Size-Productivity Paradox: Part 3

How does duration impact productivity?

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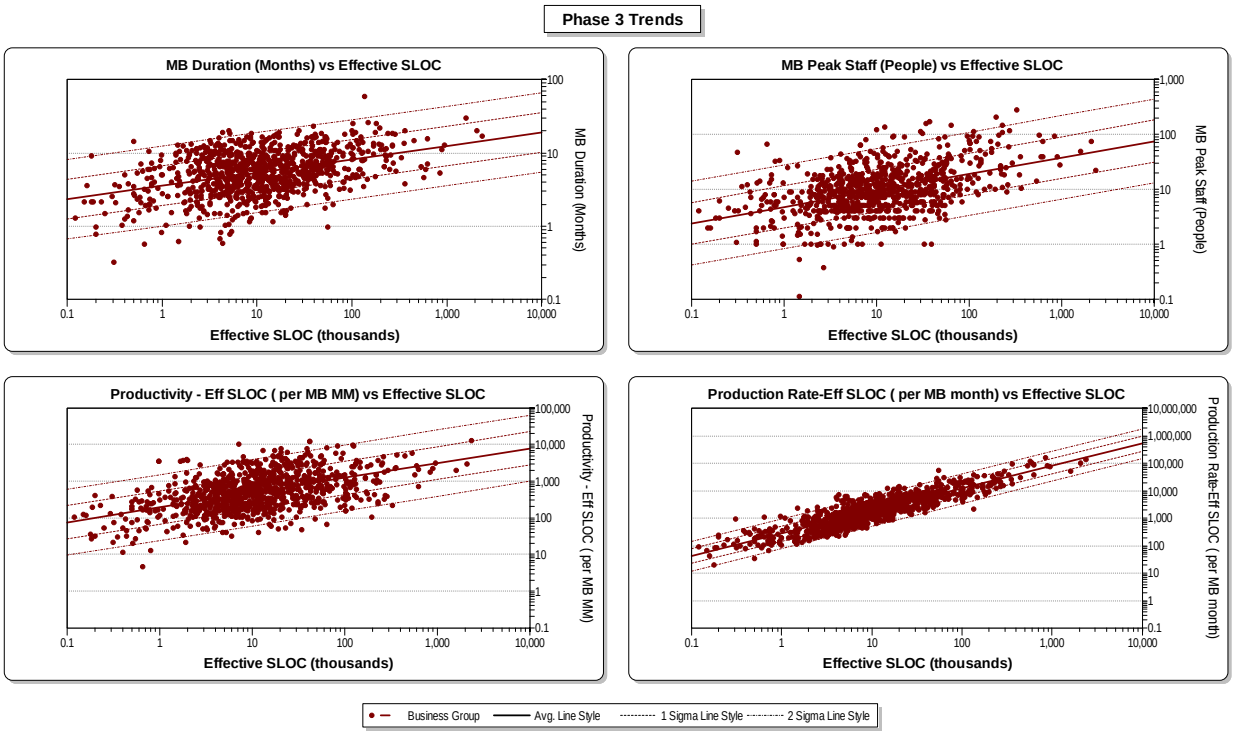
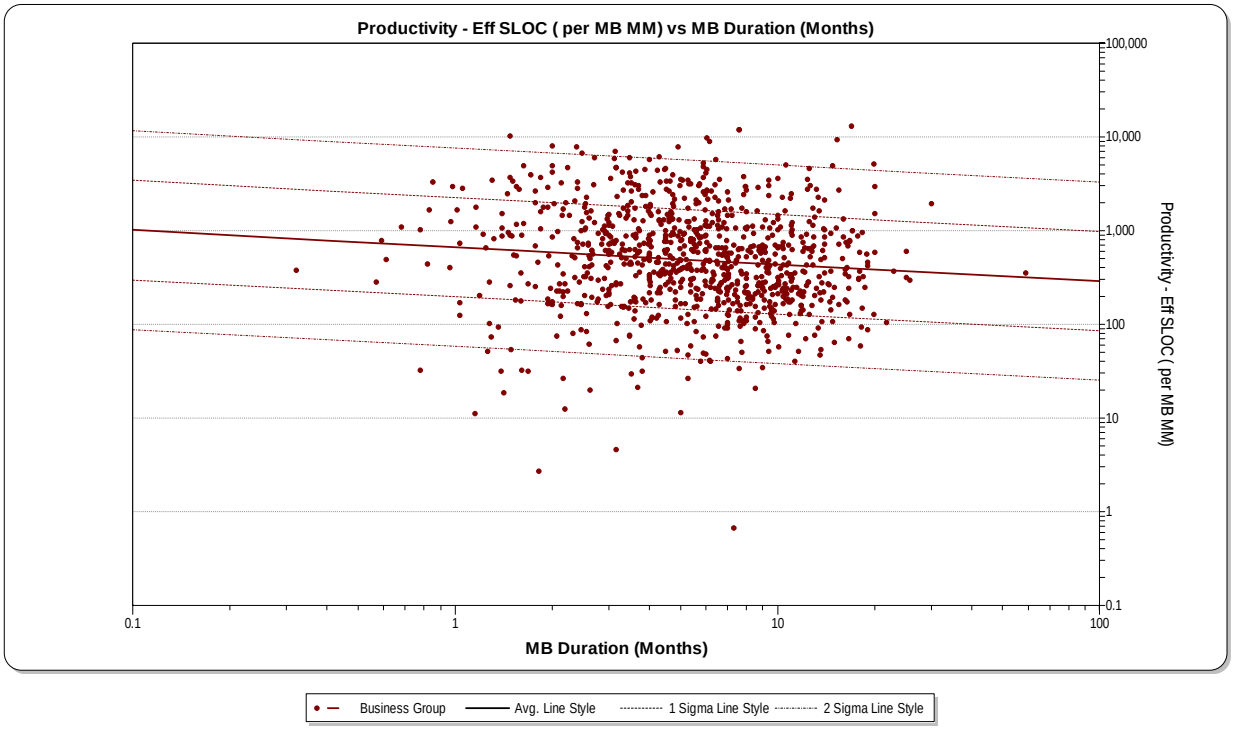
In the first part of this series we showed that average productivity (size/effort) increases with project size. This relationship held true from the smallest projects to projects that delivered a million lines of code. Above that size threshold the sample is too small to be definitive. Next we looked at staffing strategies. Though smaller teams are generally more productive, the optimal team size appears to increase with project size. Since larger projects involve more work and often require a more diverse skill set, this should not surprise us too much. It may be more helpful to view the right team as *the smallest practical one* (given the work to be accomplished).

This week we turn to another question triggered by the Performance Benchmark Tables: how does duration affect productivity? To many managers, project schedule and cost are equally important. There are significant tradeoffs involved: if the project takes too long, important market opportunities may be lost. But adding people to compress the schedule can drive up cost dramatically. For this reason, QSM uses a productivity metric that explicitly accounts for duration: the Productivity Index (or PI). Unlike ratio based productivity measures, the PI is a three dimensional measure that adds duration to the traditional size/effort equation. It explicitly accounts for the distinctly non-linear relationships between size, effort, and time.

To see the benefits of this approach, let's look at how project duration relates to simple (SLOC/effort) productivity. Once again our sample is composed of business applications completed since January, 2000. As the following graphs demonstrate, duration, effort/staffing and productivity (ESLOC/PM) all increase with project size. Inspection of the lower right hand graph below shows that the production rate (ESLOC per Month) also increases with project size.



But the *relative* rates at which these factors increase with size are important. There appears to be a relationship between productivity and duration, but the correlation is weak (the correlation coefficient is only -.076, albeit with a significance of .004). So although duration clearly has some effect on productivity, it appears to explain less than 8% of the productivity variation for projects in our database:



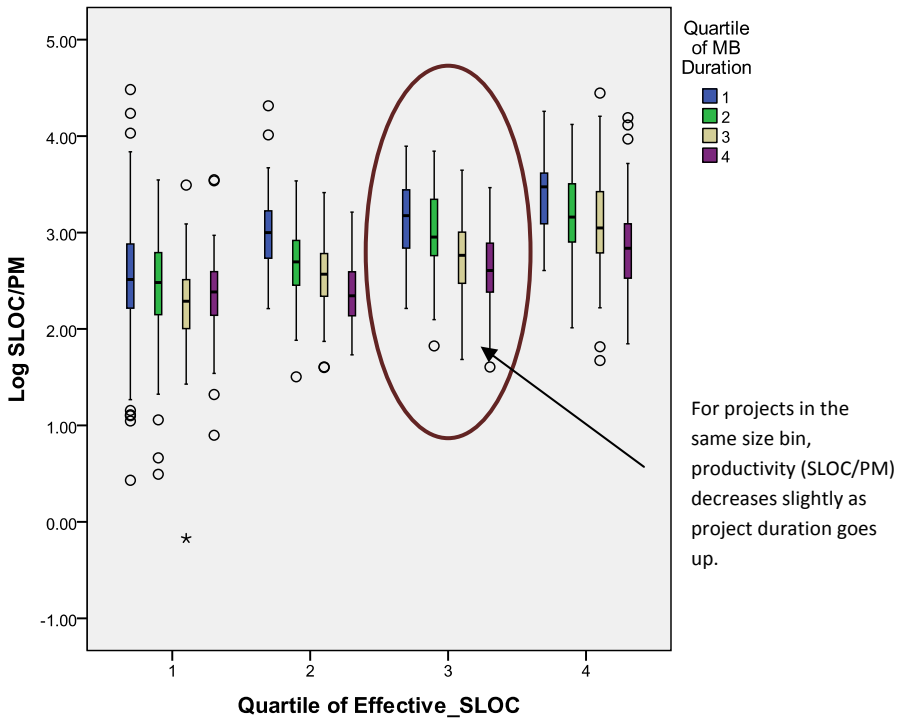
To get a better view of the underlying relationships between size, duration and productivity, we again turn to a clustered box plot. Unlike scatter plots that show only two variables, clustered box plots allow us to examine all three of our variables (size, duration, and productivity) at once.

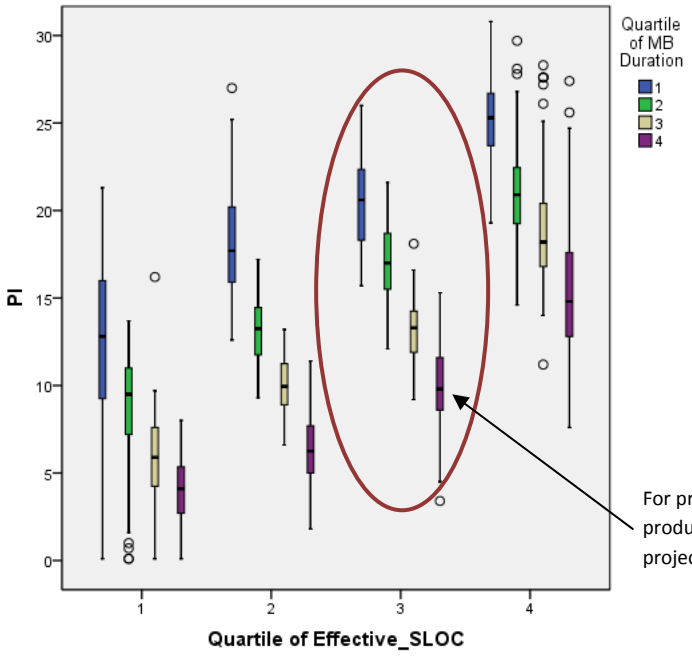
Productivity, expressed as either ESLOC/PM or PI, is shown on the vertical axis. The projects are divided into four size quartiles, with quartile 1 containing the smallest projects and quartile 4 the largest. Each size quartile is further divided into 4 duration bins. Within each size quartile the blue boxes (duration quartile 1) show projects that achieved the shortest schedules. Purple boxes (duration quartile 4) show which projects took the longest in each size bin.

As we saw with the scatter plots at the beginning of this white paper, simple productivity goes up as project size increases. The blue, green, tan and purple boxes show productivity (ESLOC/PM or PI) increasing as the size bins grow progressively larger. What does this mean, though? It suggests that the relationship between productivity and size is constant regardless of where we are on the size spectrum.

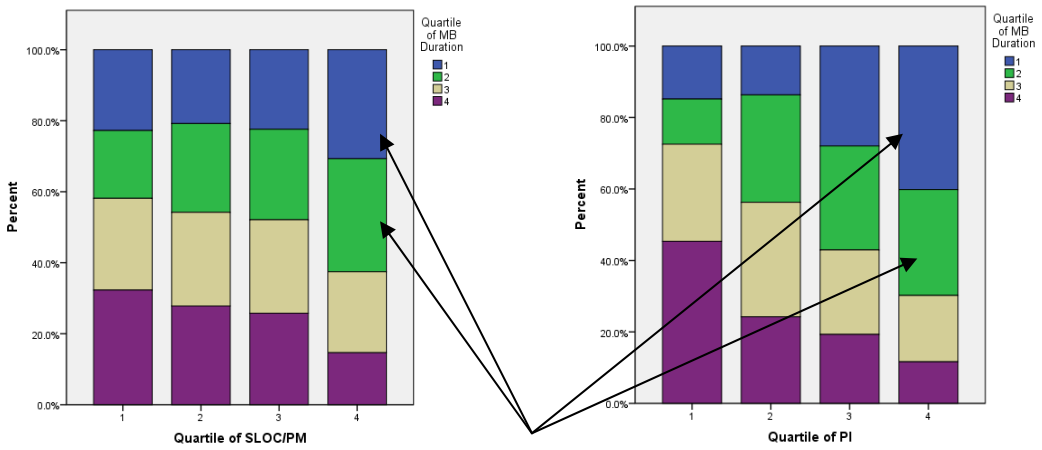
Simple Productivity (SLOC/PM) vs. PI: Changes with Size and Duration

What happens if we minimize the influence of code volume on productivity? If we separate the projects into comparable size bins, we'll be able to compare projects of roughly the same size (the difference between a "small" and a "large" project is reduced). For projects of roughly the same size, SLOC/PM *decreases* slightly as project duration goes up. We can see this by comparing the measured productivity of projects in the same size bin as duration increases. This is interesting because the equation for simple productivity does not take project size into account and yet duration appears to have some effect on productivity even if it isn't part of the productivity equation!





The change in PI is much more pronounced because duration is part of the PI formula. Note that for projects in the same size bin, the PI goes down significantly as duration increases. Stacked bar charts offer another way to look at these relationships. The high productivity projects on the rightmost bar in each graph are predominantly blue or green (shorter duration). This confirms that, whether you use conventional ratio-based productivity measures or QSM's PI, there seems to be a relationship between the project schedule and measured productivity.



Summary

Given the importance of schedule to most software development organizations it makes sense to factor duration into the productivity equation. A significant drawback to conventional (SLOC/PM) productivity measures is that they don't account for schedule. The following example compares 6 projects side by side. All six of these projects expended 6 person months of effort. All six delivered the same amount of code: 10000 ESLOC.

And all six achieved the same conventional productivity: 1000 SLOC/PM. I think we can all agree that these are six very different management strategies and yet – on paper at least - they "appear" equally productive!

Team Size	Duration in Mos.	Total PM of Effort	Delivered size	Productivity (SLOC/PM)
1	6	6	10000	1000
2	3	6	10000	1000
3	2	6	10000	1000
4	1.5	6	10000	1000
5	1.2	6	10000	1000
6	1	6	10000	1000

Which staffing strategy is the most efficient and effective? Our theoretical example makes them all appear equally viable. But research on actual (as opposed to theoretical) projects implies that in practice, not all staffing strategies are created equal. The most productive projects tend to use the smallest practical teams.

Clearly duration has some impact on productivity but the relationship is not a linear one - it's difficult to separate correlation from causation. Did the low projects achieve lower measured productivity because they took longer? Or do other productivity drivers affect both project duration and productivity?

Our next post will address these questions.