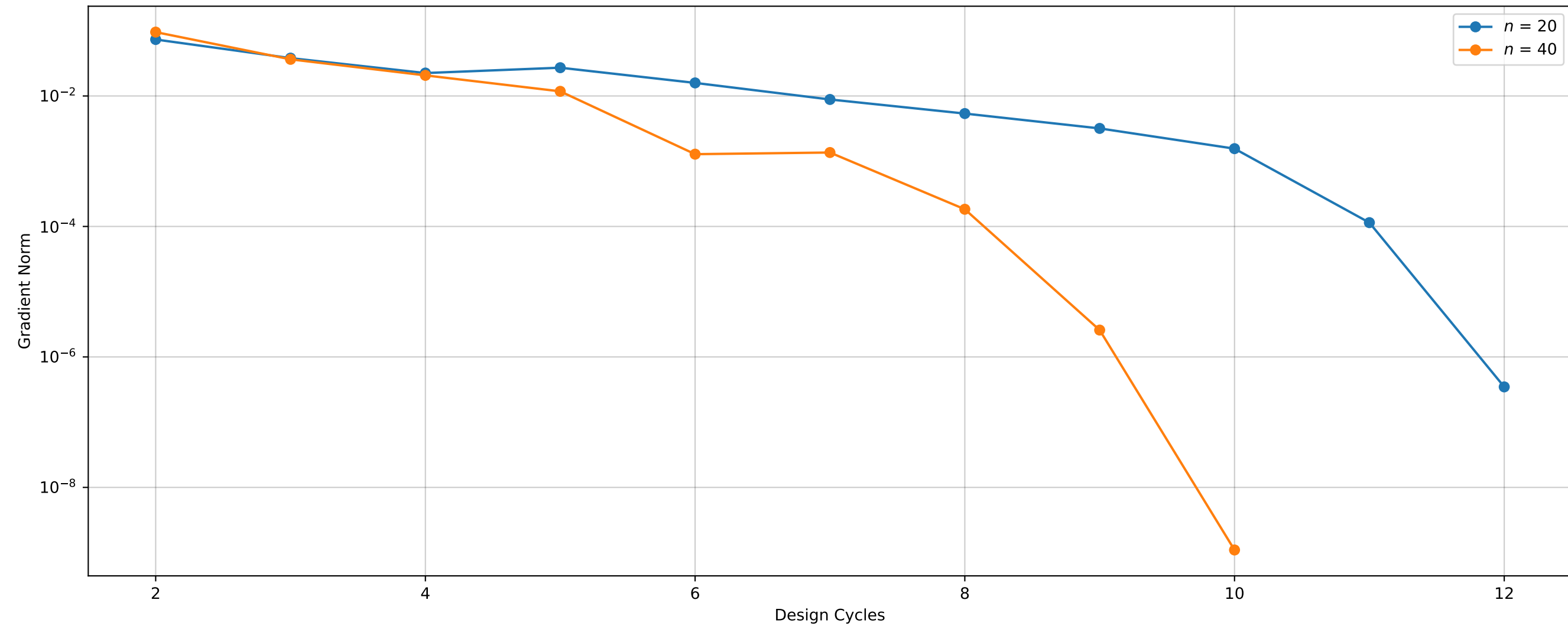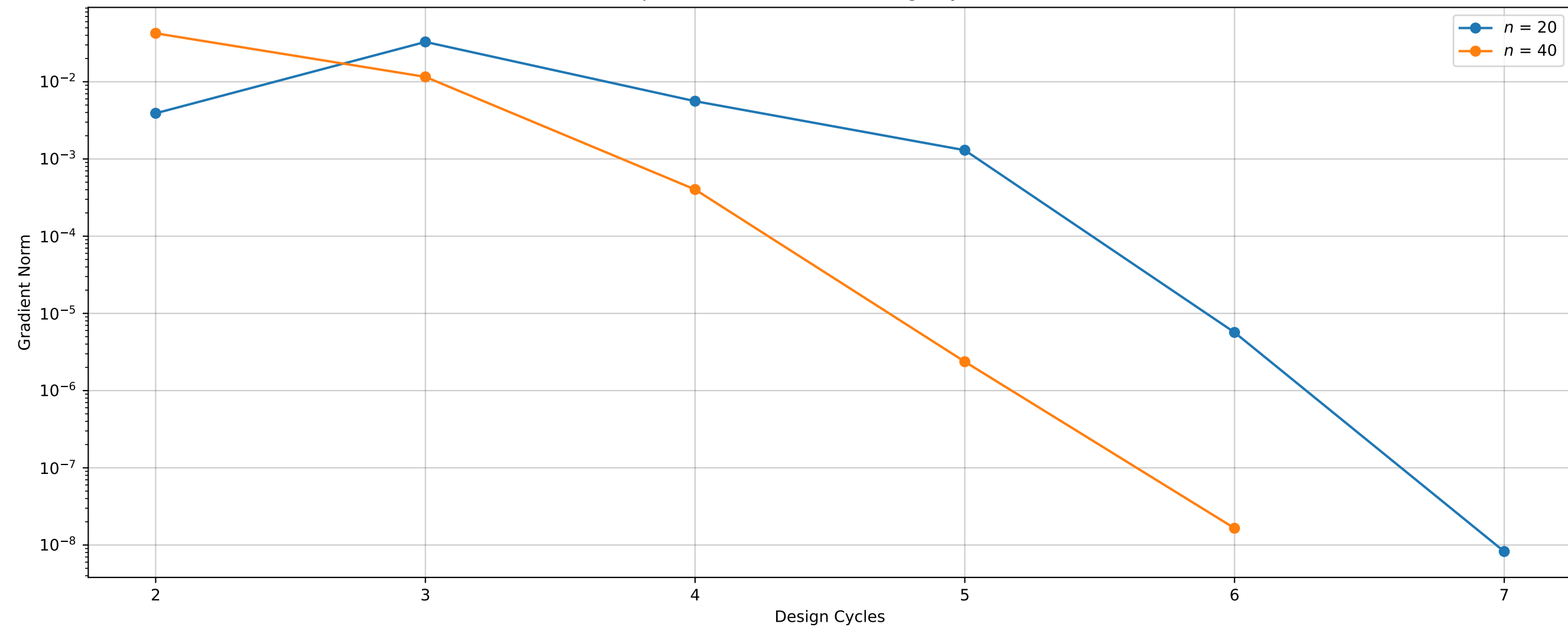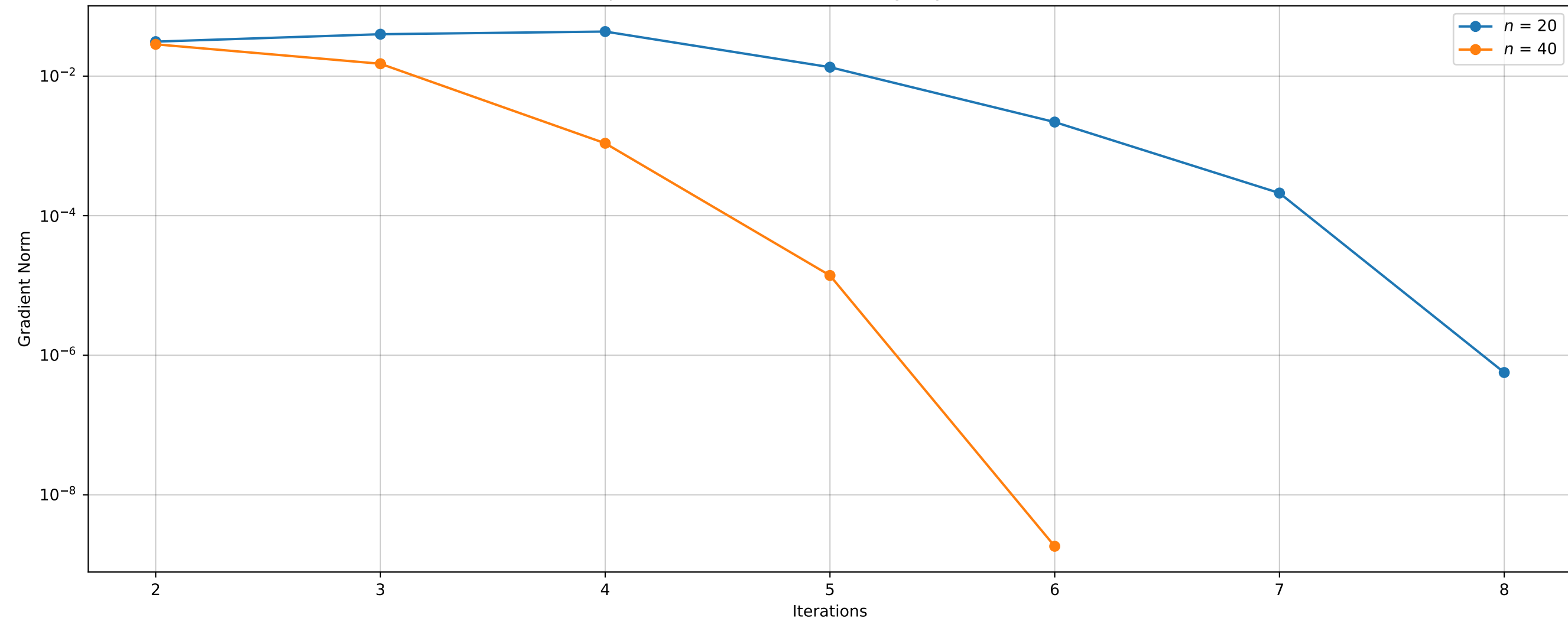Reduced-space BFGS Gradient vs Design Cycles, $m = 11184$
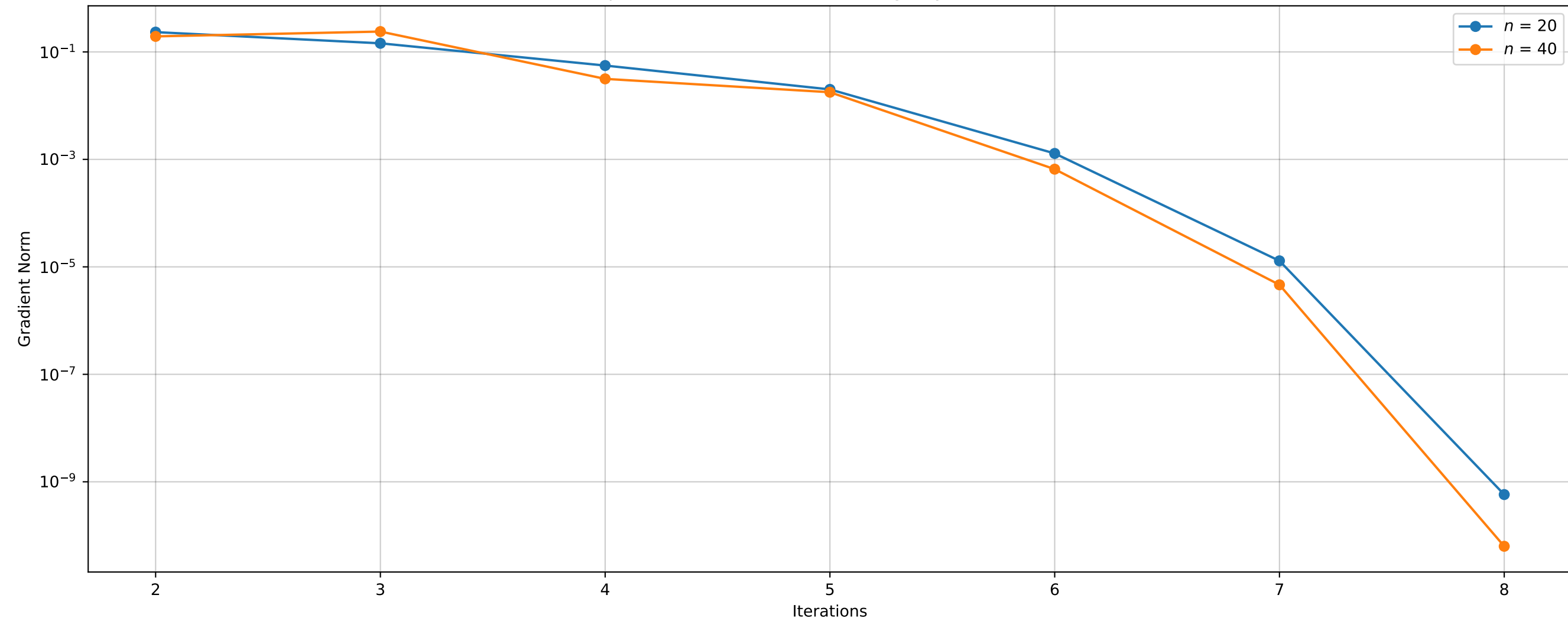
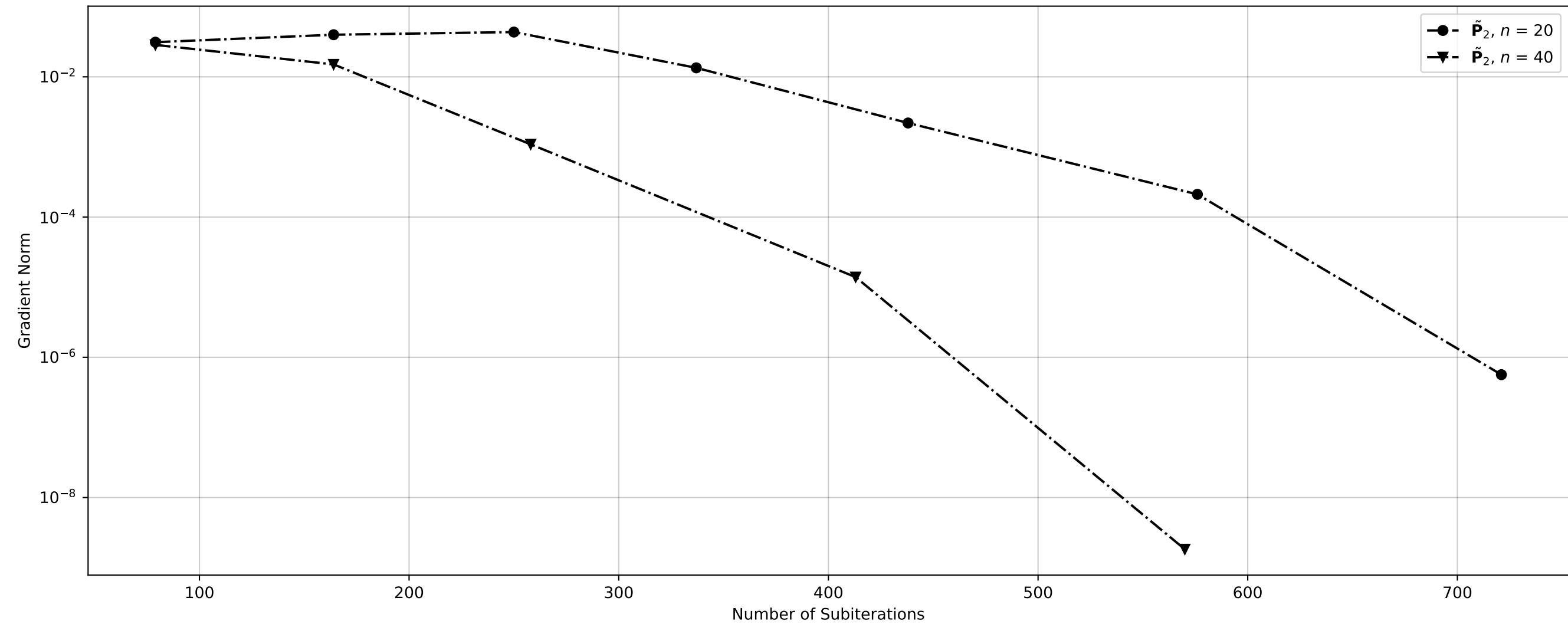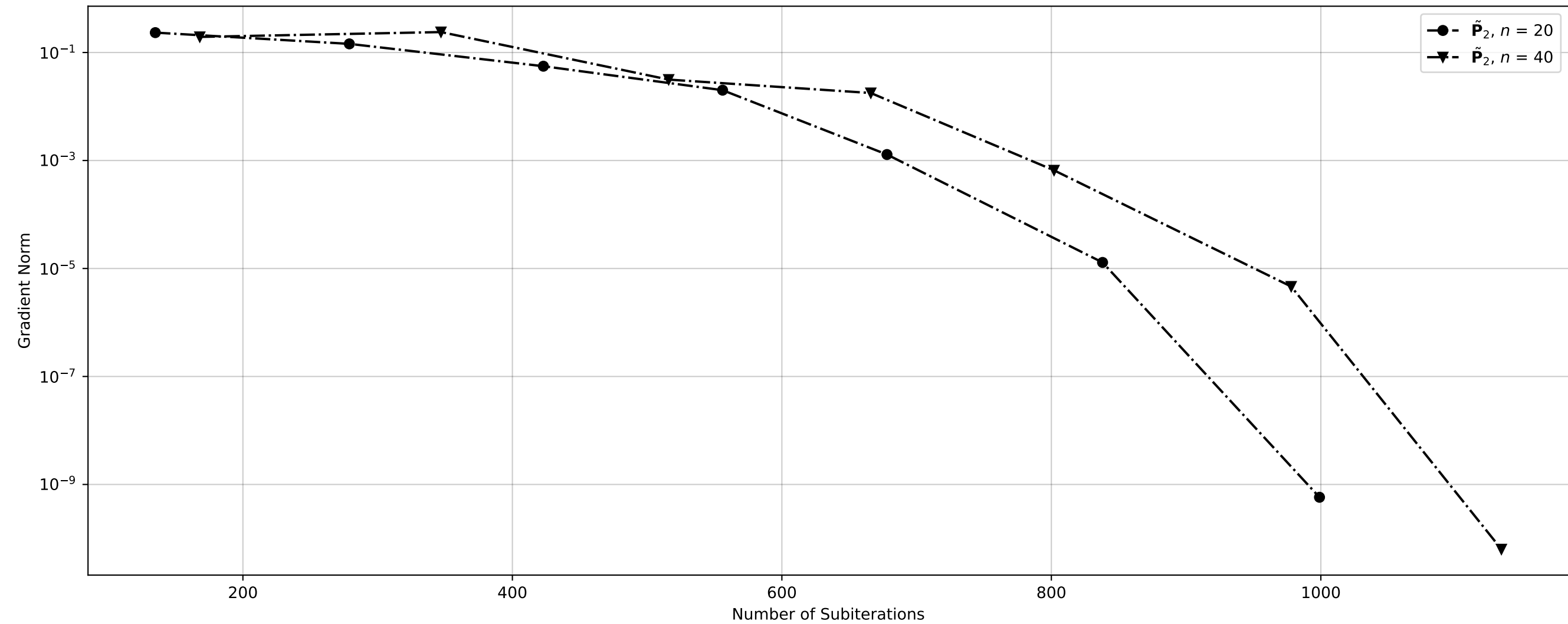Reduced-space BFGS Gradient vs Design Cycles, $m = 44736$

Full-space with $\tilde{\mathbf{P}}_2$ Gradient vs Design Cycles, $m = 11184$

Full-space with $\tilde{\mathbf{P}}_2$ Gradient vs Design Cycles, $m = 44736$
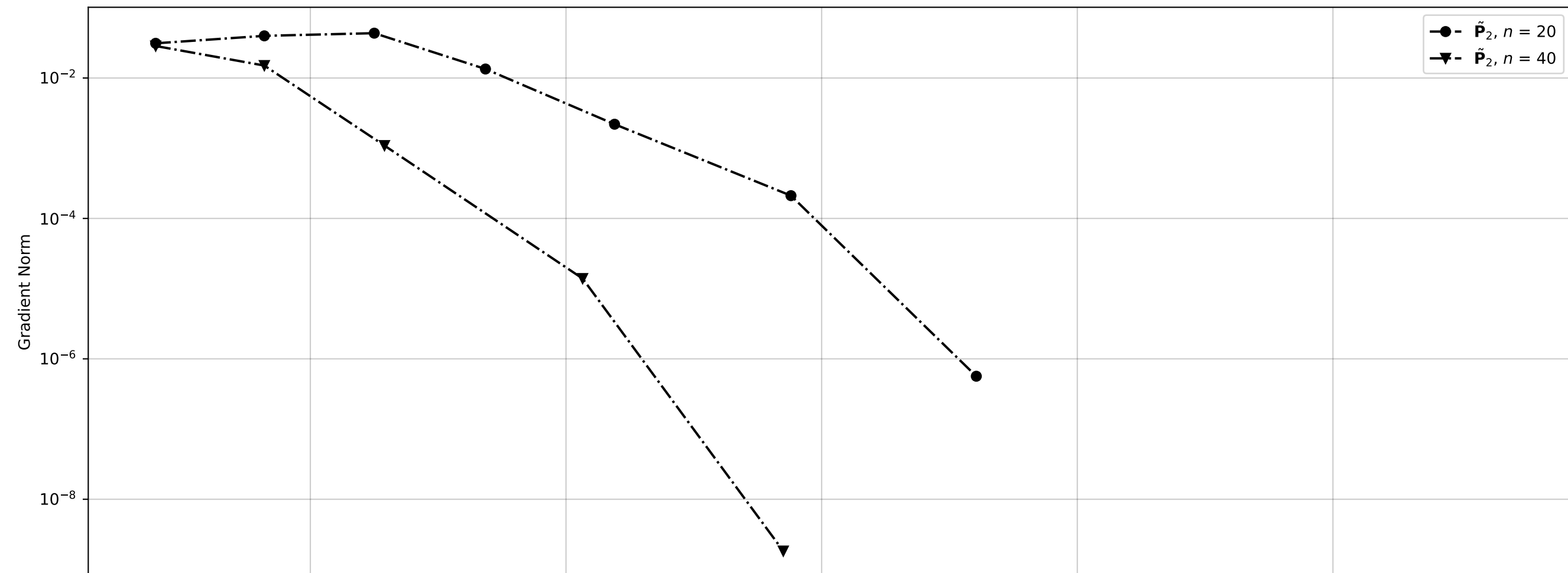
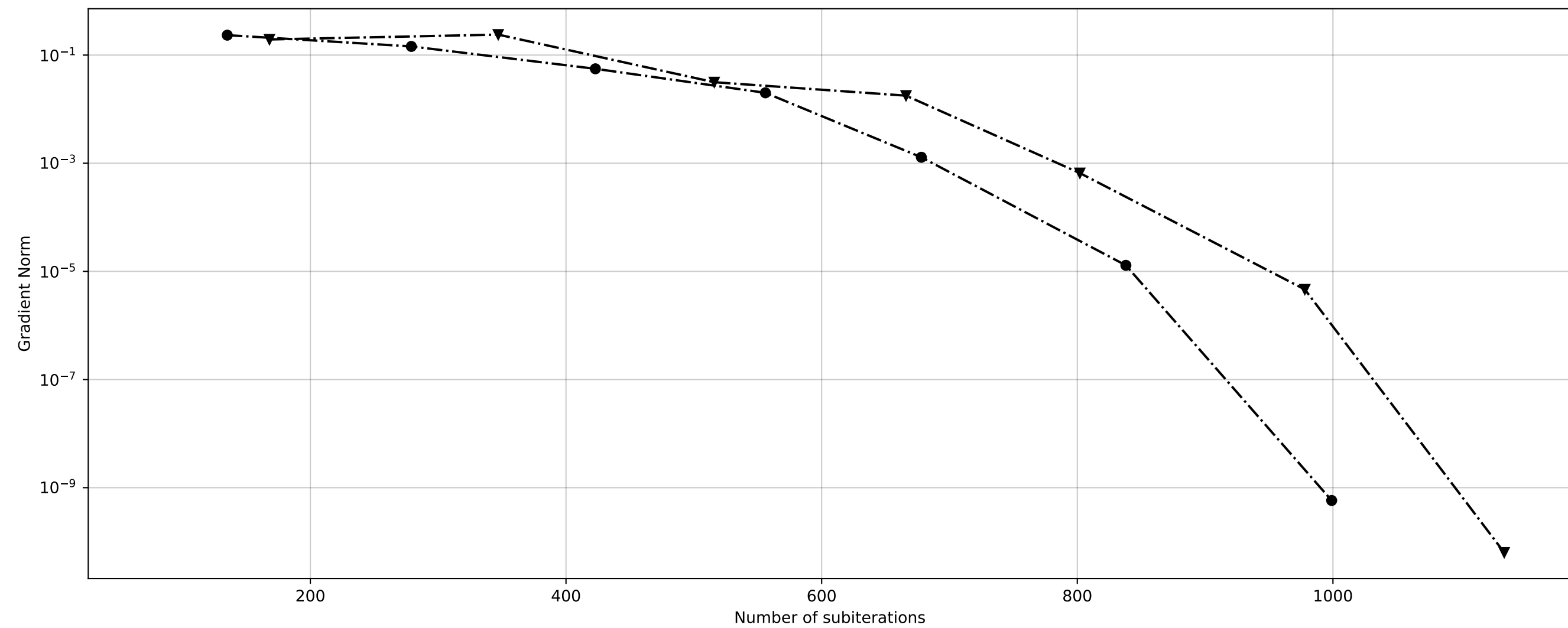Full-space Gradient vs Subiterations, $m = 11184$

Full-space Gradient vs Subiterations, $m = 44736$

Legend:
- $\tilde{\mathbf{P}}_2$, $n = 20$
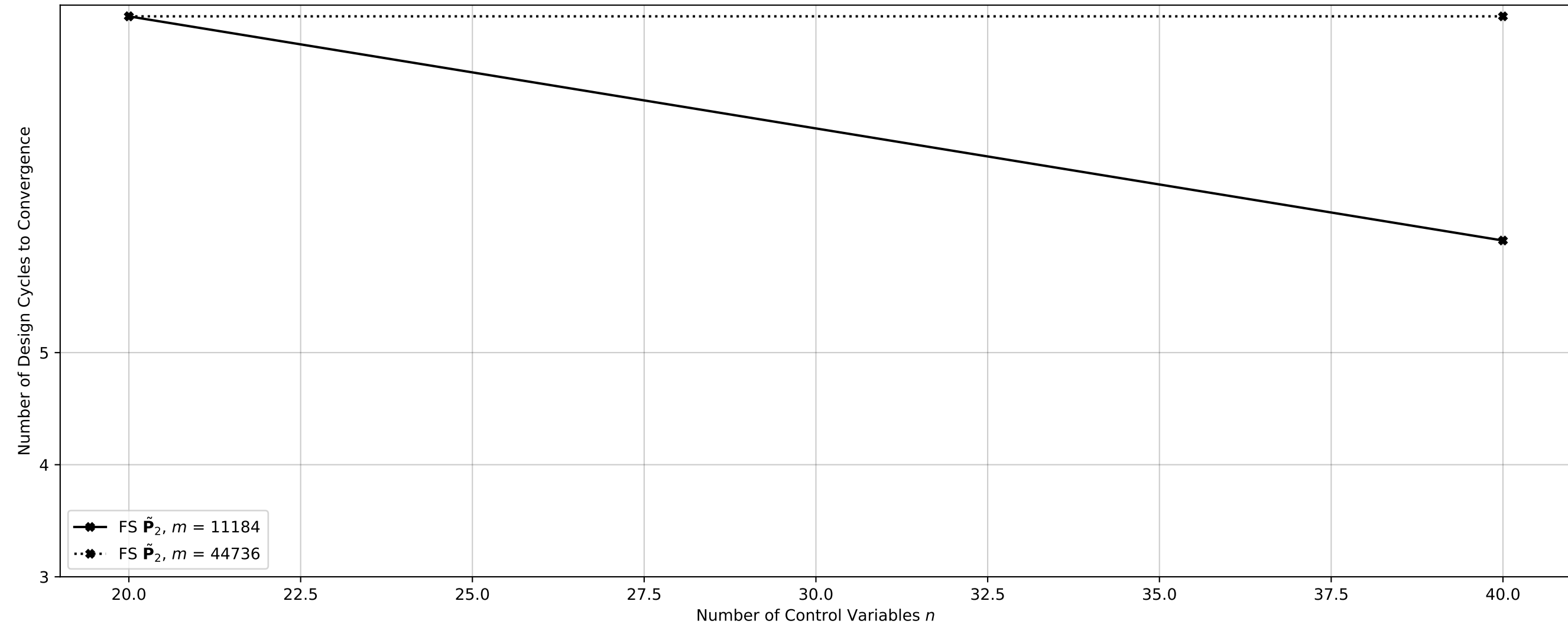- $\tilde{\mathbf{P}}_2$, $n = 40$

x-axis: Number of Subiterations
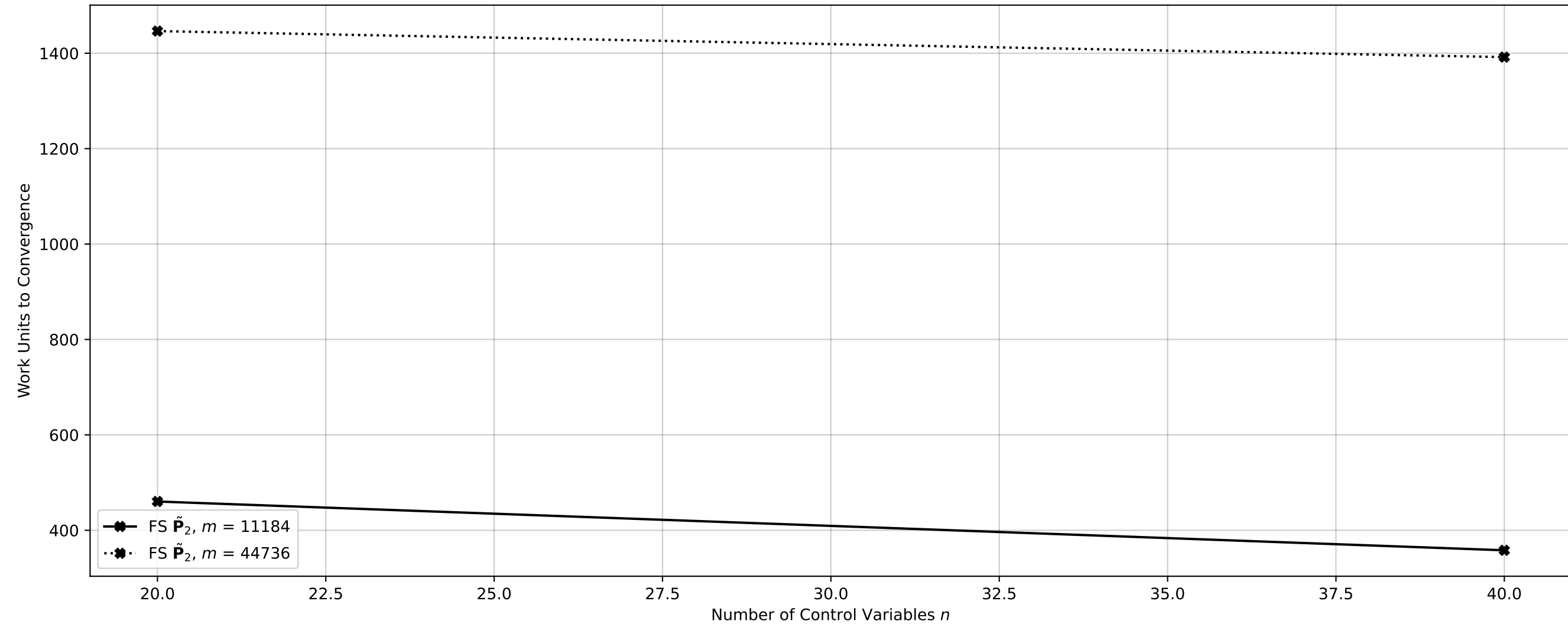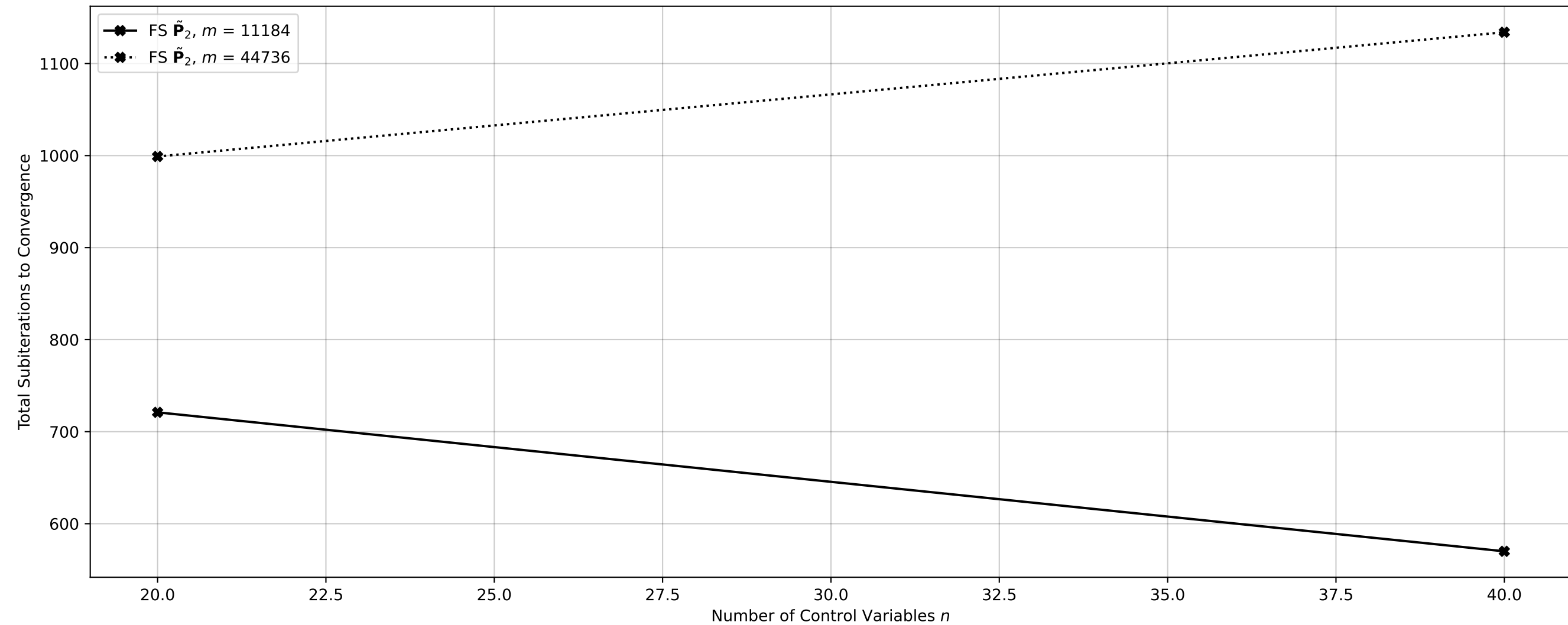y-axis: Gradient Norm

Full-space Gradient vs Subiterations

Full-space Design Cycles vs Control Variables

Work Units vs Control Variables
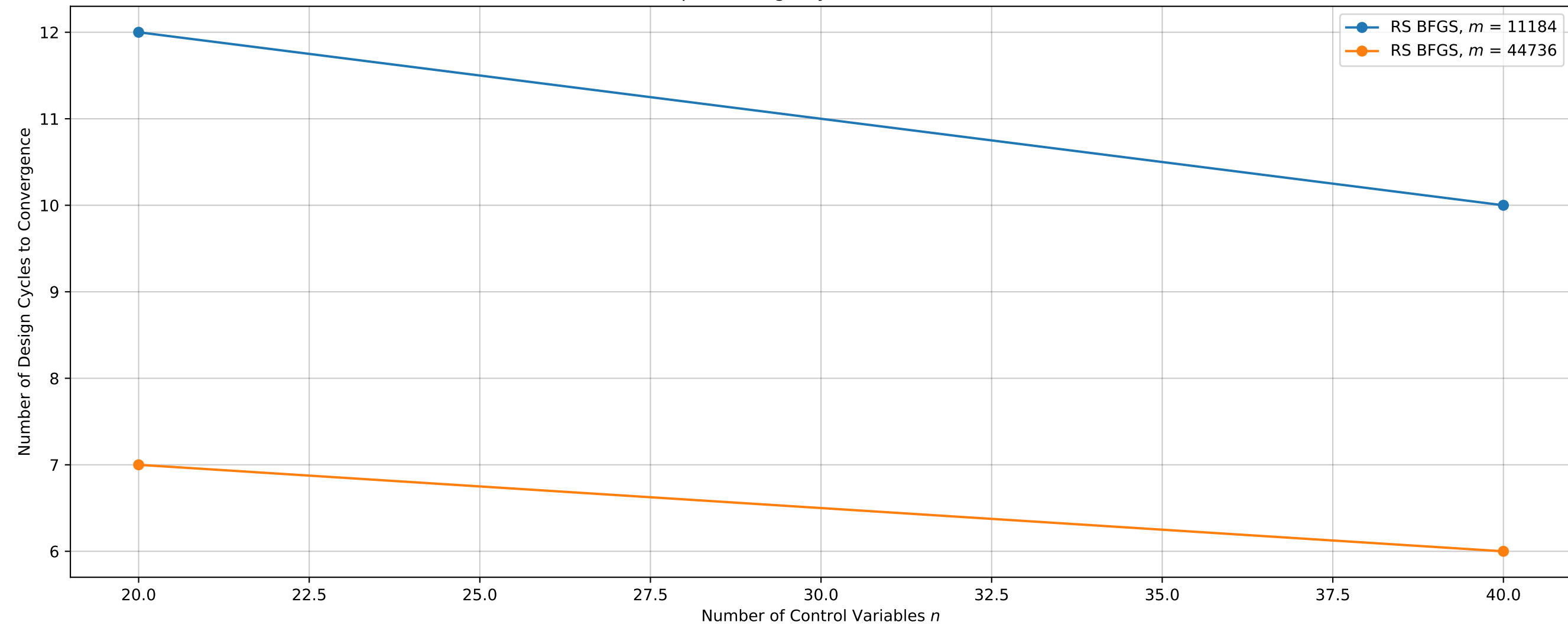
Total Subiterations vs Control Variables

FS $\tilde{\mathbf{P}}_2$, $m = 11184$
FS $\tilde{\mathbf{P}}_2$, $m = 44736$

Work Units vs Control Variables

Legend:
- RS BFGS, $m = 11184$
- RS BFGS, $m = 44736$
- FS $\tilde{\mathbf{P}}_2$, $m = 11184$
- FS $\tilde{\mathbf{P}}_2$, $m = 44736$

X-axis: Number of Control Variables n
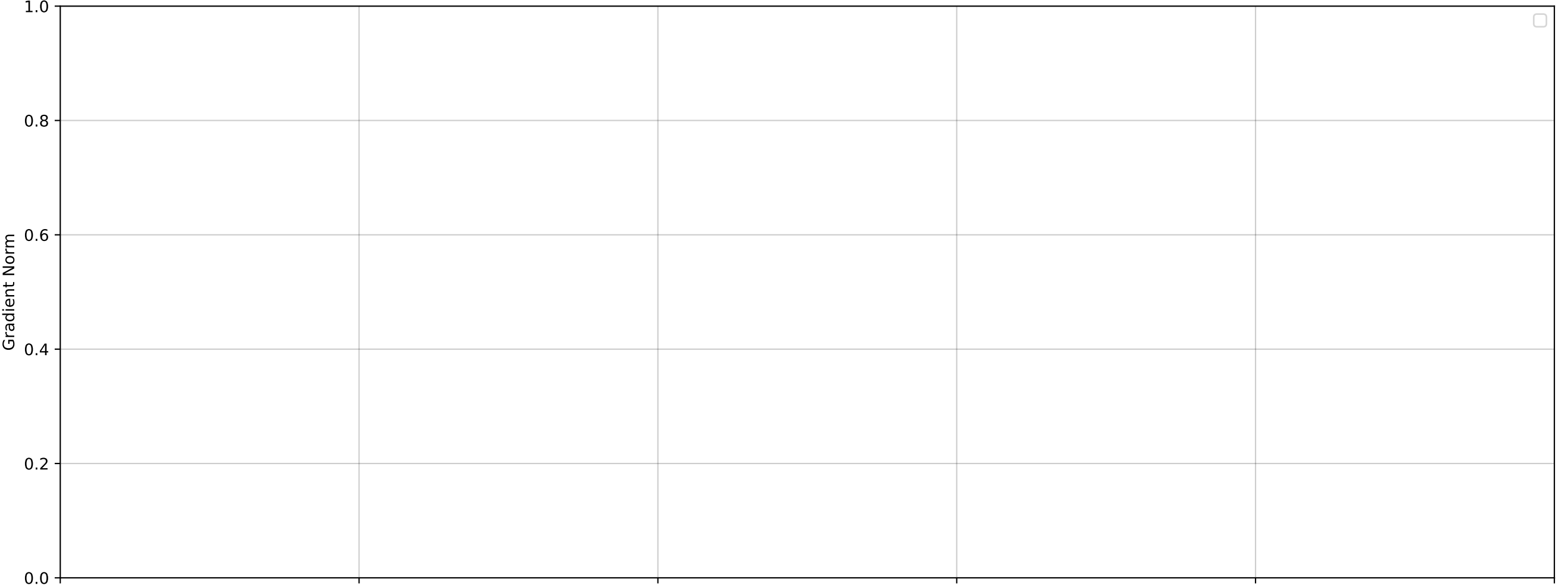
Y-axis: Work units to Convergence
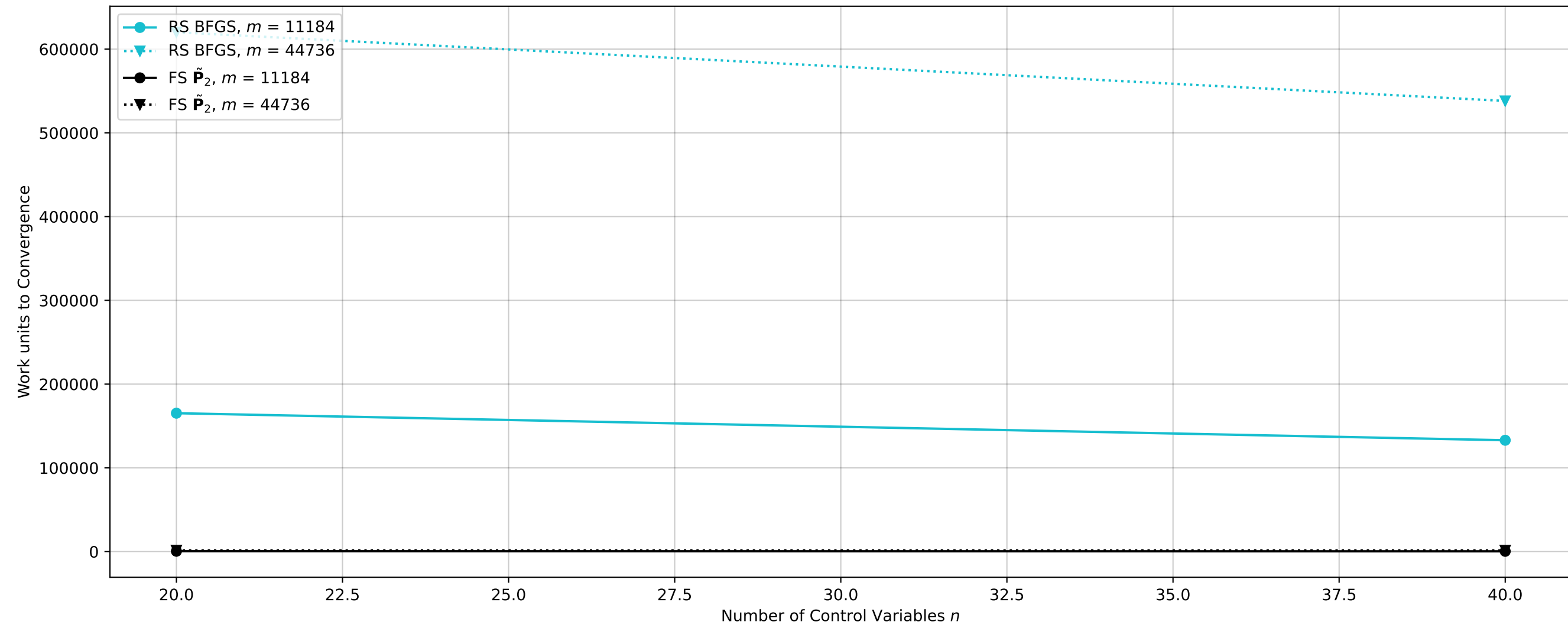
Reduced-space Design Cycles vs Control Variables

Reduced-space Gradient vs Design Cycles

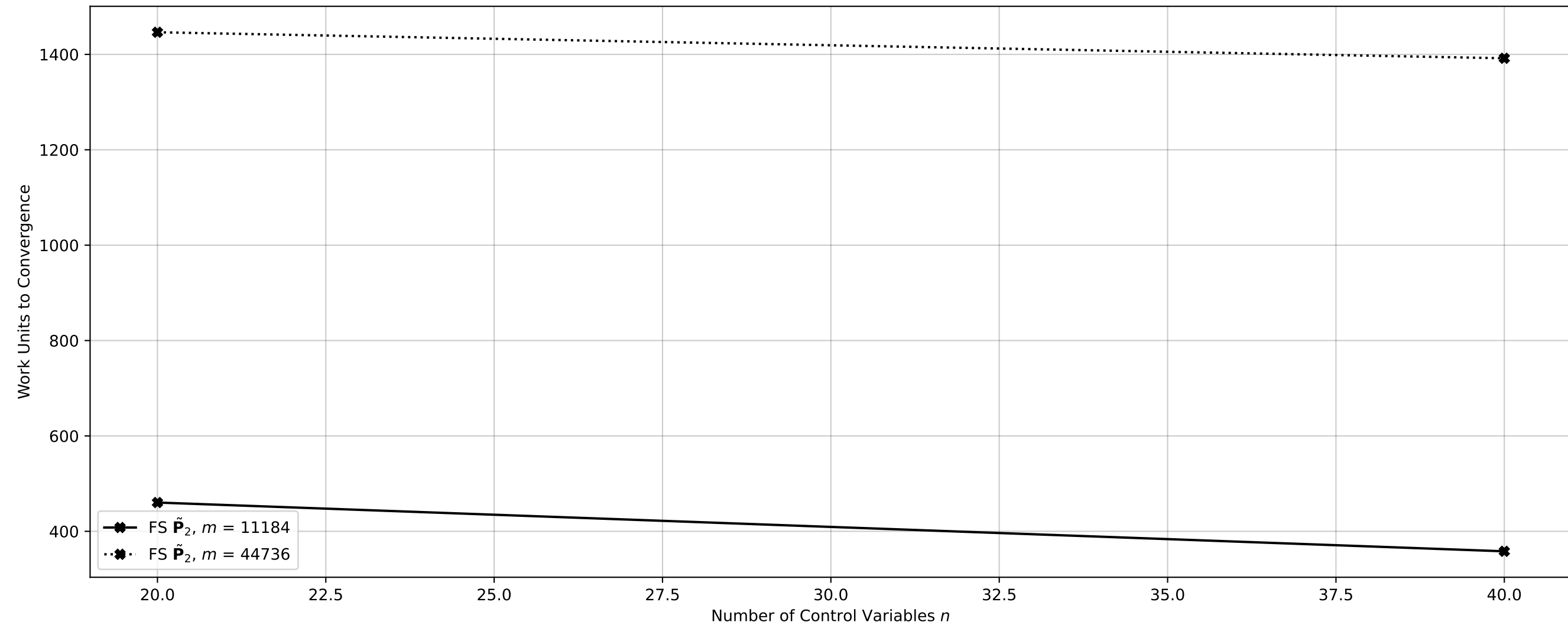### $m = 11184$
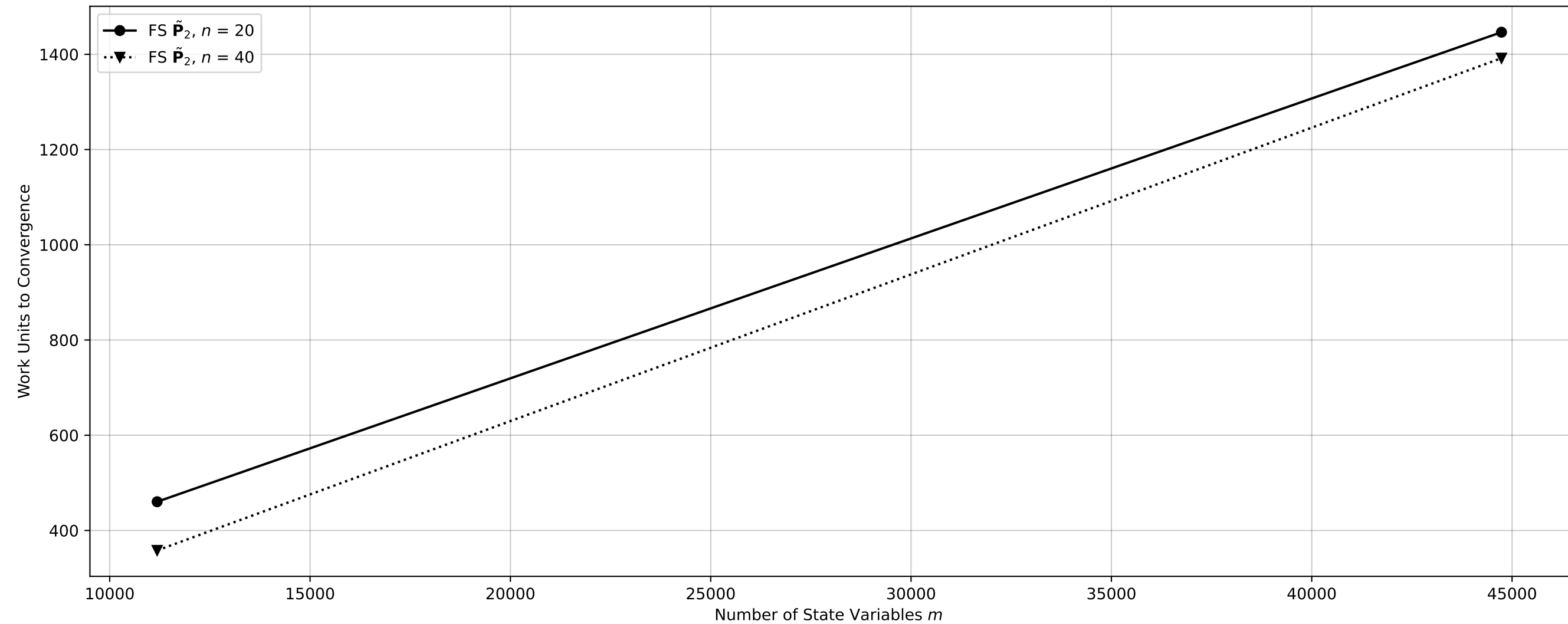
$m = 44736$

Gradient Norm

Gradient Norm
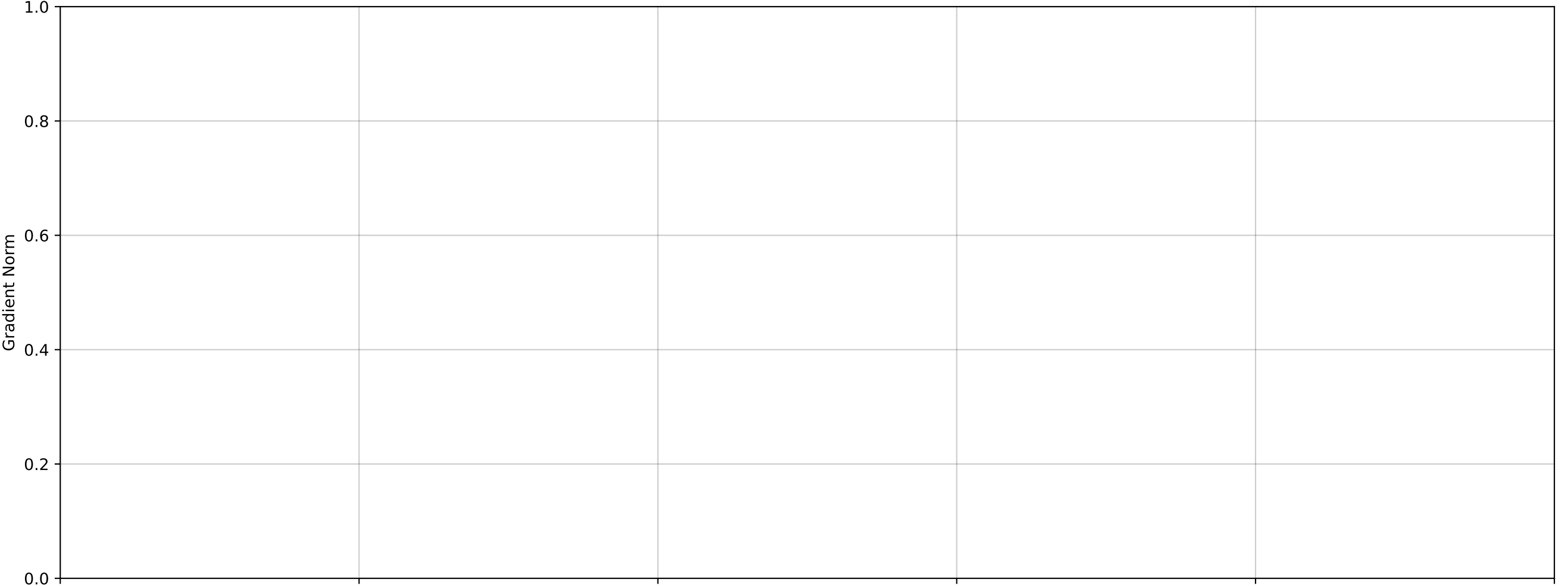
Design Cycles

Work Units vs Control Variables

Work Units vs State Variables

Gradient Norm vs Design Cycles m = 44736