indicate the general linear trend for the whole data set (blue), for craftsmen and manual workers (red) and for soldiers, sailors and mercenaries (green).