

1.1. Create a table showing the mean return and standard deviation of return for the ten industry portfolios.

In [28]:

```
mean_sd
```

Out[28]:

	mean	standard_deviation
NoDur	0.902833	3.345657
Durbl	0.733333	8.361852
Manuf	1.012833	5.310270
Enrgy	1.231167	6.081524
HiTec	0.766250	5.381191
Telcm	0.881417	4.448284
Shops	0.916333	4.093786
HIth	0.783833	3.787172
Utils	0.907167	3.701763
Other	0.489083	5.582452

1.2. Plot the minimum-variance frontier (without the riskless asset) generated by the ten industry portfolios.

This graph must have expected (monthly) return on the vertical axis and standard deviation of (monthly) return on the horizontal axis.

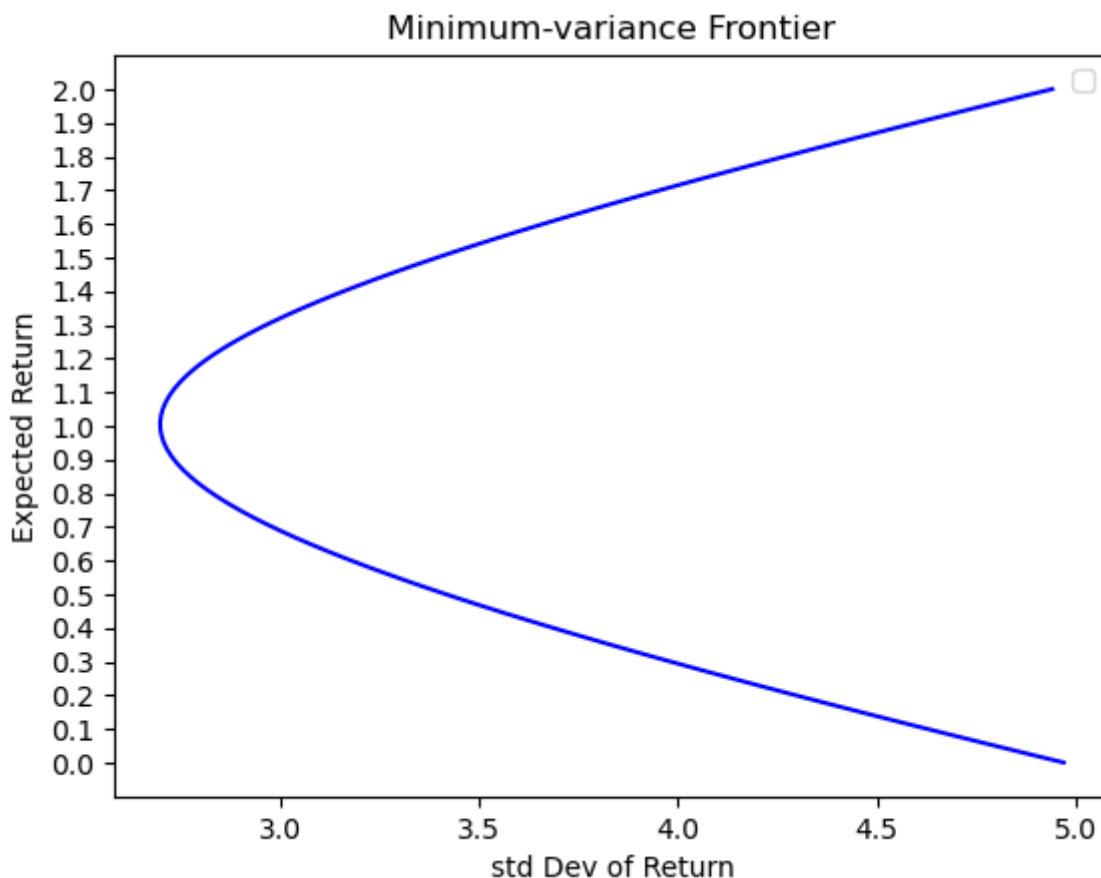
This graph must cover the range from 0% to 2% on the vertical axis, in increments of 0.1% (or less).

In [30]:

```
plt.plot(sigma_p, R_p, color='blue', linestyle='--')

plt.yticks(np.arange(0, 2.1, 0.1))
plt.xlabel('std Dev of Return')
plt.ylabel('Expected Return')
plt.title('Minimum-variance Frontier')
plt.legend()
plt.show()
```

No artists with labels found to put in legend. Note that artists whose label start with an underscore are ignored when legend() is called with no argument.



1.3. Briefly explain the economic significance and relevance of the minimum-variance frontier to an investor.

Minimum-variance frontier consists of portfolios with lowest amount of risk for different values of R_p , but only top half relevant to an investor.

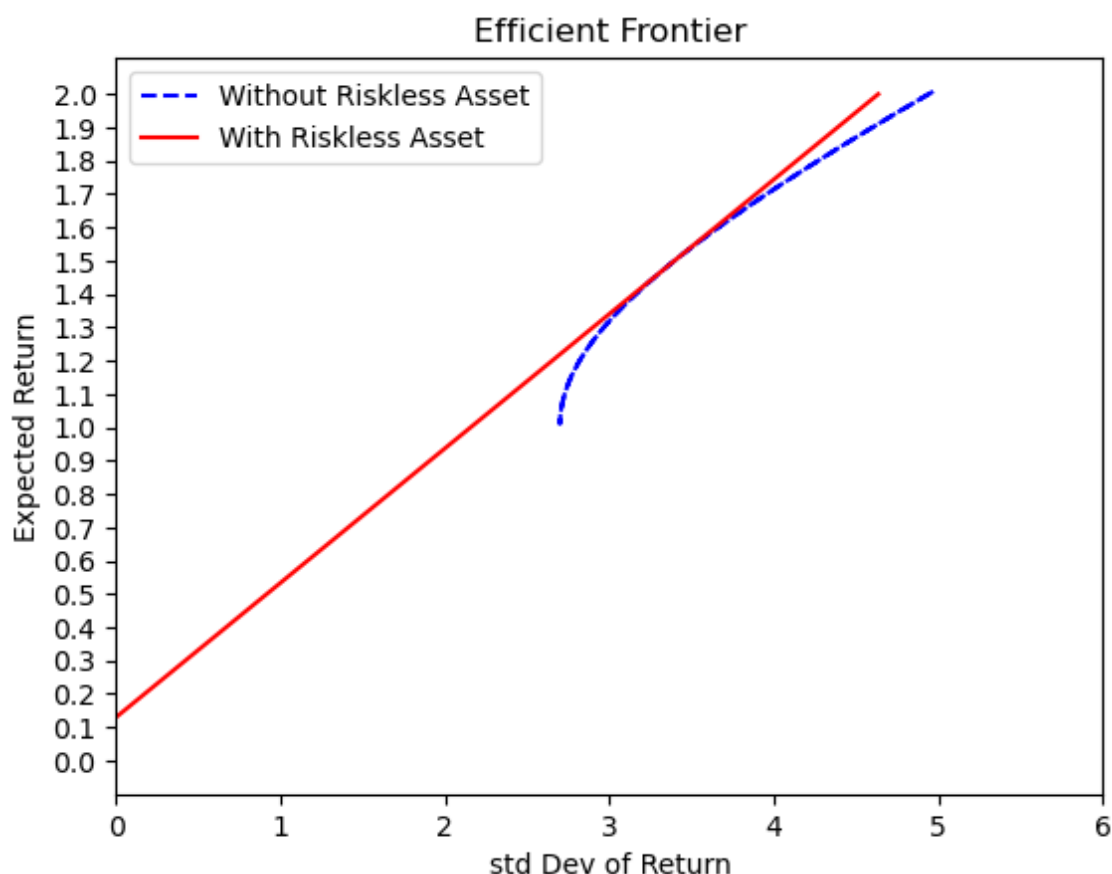
2. Now suppose that the (net) risk-free rate is 0.13% per month:

2.1. Plot the efficient frontier (with the riskless asset) on the same graph as the minimum-variance frontier generated by the ten industry portfolios.

In [32]:

```
plt.plot(sigma_p, R_p, color='blue', linestyle='--', label = "Without Riskless Asset")
plt.plot(sigma_p_riskless, R_p_riskless, color='red', linestyle='-', label = "With Riskl

plt.yticks(np.arange(0, 2.1, 0.1))
plt.xlim(0,6)
plt.xlabel('std Dev of Return')
plt.ylabel('Expected Return')
plt.title('Efficient Frontier')
plt.legend()
plt.show()
```



2.2. Briefly explain the economic significance and relevance of the efficient frontier to an investor.

Efficient frontier consisting of portfolios with highest mean return for given amount of risk, an investor can maximise his/her expected utility by choosing optimal portfolio where indifference curve is tangent to frontier.

3 The two frontiers will intersect at single point: the tangency portfolio:

3.1. Calculate the Sharpe ratio for the tangency portfolio, and also the tangency portfolio weights for the ten industry portfolios.

In [34]:

```
sharpe_ratio
```

Out[34]:

```
0.4035655993495088
```

In [36]:

```
w_star
```

Out[36]:

```
NoDur    0.567972
Durb1    -0.214073
Manuf     0.714105
Enrgy     0.104087
HiTec    -0.363438
Telcm    -0.095463
Shops     0.991647
Hlth      0.075570
Utils     0.132643
Other    -0.913051
dtype: float64
```

3.2. Briefly explain the economic significance and relevance of the tangency portfolio to an investor.

Risk-averse investors prefer to hold risky portfolio(tangency portfolio) with highest possible "reward-to-risk" ratio.

